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C.D. Howe Institute COMMENTARY

FISCAL POLICY

Greater Saving Required:

How Alberta can Achieve Fiscal Sustainability from its Resource Revenues

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In this issue...

How much to set aside? Alberta needs to set aggressive savings targets for its resource wealth if it is to achieve intergenerational equity and fiscal sustainability.

The Authors of This Issue

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The Study in Brief

The challenges that come with an abundant supply of resource wealth present difficult fiscal decisions for the Alberta government. One highly publicized concern is the need for the province to devise a long-run plan for resource revenue savings. This study focuses on the appropriate measures that fiscal planners must take to ensure the province's long-term fiscal sustainability. The study uses a forward looking model, taking into account the resource revenues Alberta can expect from its energy future, and targets the equal distribution of government spending from resource wealth across current and future generations of Albertans. The results of the model are compared against the province's current ad-hoc budget rules to illustrate the fiscal consequences of spending too much resource wealth upfront and not saving enough for generations to come.

We find that Alberta's current annual level of savings should be even more aggressive than the Norway standard. The province should amalgamate its savings funds; broaden the debate on the true impact of resource wealth on annual budgets – through personal and corporate income taxes in addition to royalties and leases – and aim to distribute the province's per capita spending from resource wealth equally over time.

Alberta has enjoyed unprecedented prosperity thanks to the recent run-up in oil and natural gas prices. Between 1999 and 2006, direct resource revenues accruing to the government increased 152 percent, program expenditures increased 80 percent and the government paid off all outstanding debt.[1]

Nonetheless, this state of affairs rests on a precarious foundation of volatile revenues from an exhaustible resource base. For this reason, many Albertans are asking whether the province has saved enough for the future. This question has taken on particular importance in light of recent media reports about the successful example of Norway, an oil-rich country that places more emphasis on saving its resource revenues than Alberta.[2] In order to address these concerns, we will focus in this *Commentary* on the following four questions:

- Has Alberta saved enough to date?
- What level of spending out of resource wealth is sustainable, moving forward?
- What are the implications of such a sustainable policy for provincial budget planning?
- Should Alberta follow Norway's example?

To answer these questions, policymakers must first identify the principles that should guide fiscal policy over the long run. In recent years, the concept of sustainability has emerged as one such principle.

Economists define fiscal sustainability in terms of the Permanent Income Model, first proposed by Milton Friedman in the 1950s. In recent years, researchers working at the International Monetary Fund have adapted this model for resource-rich jurisdictions in a version we call the Permanent Resource Income Model (PRIM). In simple terms, PRIM identifies the highest level of annual government spending that can be financed indefinitely from resource wealth, given what is known and expected about the resource endowment.

We argue that this level should be calculated in per capita terms in order to balance competing objectives of intergenerational equity, economic efficiency and fiscal prudence. The model deals with the eventual exhaustion of the resource base by building up sufficient financial wealth to provide an alternative stream of future income.

Applying the model to Alberta yields the following answers to our four questions:

- Alberta has, in fact, saved more than enough to date compared with a hypothetical sustainable policy implemented at the beginning of oil and gas exploitation in 1948.
- Notwithstanding this positive result, the province must now begin an aggressive savings policy if it wishes to sustain a constant level of per capita expenditure in the future. In particular, given our reference forecast of future revenues, the government must aim to save an amount equal to 139 percent of direct resource revenues over the next five years. Failure to meet this target will lead to a permanent decline in fiscal capacity this century, as the resource base and revenues diminish.[3]
- Alberta's *Fiscal Responsibility Act* provides for less than half the savings called for during the next five years, and its relative performance will deteriorate beyond that point. While further increases in resource royalties may help, our analysis suggests that the government will also have to undertake a combination of

The authors would like to thank Finn Poschmann, Robin Banerjee, Bev Dahlby, Yvan Guillemette and Maciej Kotowski for their helpful comments on earlier drafts.

1 Figures based on data from Alberta (2007).

2 See, for example, Saunders (2008) and Scoffield (2006).

3 Our forecasts show the resource base being depleted in 2095.

spending cuts and increases in non-resource tax levels.[4]

- The Permanent Resource Income Model is conceptually different from the approach followed by Norway. In particular, while PRIM seeks to equalize per capita spending over time, the Norwegian approach contains an explicit bias in favour of future generations. Nonetheless, under present circumstances, PRIM actually calls for Alberta to save more than the Norwegian approach, not less.

Beyond specific targets and values, PRIM provides the ground rules for a process of sustainable fiscal planning that any jurisdiction can follow. At its centre is the idea that government expenditure based on resource wealth should be smoothed out over time so that all citizens share equally in the resource bounty.

In contrast, current debates over resource-wealth spending usually revolve around the government's short-term record. In this vein, Alberta has in recent years legislated fiscal rules to eliminate deficits and constrain the budgeting process.[5] While these rules have proven useful as statements of the government's budgeting priorities, they are, in general, too ad hoc to provide long-lasting guidance on fiscal policy. Indeed, their history is one of constant revision as new developments render yesterday's rules obsolete. Unfortunately, repeated revisions have led to increased complexity, including a proliferation of savings funds. This complexity has reduced the transparency of the budgeting process and does not serve Albertans well.

The Permanent Resource Income Model, however, provides a comprehensive and clear framework for guiding long-term fiscal policy. The model supersedes all other fiscal rules. It also calls for the consolidation of Alberta's various savings funds, thus increasing the transparency of the budgeting process and the public accounts.

Fiscal Sustainability

The debate over managing resource revenues revolves around the following key questions: how much should be saved in any given year? and how much should be spent for the immediate benefit of citizens (i.e. program spending)? By saving, we mean payment of interest or principal, if the government is a net debtor, or accumulation of financial assets, if it is a net creditor.[6]

We interpret sustainability to mean that a given policy can be continued at the current level indefinitely. It follows that sustainability requires a shift of focus from the short term to the long term. Short-term thinking about fiscal policy revolves around the current budget balance. In contrast, long-term thinking focuses upon the government's total wealth — in particular whether this wealth is adequate to support a long-term fiscal plan of which the current budget balance is only one element. For this purpose, the government's total wealth consists of two components: its financial position (the difference between assets and liabilities); and the present value of future revenue streams.

Economists interpret fiscal sustainability in terms of the Permanent Income Model of budget planning, originally developed by Friedman (1957). Permanent income is defined as the annuity value of total wealth. In effect, it is as if the government could invest its total wealth (including the rights to future streams of revenue) in the bond market and receive an annual return on the investment. Permanent income indicates the amount that can be spent in a year consistent with maintaining total wealth constant.[7] Spend

4 Our estimation of the sustainable benchmark already takes into account the increases in royalty rates announced following the 2007 Alberta Royalty Review Panel.

5 See Kneebone (2006) for a history of such rules in Alberta.

6 We include debt interest payments in the saving envelope, although it is conventional to account for them as current expenditure. Interest payments represent a transfer from taxpayers to bond holders and thus do not provide a net benefit for society in the period in which they are made.

7 In fact, following Engel and Valdes (2000), what we have here is a special case of the Permanent Income Model in which the agent's subjective discount rate is equal to the (exogenous) real interest rate.

more than this amount and wealth will fall; spend less and wealth will grow. Thus permanent income corresponds with the maximum annual spending level that can be maintained indefinitely, assuming nothing changes.

When assessing fiscal sustainability for resource-based economies, economists typically narrow the focus of the model to resource-based wealth only; i.e., financial assets plus the present value of future resource revenues.[8] For this purpose, we denote spending from resource wealth[9] as G^R. We take the view that all Albertans, including those yet to be born, are entitled to an equal share of resource-based spending. Therefore, we define fiscal sustainability in terms of the maximum constant value of G^R per capita. By definition, this value is equivalent to permanent resource income per capita, which is the annual return on per capita resource wealth.

In a given year, resource revenue may be less than or greater than G^R. If less, then the difference is covered by either investment income or borrowing. If greater, the surplus is savings. The role of borrowing springs from the fact that resource revenues do not, in general, flow at a constant rate. In particular, if revenues start out low at the beginning of extraction and increase over time, the Permanent Resource Income Model entails borrowing against future revenues at the outset, then paying off the debt and building positive wealth later when revenues are greater. This way, all generations can enjoy the same level of spending per capita from the resource base, despite variations in the revenue flow. In the long run, it is important to build significant financial wealth to provide a base for continued spending once the resource base is exhausted. Thus, over time, the flow of resource revenue is replaced by a flow of investment income, as in-ground wealth is converted into financial wealth.

This blending of borrowing and saving is analogous to household financial planning. When income is temporarily low, the household may borrow against future earnings; when income is unexpectedly high, the household may save the surplus. And, ultimately, the household will probably wish to accumulate adequate financial wealth to provide for spending during retirement. In this context, debt is not a bad thing, because it is manageable within a long-term plan.

There are, however, other perspectives on fiscal sustainability. Tersman (1991), for one, defines sustainability in terms of a constant ratio of G^R to non-resource GDP. Assuming non-resource GDP grows over time, this rule entails that G^R grows at the same rate. Further, if non-resource GDP grows faster than the population, it follows that G^R must also grow faster than the population. While such growth may seem attractive, it comes with a price. In particular, compared with the constant path we propose, G^R per capita in Tersman's framework must start out lower, with more of the resource revenue saved in every period. Consequently, this growth in G^R per capita benefits future generations at the expense of early generations. In light of the fact that future generations will also benefit from higher non-resource GDP per capita in this scenario, we see no ethical basis for skewing resource-based spending in their favour as well.

Engel and Valdes (2000) point out that even constant G^R per capita may be too generous for future generations since, as mentioned, they will likely benefit from higher non-resource GDP per capita. With this in mind, they propose that resource wealth be used to compensate earlier generations for lower non-resource incomes. This approach entails a declining path of G^R per capita.[10]

Fiscal policy must also take into account the impacts of taxation and uncertainty. A constant or declining path of G^R per capita must be accompanied by an increasing path of non-

8 See, for example, Tersman (1991), Liuksila et al. (1994), Davoodi (2002) and Barnett and Ossowski (2002).

9 We use spending out of resource wealth, resource-based spending, resource spending and resource expenditure synonymously.

10 Engel and Valdes present two such models. The first is a full application of the permanent income approach, in which the government uses taxes and transfers to achieve a constant level of total spending (private plus public) per capita over time. In the second, which they call the "conditionally normative model," the government does not touch the intergenerational distribution of private spending (consumption in their vocabulary), but rather uses resource revenues to top-up the spending of early generations, because they are poorer in terms of private spending.

resource tax rates if, as expected, the per capita demand for public goods grows in step with per capita GDP. Such increases in tax rates have a cost in terms of greater economic distortion. Economists argue that stabilizing tax rates over time — a condition known as "tax smoothing" — can minimize the distortionary cost of taxation.[11] But stabilizing tax rates would require a constant G^R/GDP ratio, rather than constant or declining G^R per capita.

Uncertainty complicates fiscal planning further. The Permanent Resource Income Model generates a prescription for a constant level of resource expenditure, provided nothing changes. In reality, however, most of the relevant factors, including resource prices, extraction rates, costs and reserve size have proven to be quite volatile over time. Applied research uses a "certainty equivalent" approach, in which expected values of variables are treated as certain values in the solution of the model, and no other adjustments for uncertainty are made.[12] This approach is followed here. However, theoretical research indicates that risk-averse agents respond to uncertainty by saving more than the certainty equivalent level, a phenomenon referred to as "precautionary saving."

To summarize, we have identified three arguments for deviating from our rule of constant G^R per capita. First, the equity argument: since early generations will likely be poorer than future generations, we should skew G^R in the the former's favour. Second, following the theory of tax smoothing, we should maintain a constant G^R/GDP ratio to keep tax rates constant and minimize related distortions. In contrast to the equity argument, this approach calls for skewing G^R in favour of future generations. Third, precautionary savings requires more saving and less spending than certainty equivalence, thus skewing G^R in favour of future generations compared with our rule.

Accounting formally for these three arguments is beyond the scope of this Commentary. However, we note that our model's deviation on the first item is opposite to its deviations on the second and third items. Thus, the deviations may be at least partially offsetting. Further, we note that Alberta's tax system is among the least distorted in Canada, with flat tax rates of 10 percent on both personal and corporate income and no provincial consumption tax.[13] Thus, the argument for tax smoothing may be weaker for Alberta than elsewhere. Since equity and efficiency are pulling policy in opposite directions here, a rigorous approach would require finding an optimal balance, which of course would lie somewhere in the middle. It is possible that our constant G^R per capita rule may not be far off.

Finally, we note that, as a practical matter, uncertainty of future variables means that regular revisions of the fiscal plan will be necessary as new information becomes available. At a given planning date, the permanent income approach yields a prescription for a constant level of resource-based spending based on expected values of variables and assuming nothing changes. But of course conditions do change. In every planning period (e.g. next fiscal year), the exercise will need to be repeated, using realized values for the elapsed period and updated forecasts of future variables. In light of these changes, the prescribed level of resource spending would change as well. Thus, in retrospect the amount of per capita resource spending would be variable, while in any given year the plan would call for a constant value moving forward.

Historical Perspective: Has Alberta Saved Enough?

An essential part of the debate over resource management in Alberta concerns whether past governments have saved enough to provide for future generations once resource stocks run out. This question reflects a widely held belief, or at least suspicion, that too much of the finite resource wealth has been spent to date and not

11 Blanchard and Fischer (1989, 583-589) provide a discussion of the related literature.

12 See Tersman (1991), Liuksila et al. (1994) and Davoodi (2002) for examples of this approach.

13 See Chen, Mintz and Tarasov (2007).

enough saved.[14] This concern has been fuelled by numerous stories in the press (e.g. Scoffield 2006, Saunders 2008) comparing Alberta's approach with that of Norway, which places a greater emphasis on saving.[15]

This question appears to be backward looking, as it concerns whether governments have made appropriate decisions in the past. However, upon examination, it is apparent that one cannot answer this question without also taking into account probable conditions in the future. One needs a roadmap of where Albertans want to go — or more precisely a statement of what future citizens have a right to expect — in order to assess whether adequate provisions have been made in the past. The Permanent Resource Income Model provides such a roadmap.

Alberta has saved more than enough of its resource wealth to date, compared with our benchmark.

For this purpose, we suggest a "perfect foresight" approach, in which past values are taken as given and forecast values are assumed to be certain. This approach amounts to a thought experiment, in which spending and saving decisions are retrospectively calculated from 1948 through to the end of extraction, following the model.[16] Of course, the government of Alberta was not in this position in 1948, since it most certainly could not foresee the paths of prices, reserves, extraction and other variables. Nonetheless, one can ask whether by accident the government saved as much as prescribed by this hypothetical scenario.

As described previously, the task is to calculate the annuity value from the government's total wealth, which consists of current financial assets plus the present value of future resource revenues. Estimating future resource revenues requires forecasts of key variables, including resource prices, reserves, extraction rates, royalties, interest rates, inflation and population. We have based our forecasts on the leading authorities in the field, including the International Energy Agency (IEA), the Energy Information Administration (EIA) of the US Department of Energy, the Canadian Association of Petroleum Producers (CAPP) and others. We consider high, medium and low forecasts associated with these variables. The medium case is the most likely, and we refer to it henceforth as the reference forecast. (Appendices A and B describe the data we use and the mechanics of the PRIM.)

Based on the PRIM, we estimate that, under the reference forecast, a perfectly foresighted planner would have fixed G^R at a constant value of $3,576 per capita, starting in 1948, and would have carried a net debt of approximately $74 billion at the beginning of the 2007/08 fiscal year.[17] In contrast, the province managed a positive net financial holding of $35.7 billion by that year. Thus, we conclude that Alberta has saved more than enough of its resource wealth to date, compared with our benchmark.

The high level of debt prescribed under "perfect foresight" for 2007 results from the unequal flow of resource revenues over time. Figure 1 presents the paths of total resource revenues, budget balances under perfect foresight (PRIM) and actual budget balances for the planning horizon 1948-2095.[18] As shown, most of Alberta's resource revenues are expected to be realized after 2005.[19] Thus, our hypothetical

14 For many expressions of this point of view, see the submissions to the Alberta Royalty Review Panel at www.albertaroyaltyreview.ca

15 We provide a detailed analysis of Norway's approach later in the paper.

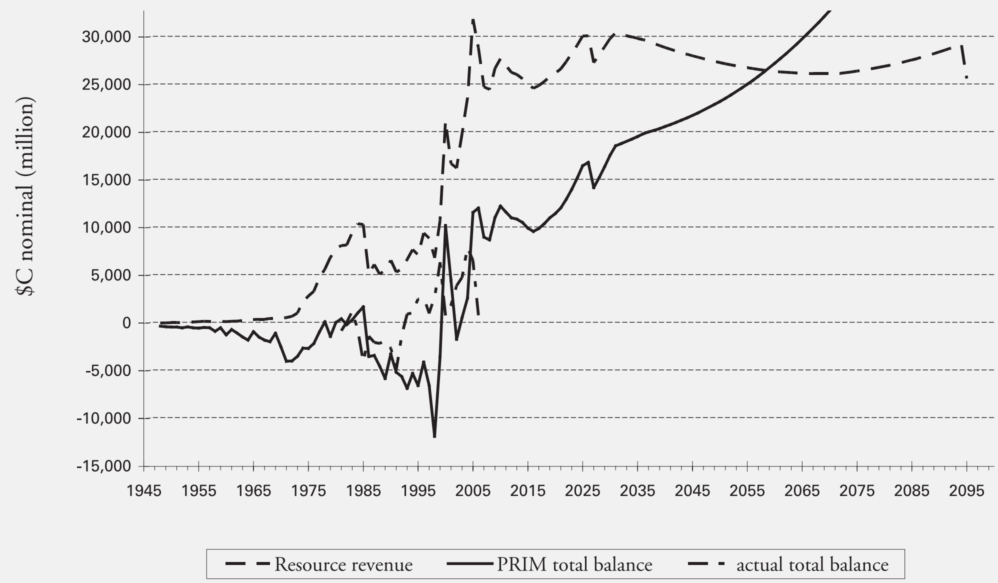
16 See Tersman (1991), Liuksila et al. (1994) and Davoodi (2002) for examples of this approach.

17 Except where noted, all monetary values are in 2007 dollars.

18 We are referring here to the consolidated budget of the province, including all saving funds. This version differs from the common notion of the government's budget, which corresponds with the General Revenue Fund. Note our numbers for the actual budget balance (as opposed to PRIM) only cover the sub-period 1981-2007.

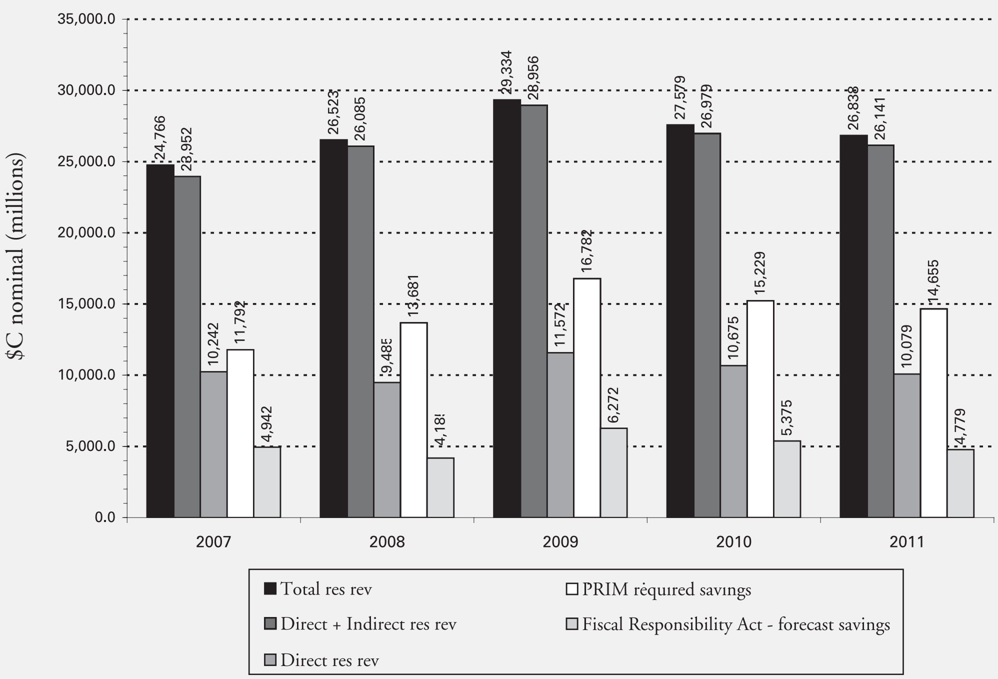
19 As the figure presents nominal values, inflation accounts for some of this skew in the flow of revenues. Of course, inflation works to the advantage of debtors as it erodes the value of debt principal. The brief decline and recovery of revenues during 2026-2031 reflects the forecast exhaustion of conventional oil and natural gas in 2026, followed by the forecast peak in revenues from the oil sands in 2031.

Figure 1: Revenue and Savings



Source: Authors' calculations based on reference forecast; Alberta Budget Documents.

Figure 2: Revenue and Savings (forecast vs. required)



Source: Author's calculations using reference forecast.

1948 planner borrows against future earnings until 1999 (with minor exceptions), in order to finance spending in these early years. Then, from 2000 to 2013, the planner pays off debt. Finally, the planner begins to accumulate net wealth in 2014.[20] In contrast, the actual experience of the province to date has involved more frequent surpluses, as evidenced by the positive value of net wealth in 2007 ($35.7 billion) and by the actual budget balance series shown in the figure (1981-2007 only).

Looking Forward: a Sustainable Policy for Resource Revenues

The fact that Alberta has accumulated more wealth to date than required under the "perfect foresight" scenario allows it to sustain a more generous level of G^R per capita moving forward. Starting in 2007/08, based on net financial wealth of $35.7 billion, the model returns a G^R value of $4,501 per capita in the reference case (roughly $900 more per capita than for the historical perspective).

This plan requires a significant increase in the government's savings rate starting immediately, notwithstanding its superior performance in the past. To illustrate, Figure 2 compares resource revenues during the five years from 2007-2011 (reference forecast) with the budget surpluses required by the model ("PRIM required savings"), and with the forecast budget surpluses under current fiscal rules ("*Fiscal Responsibility Act* — forecast savings").

Figure 2 presents both total and direct resource revenues. As explained in Appendix A, we classify resource revenues as direct, indirect or diversified. Direct revenue is equivalent to the line item labelled "resource revenues" in the public accounts, which includes royalty taxes, Crown land leases, rentals and fees. Indirect revenue corresponds with all other tax revenues generated by oil, gas and related sectors in the province — for example, corporate and personal income taxes. Diversified revenue corresponds with taxes paid by upstream and downstream firms that have diversified away from reliance on the domestic oil and gas sector. For example, firms that started by servicing the oil and gas sector may eventually find clients outside the province or in unrelated domestic sectors. Although no longer generated by domestic oil and gas activity, these revenues are still classified as resource revenues since they would not have come about without the impetus provided by the resource sector.

As shown in Figure 2, the required savings under PRIM exceeds direct resource revenues by a significant margin. In particular, for the five years 2007-2011, the cumulative surplus under PRIM amounts to 53 percent of total resource revenues and 139 percent of direct revenues — i.e., more than one-third greater than the cumulative value of resource royalties, land leases, rentals and fees. Furthermore, these proportions are set to increase progressively beyond the dates shown in the figure.

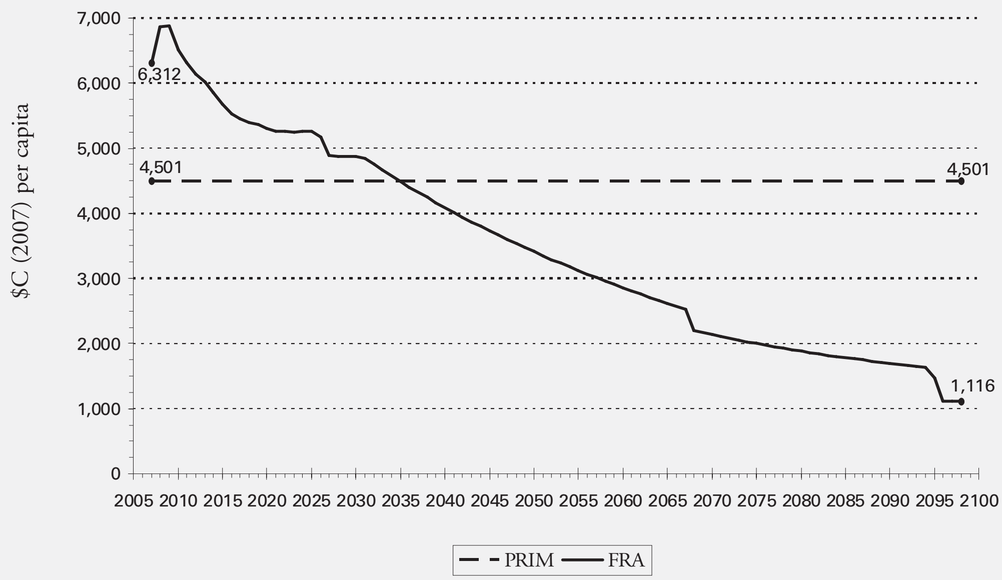
The *Fiscal Responsibility Act* of 2007 (FRA) establishes the province's current policy toward saving. Under the FRA, the first $5.3 billion of direct resource revenues are to be allocated to current spending, with the remainder saved. Figure 2 shows the estimated size of the remainder based on our reference forecast of resource revenues.[21] For the five years shown, cumulative savings under FRA amount to only 36 percent of the level prescribed by PRIM (alternatively, 48 percent of direct resource

This plan requires a significant increase in the government's savings rate starting immediately, notwithstanding its superior performance in the past.

20 The series on net wealth is not shown in the figure.

21 As well, extra savings could come from unbudgeted surpluses. Thus, the values presented in Figure 2 represent a minimum expected level of savings under the FRA. However, we note that the In-Year Surplus Allocation Policy requires two-thirds of unbudgeted surpluses to be allocated to the Capital Account — in other words, on spending rather than saving. Also, the Sustainability Fund is currently not required to retain all deposits legislated by the FRA and can direct funds towards capital projects. This reduces the expected level of savings under the FRA.

Figure 3: Resource-based Spending under PRIM and the *Fiscal Responsiblity Act*



Source: Authors' calculations using reference forecast.

revenues). We conclude, therefore, that the current savings commitment is insufficient to maintain a constant level of G^R per capita in the future, under the reference forecast. This conclusion is supported as well under high and low forecasts of the variables as shown in Appendix C.

We can also forecast the effect of the *Fiscal Responsibility Act* over the long term (Figure 3, reference forecast). Initially, the lower savings rate under the FRA produces higher G^R per capita than the PRIM benchmark, but the spending level declines steadily. By 2034, resource spending under the FRA falls permanently below the benchmark. By 2095, when the resource base is exhausted, the spending level under the FRA is only 25 percent of the PRIM benchmark. This level is sustained thereafter by interest on accumulated savings and by the flow of diversified revenues (assumed constant after exhaustion).[22]

By 2068, direct resource revenues (not shown) fall permanently below the $5.3 billion threshold, and no further saving of resource revenues is undertaken under the FRA. At this point, we assume the government would adopt a minimalist wealth preservation strategy by saving enough of investment income every year to inflation-proof the accumulated fund. The remainder of investment income under this strategy is spent.

Figure 3 highlights the choice Albertans must make between a sustainable policy of resource-based spending and the current policy that favours present over future generations. We summarized earlier the debate among economists over skewing resource expenditure in one direction or another (the equity argument versus tax smoothing and precautionary savings). Following Engel and Valdes (2000), one could justify the FRA policy on the basis of equity, provided that non-resource GDP per capita grew

22 In the absence of diversification, the long-run expenditure level would be lower under both PRIM and the FRA.

in an offsetting fashion. However, as discussed, tax smoothing and precautionary savings pull policy in the opposite direction.

Moreover, while non-resource GDP may indeed grow in the future, it is doubtful that it will grow quickly enough to fully compensate for the decline in G^R under the FRA. We forecast that decline at an average annual rate of 1.88 percent (real) in the reference case. Given the difference in size of the resource and non-resource sectors, it is likely that non-resource GDP would have to grow faster than 1.88 percent to fully offset the lost resource revenues. For example, for the 25-year period from 1981-2006, we estimate that Alberta's resource-based GDP was on average 35 percent larger than its non-resource GDP.[23] It follows that the annual growth rate of non-resource GDP per capita would have to be 35 percent larger than this decline rate — i.e., 2.54 percent. Yet the average real growth rate of non-resource GDP per capita in Alberta during this period was only 1.2 percent per annum.[24] Moreover, this rate is set to erode as the labour force participation rate drops with the aging of the population. Thus, there is ample reason to doubt that non-resource growth could fully compensate for the decline in G^R entailed by the FRA.

Over the three years from 2007-2009, we forecast the shortfall of planned savings under the *Fiscal Responsibility Act* compared with the benchmark in our reference model will average $8.8 billion per year ($2007) — an amount equivalent to 26 percent of total expenditures planned for this period in Budget 2007. Part of this gap could be covered by unbudgeted surpluses, but part would undoubtedly have to be made up by either reductions in current expenditures, increases in resource tax rates or increases in non-resource tax levels.[25]

Resource tax rates include royalty rates (direct resource revenues) as well as personal and corporate taxes on income earned in the sector (indirect resource revenues). While increasing these rates would generate more revenue if nothing else changed, in reality it would also produce a number of offsetting effects. First, higher resource taxes would boost the government's wealth by increasing the present value of future resource revenues. As a result, the prescribed level of G^R per capita would increase as well. This change would require either more or less saving, depending where the government was at in the borrowing/saving cycle of the model (less saving early on, more saving later). Second, increasing resource taxes would have a dampening effect on activity in the sector, an effect that was hotly debated during the recent royalty review in the province.

While accounting for these effects explicitly is beyond the scope of the paper, we have conducted sensitivity analysis on the effect of higher royalty rates, holding everything else constant.[26] Our results indicate that while increasing royalty rates (increasing prices) does reduce the savings gap (111 percent of direct revenues versus 139 percent), it does not come close to eliminating it. Therefore, we expect that the government would also have to pursue reductions in expenditures as well as increases in non-resource tax rates to close the savings gap.

The prescribed policy provides a level of per capita expenditure based on resource wealth that could be sustained indefinitely if the forecast proved to be true. The key to sustainability is the gradual replacement of resource revenues with income from accumulated savings. Figure 4

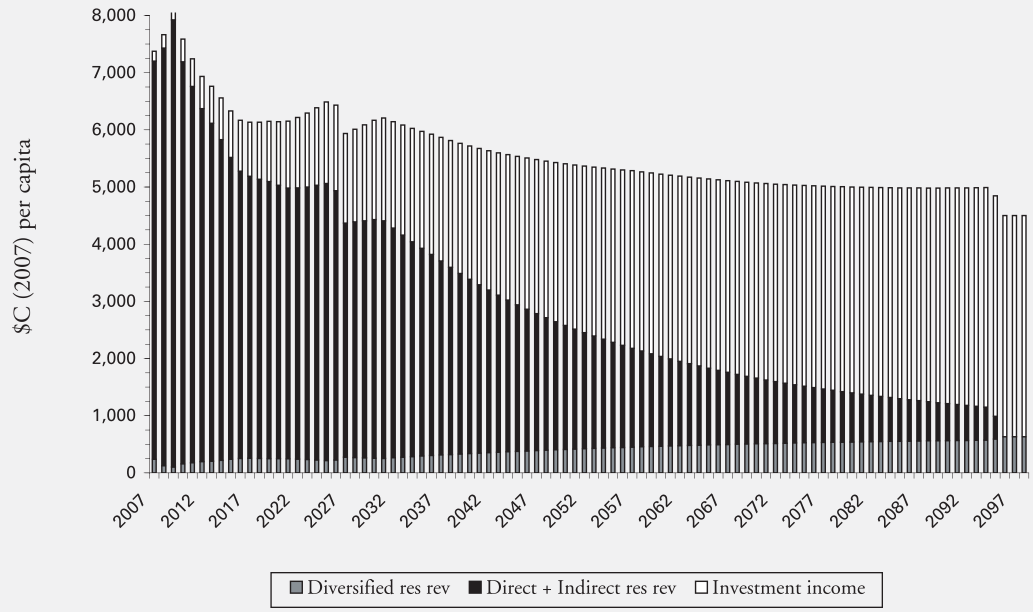
23 We focus on private GDP; i.e., net of government expenditure. Mansell and Shlenker (2006) estimate resource activity accounts for approximately 50 percent of Alberta GDP.. Therefore, multiplying GDP values (Statistics Canada, CANSIM V3839827) by 0.5 and subtracting total government expenditure (Alberta budget documents) yields private non-resource GDP.

24 In neighbouring British Columbia, the growth rate for total GDP per capita during this period was even lower, at 0.9 percent per annum (real). Statistics Canada, CANSIM V3839831.

25 Our reference forecast already makes provision for the announced increases in resource royalties in response to the Alberta Royalty Review Panel.

26 The results of the sensitivity analysis are presented in Table C1, Appendix C. We model an increase in resource royalty rates as equivalent to an increase in resources prices holding royalty rates constant.

Figure 4: Sources of Resource-based Income



Source: Authors' calculations using reference forecast.

illustrates this replacement process for the reference forecast. Initially, investment income amounts to only a few hundred dollars per capita, while resource revenue amounts to more than $7,000. By 2048, the two amounts are equal. By the end of our horizon, investment income accounts for approximately 86 percent of the total value of GR per capita ($4,501). The remaining 14 percent ($633) consists of diversified resource income, which we assume continues at a constant level after the exhaustion of the resource base.[27]

The Bird-in-the-Hand Approach: Should Alberta Follow Norway's Example?

Much discussion in recent years has focused on whether Alberta should follow Norway's example of saving a larger share of its resource wealth.[28] Bjerkholt and Niculescu (2004) refer to this as the Bird-in-the-Hand approach (BIH), because it does not treat resource revenue as part of the government's wealth until the resource is extracted and the revenue is realized. In this approach, the government's wealth consists solely of current financial assets. Resource revenues are to be saved in a fund, and only the income on the fund is made available to the government for spending in its annual budget.

Norway began managing its oil revenues in this fashion in 1991. Since then it has accumulated $368.2 billion in its saving fund, equivalent to approximately $78,000 for every Norwegian (Saunders 2008). Current legislation permits an annual transfer of four percent of the equity for spending in the government's budget, equal to the average expected rate of return of the fund (Bjerkholt and Niculescu 2004). At present, approximately 10 percent of the government's budget comes from this source (Saunders 2008).

27 Prior to exhaustion in 2095, the sum of resource revenues and investment income exceeds the value of GR per capita by the amount of savings (total budget surplus). In our low variant of the forecast, diversified revenues are zero and investment income equals 100 percent of GR after exhaustion. See Appendix C for the presentation of the various forecast scenarios.

28 See for example Saunders (2008), Scoffield (2006) and ARRP (2007).

Alberta also has a vehicle for saving resource wealth, the Alberta Heritage Savings Trust Fund — commonly referred to as The Heritage Fund. Established in 1976, it grew to $12.7 billion by 1987, but no further deposits were made until 2005. It now stands at $16.6 billion, or approximately $4,900 per Albertan (AHST 2007, 2008 and Statistics Canada). In contrast, since 1976, the province has received a total of $148.1 billion in direct oil and gas revenues and an estimated $330.7 billion in total revenues (direct + indirect + diversified). During the same period (1976-2007), direct oil and gas revenues (net of deposits into the Heritage Fund) accounted for 29 percent of current government spending, while total revenues (net of deposits into the Heritage Fund) accounted for an estimated 69 percent of current spending. Finally, investment income received from the Heritage Fund accounted for an additional six percent of spending (Boothe 1995, Alberta budget documents and authors' estimation).

Arguments that have been put forward in support of the Bird-in-the-Hand approach include inter-generational equity, precautionary savings and maintaining competitiveness in manufacturing and other non-resource sectors (avoidance of the so-called "Dutch disease").[29] The equity argument in this case differs from the one discussed earlier (i.e. skewing G^R in favour of present generations to compensate for lower non-resource GDP). In this case, equity reflects the perception that current spending of resource revenue is wasteful by definition, while saving is far-sighted and disciplined. Precautionary saving, as above, responds to the possibility of negative shocks, such as a sudden downturn in resource prices or an adverse shock to the non-oil economy. Similarly, the prospect of increasing government obligations for health care spending in an aging society would seem to recommend saving more for the future.

The Dutch disease phenomenon consists of two effects, one operating through the currency and the other through aggregate demand. The first effect involves the appreciation of the local currency, due to the impact of export revenues. The higher exchange rate makes imported goods cheaper than those manufactured at home, thus undermining the competitiveness of the domestic manufacturing sector. The second effect involves the potentially inflationary impact of high government spending when it is financed by resource revenues rather than taxation. If inflation feeds through to wage levels, competitiveness is again undermined. The BIH approach limits these effects, provided the equity of the savings fund is held in foreign assets, as is the case with Norway. This practice limits the pressure on the domestic currency by limiting the annual inflow of revenue. In the same way, the inflationary impact of government spending is restrained.

We believe that most of these arguments either go too far in favouring future generations or do not apply fully to Alberta. Barnett and Ossowski (2002) describe the Bird-in-the-Hand approach as "an extreme form of precautionary savings, in that it is tantamount to assuming that there would be no future oil revenues" (p. 9). Such an outcome would occur, for example, if there were a sudden, permanent collapse in the price of oil. But since the likelihood of such an outcome is extremely small, the BIH approach is excessively cautious. Further, as we will show below, the BIH approach in its pure form entails an extreme bias in the allocation of resource benefits in favour of future generations.[30]

In terms of Dutch disease, we note that, as one province in a large federation, Alberta's influence on the Canadian dollar is more limited than it would be if, as Norway, it were a national economy with its own currency. Further, labour mobility within the federation helps moderate wage pressures, compared with what they would be otherwise. Historically, there has been scant evidence of an adverse impact on non-resource sectors in Alberta. Indeed, one could argue that a diversified economy did not substantially exist in

29 See Saunders (2008), Scoffield (2006) and Bjerkholt and Niculescu (2004).

30 York (2008) provides a telling illustration of the future bias of BIH in the context of East Timor.

Alberta prior to the discovery of oil and gas, and it is the exploitation of these resources that has stimulated the development of manufacturing in upstream and downstream industries. More recently, manpower shortages and wage pressures have started to resemble the symptoms of Dutch disease. Yet these results are clearly due to the investment boom in the oil sands rather than the government's fiscal policy.

Therefore, we conclude that the Bird-in-the-Hand approach does not provide a compelling framework for guiding fiscal policy. Nonetheless, some of the arguments above have validity in terms of savings funds in general. To the extent that the recent surge in the Canadian dollar may be partially due to increased exports of oil and natural gas, holding the equity of the fund "offshore" — i.e., in foreign assets — could provide some benefit by reducing upward pressure on the dollar.[31] Similarly, any savings plan would by definition restrain government spending, thereby moderating potential inflationary pressures.

In any case, using 2007 as a starting point, the Permanent Resource Income Model actually calls for more saving than BIH in all but the most optimistic scenarios, if one follows the Norwegian approach of saving only direct resource revenues.[32] In other words, using realistic assumptions, Alberta should not follow Norway's example, but in fact it should save more.

To illustrate, we consider both pure and practical applications of Bird-in-the-Hand under the reference forecast (Figure 5). The pure application would save both direct and indirect resource revenues,[33] while the practical (Norwegian style) application focuses only on direct revenues. We apply a transfer rate of 3.5 percent to the fund equity – this amount of investment income is transferred each year to the government's budget for spending. This rate is equal to our reference forecast for the real return on investment.

The extreme future bias of the pure BIH approach is evident. As argued above, we do not find such a bias to be ethically compelling. Moreover, the savings commitment for this version of BIH is extreme. As was shown in Figure 2, the sum of direct and estimated indirect revenues is only slightly less than total resource revenue. During the three years 2007-2009, this sum amounts to approximately 77 percent of the forecast for total government spending provided in Budget 2007 and 2.5 times the value of direct resource revenues. In political terms, this savings plan would probably be impossible, even if it were desirable.

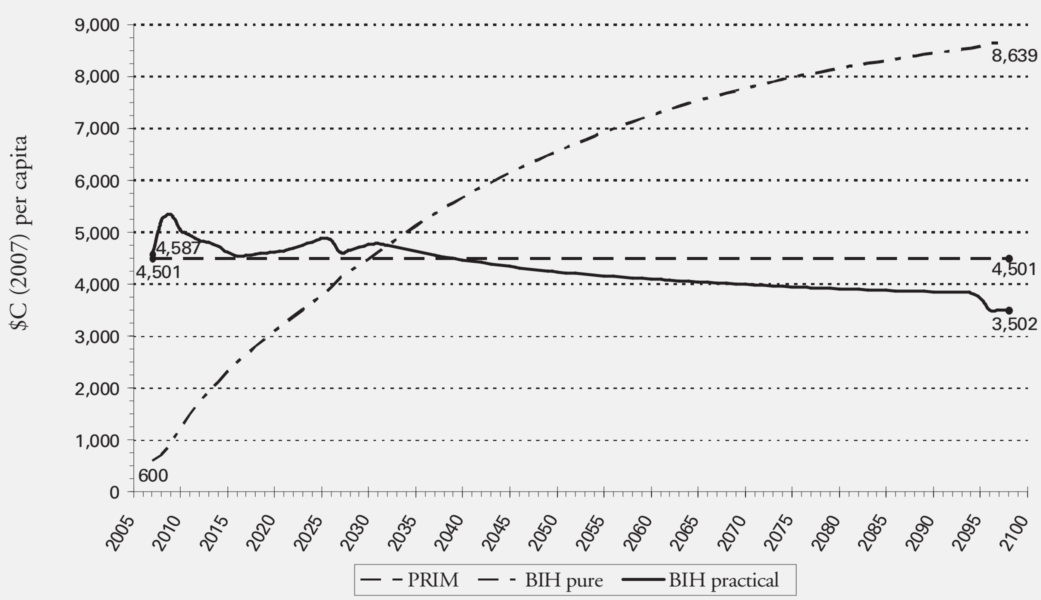
In contrast, the practical version of BIH (saving only direct revenues) projects a gradual downward trend in G^R per capita. While this trend is not so pronounced as under the *Fiscal Responsibility Act* and therefore perhaps more acceptable (compare Figure 3), we note a tendency for fluctuations in the first 25 years of the plan that cannot be justified in terms of any meaningful economic or social objectives. This outcome results from the arbitrary decision to limit savings to a particular category of revenue rather than focusing on a compelling long-term goal, such as sustaining G^R per capita. For this reason, as argued above, we favour the constant spending policy model (PRIM). As already discussed, this policy requires savings in excess of direct resource revenues — 39 percent more during the five years 2007 to 2011 under the reference forecast. In return, it results in a long-run value of G^R per capita that is approximately 29 percent higher than the practical (Norwegian) version of BIH ($4,501 versus $3,502 after 2095).

31 See Laidler (2008) for a discussion of the link between the Canadian dollar and resource prices. According to AHST (2008), just over 30 percent of the equity of the Heritage Fund was held in foreign-denominated investments, as of December 31, 2007.

32 See Appendix C for the sensitivity analysis.

33 It would not save diversified revenues, since these revenues are sustained after exhaustion of the resource. Unlike PRIM, which focuses on smoothing the benefits from all sources, BIH only saves revenues from exhaustible sources.

Figure 5: Resource-based Spending under PRIM and BIH



Source: Authors' calculations using reference forecast.

Reforming the Budgeting Process

Budget Planning

Our discussion leads to the following recommendations for changes to Alberta's budgeting process.

- Target a constant per-capita level of spending out of resource wealth.[34]
  Our estimate of G^R per capita in the reference case is $4,501. The sensitivity analysis (Appendix C) shows how this value varies with assumptions about the forecast.
- Pursue an aggressive program of savings, based on the model's estimates.
  In our reference case, required saving in the near-term (2007-2011) is equal to 139 percent of direct resource revenues. The sensitivity analysis (Appendix C) shows how this requirement varies with assumptions about the forecast. In the most plausible scenarios, the savings requirement is uniformly greater than direct revenues. In comparison, the current rule under the *Fiscal Responsibility Act* results in a savings rate (near-term) of less than 50 percent of direct resource revenues in the reference case. Clearly, the government has significant work to do in closing the gap between our recommended target and the existing policy. Achieving the target will require a combination of reductions in annual spending and increases in non-resource tax levels.
- Revise the plan regularly.
  As discussed, the estimate of a constant value of G^R per capita depends upon forecast values of future variables. As information changes, the forecast changes and, therefore, the estimated value of G^R must change as well. It follows that the goal of a constant value of G^R

34 In technical terms, this is known as the Non-resource Primary Deficit. See Appendix B and Busby (2008) for a discussion.

will only be realized in the hypothetical sense, within the context of a given year's plan. In reality, the attained value of G^R will vary from year to year as information — and thus the plan — changes as well.

Reporting and Data

Implementing this approach to budget planning calls for the following changes in the way the Alberta government reports its results and in the data available to budget planners and the general public.

- Consolidate the government's savings funds.
  A coherent approach to long-term fiscal planning requires a comprehensive view of the government's budget. The current practice of presenting "the budget" in terms of a single account (the General Revenue Fund) distinct from other funds and accounts (e.g., the Heritage Fund, the Sustainability Fund, the Capital Account, and the Alberta Heritage Medical Research and Endowment Fund) diverts attention from the big picture and makes a long-term focus difficult. The Permanent Resource Income Model assumes one comprehensive savings fund for financial assets and one current budget account.
- Publish estimates of indirect resource revenues in addition to direct revenues in the public accounts and budget documents.
  Currently, the government's financial reporting distinguishes only direct resource revenues from other forms of taxation. This presentation significantly underestimates the true level of revenues from natural resources and thus distorts the public's perception of the sources of government wealth. An informed public debate about the allocation of resource wealth over time requires full information about the amounts involved.
- Improve estimation techniques for indirect and diversified resource revenues.
  Unlike direct revenues, which can be easily identified through the accounting trail, estimating indirect revenues requires an economic modelling exercise in order to isolate the components of corporate and personal income taxes (and other taxes) that come from resource-based activities. Further research effort is needed to improve the available modelling capacity. This requirement is even more acute in relation to diversified revenues. Our current ability to estimate this category amounts to little more than educated guessing and yet, as demonstrated, these revenues play a key role in planning a coherent fiscal policy.
- Display long-term consequences.
  Budget debates typically focus on next year's total balance — i.e., whether the budget is forecast to be in surplus or deficit. In addition, the government produces a three-year plan with the budget. Yet, because non-renewable natural resources will run out, the consequences of spending resource revenues are permanent. Therefore, budget planners should present the expected consequences of current spending decisions in the short, medium and long-term. For example, our analysis of the *Fiscal Responsibility Act* above (Figure 3) shows in a simple and clear way that high spending today will permanently lower spending in the future, under the assumptions of the forecast. This type of information is essential for an informed public debate.

Conclusion

In this *Commentary*, we have sought to answer (i) whether the government of Alberta has saved enough of its resource wealth to date, (ii) what policy is sustainable, moving forward, (iii) what are the implications of this policy for current budget planning, and (iv) whether the province should follow Norway's example of saving all of its direct resource revenues. We concluded that although the government has saved more then enough to date, it now needs to embark on an aggressive savings program (139 percent of direct resource revenues during the five years 2007-2011 under the reference forecast) in order to sustain a constant level of per capita spending out of resource wealth. Indeed, in most scenarios, it must save more than the Norwegian standard, not less.

This result may seem somewhat paradoxical. On the one hand, the savings rate has been more than sufficient to date. On the other hand, the current requirement under the *Fiscal Responsibility Act* — which even on its own will take resource savings to new highs — nonetheless falls seriously short of what is needed to meet the sustainability benchmark in the future.

The explanation for this apparent contradiction lies in the very large scale of borrowing and saving entailed in the Permanent Resource Income Model. Unlike the Norwegian approach, the PRIM manages all three categories of resource revenues over time — direct, indirect and diversified. Given the large sums involved, the model generates very large targets, both for borrowing, when appropriate, and for saving. Our analysis of the historical question (starting in 1948) shows that Alberta has only recently passed the prescribed transition date from borrowing to saving (1999). The sudden swing from more than enough saving to grossly inadequate saving is consistent with the model.

We have followed a rather conventional, optimistic view of prospects for the oil and gas sector — one that foresees only moderate downside risks in terms of prices and revenues. In contrast, the possibility exists for major negative shocks. For example, the development of alternative technologies or stringent environmental standards could render the resource obsolete even before exhaustion. Alternatively, environmental degradation or resource scarcity may make future generations worse off than present. All these possibilities point to a heightened precautionary motive for savings.[35] Thus an argument can be made that our savings target — as aggressive as it is — perhaps should be viewed as a minimum threshold for current policy.

Planning for a sustainable fiscal policy is complicated by large uncertainties and approximation errors related to future oil and gas prices, recoverable reserves, indirect revenues, and diversification, among other things. Combined with the more garden-variety fluctuations in the economic environment, these factors suggest that the estimate of permanent income that underlies the model will constantly change. While this volatility is less than ideal, it is certainly not unusual in public affairs. For example, Canadians are accustomed to variability in the conduct of monetary policy, and we have developed significant institutional capacity and mechanisms to manage uncertainties in this context. Therefore, there is every reason to believe that stakeholders would be able to adapt to variability in the conduct of a sustainable fiscal policy. Provided the government updates its estimate of permanent income in a timely and transparent manner, the adoption of this approach should bring greater coherence and discipline to the formulation of fiscal policy than has been experienced to date.

35 On the other hand, we note that the most efficient approach to environmental and scarcity problems is to control them at the outset, rather than letting them get out of hand and then seeking to compensate victims after the fact.

Appendix A: Data

A1. Historical data

Horizon

Our historical analysis begins in 1948, which marked the beginning of major oil exploitation in Alberta and continues until fiscal 2006/07 inclusive.[36]

Direct resource revenues

We define direct revenues as those which are levied on the resource rather than the company. This category includes royalty taxes and Crown land leases. For practical purposes, we take it as equivalent to the Alberta Public Accounts line item labelled "resource revenues."[37] We have assembled this data from Boothe (1995) for the period 1948 to 1980 and from Alberta budget documents from 1981 to 2007. Due to the quasi-consolidation techniques applied by Boothe (1991, 1995), the values from 1976 to 1980 had to be increased to account for transfers to the Heritage Fund.

Indirect resource revenues

We define indirect resource revenues as all other tax revenues generated by the oil and gas sector in the province. This category includes: corporate income taxes paid by oil and gas firms as well as upstream and downstream firms (businesses that either service the sector or process its outputs); personal income taxes paid by employees of such firms; and other taxes and fees paid by households that derive their income from such firms. Indirect resource revenues are not distinguished by particular line items in the public accounts and, therefore, it is necessary to employ some method for estimating them from available data. The challenge is to extract the portion of revenues in these line items (e.g. corporate income tax, personal income tax) that can be attributed to oil and gas activities in the province.

An ideal approach would involve using a dynamic simulation model of the Alberta economy to counterfactually identify indirect resource revenues. Unfortunately, to the best of our knowledge, such a model does not exist. Mansell and Shlenker (2006) employ Statistics Canada's Interprovincial Input-Output Model to estimate the total impact of oil and gas extraction on Alberta's economy during the period 1971 to 2004, and we use their results as the basis for a simple multiplier showing the relationship between indirect resource revenues and activity in the oil and gas sector. The Interprovincial Input-Output Model is static in nature, which means that it is calibrated for a particular year — 2001 in the version used by Mansell and Shlenker.[38] Given the length of our time frame — 149 years from 1948 to 2095 — we opted against using the model directly.

We define the indirect revenue multiplier (IRM) as the ratio of the total value of indirect resource revenues in an average year to the total value of production of oil and gas (sales revenue) in the year.

36 The government's fiscal year runs April 1 - March 31, whereas our analysis employs calendar years. For simplicity, we attribute data to the first year of the split fiscal year, e.g., 2006 in the case of fiscal 2006/07.

37 One could quibble whether royalty taxes are levied on the resource or the company, since royalty formulas typically take into account much firm-related detail, including revenues and costs. However, in theory, the royalty represents a payment to the owner for the sale of the resource. Therefore, we classify it as a direct charge on the resource.

38 Statistics Canada has versions of the model available for the years 2000-2003.

During the same period, the cumulative value of direct resource revenue was approximately $126 billion. The $151 billion difference is the cumulative value of indirect resource revenues during this period.

CAPP (2007a) provides data on aggregate sales revenue per year for oil and gas in Alberta. The cumulative value of sales revenue for 1971-2004 was $710 billion. Thus, the baseline estimate of our multiplier is 0.213 (equal to 151/710). We then apply this multiplier to the sales revenue in every year to obtain an expected value of indirect resource revenue that year.

We are aware that this calculation may be subject to distortion, arising from (i) changes in the tax code over time and (ii) changes in the relative importance of conventional oil, natural gas and oil sands in the product mix. For this and other reasons, we conduct sensitivity analysis in Appendix to investigate the effects of changes in the value of the multiplier. In addition to the baseline estimate of IRM of 0.213, which we label medium, we also test high and low values of 0.25 and 0.15 respectively. These values are summarized in Table 1.

Table 1: Multipliers

	IRM	DR
high	0.250	0.250
medium	0.213	0.150
low	0.150	0.000

IRM: indirect revenue multiplier
DR: diversification rate

Alberta Finance (2007) claims that the use of the input-output model overestimates the relative size of the oil and gas sector in provincial GDP. We conclude, therefore, that the weight of uncertainty on the IRM is likely on the low side.

Non-resource primary deficit

This measure is defined as the difference between non-resource primary revenues (i.e. non-resource total revenues minus investment income) and current program expenditures. The necessary data on revenue and expenditure are obtained from the same sources as direct resource revenues.

Net financial wealth

This measure is defined as the difference between the total of all the government's financial assets, including the equity in savings funds, and its financial liabilities. At present, our series is only partial: we have an initial data point for 1948, obtained from the Public Accounts (Alberta 1948) and a subsequent series, 1981 to 2007, obtained from Alberta budget documents.

Rate of return

We have calculated annual rates of return for the Heritage Fund using data on income and equity obtained from AHSTF (2007) and AHSTF (2008). We consider these rates indicative of the opportunities available to Alberta government planners during the period of operation of the fund (1977 to 2007). We use these rates as the basis for calculating present values during this period.

For the earlier period (1948 to 1976), we consider returns on a hypothetical portfolio consisting of a mix of bonds and equities. For 1948 to 1956, we assume an equal mix of government and industrial bonds. For 1957 to 1976, we assume one-third government bonds, one-third industrial bonds and one-third equities. For government bonds, we use average yields on 10-year maturities. For industrial bonds, we use annual average yields reported by McLeod, Young and Weir. For equities, we use the benchmark index of the Toronto Stock Exchange. The data are obtained from Statistics Canada, Historical Statistics of Canada, Cat. No.11-516-XIE, sections J471-480 (bond yields) and J481-494 (TSE index).

Table 2: Rates of Return (nominal %)

max value:	1980	15.7
min value:	1948	-8.4
averages:	1948-07	7.6
	1948-59	2.5
	1960-69	7.4
	1970-79	9.0
	1980-89	12.1
	1990-99	8.7
	2000-07	6.5
	2008+	5.6

Source: Authors' calculations; Statistics Canada, Historical Statistics of Canada; AHSTF (2007, 2008).

Table 2 summarizes the rate of return data. A maximum nominal value of 15.7 percent is obtained in 1980, with a minimum value of -8.4 percent in 1948. The decadal averages are indicated as well.

Inflation

Our measure of the inflation rate for 1948 to 1978 is the national consumer "all-items" price index, obtained from Statistics Canada, CANSIM series v41693271. For 1979 to 2007, we use the provincial consumer "all-items" price index, CANSIM series v41694625. While the implicit GDP price deflator would seem to be a more comprehensive measure of inflation, we could not find consistent data on this statistic prior to 1961.

Population

We have obtained annual population data from Statistics Canada, CANSIM series V15.

A.2. Forecast data

Horizon

Our forecast period begins in 2007 and terminates with the anticipated exhaustion of the resource stock in 2095 (see below for details).

Resource prices

EIA (2008) and IEA (2007) long-term price forecasts of oil are averaged into one price path for our reference case. The EIA forecasts of oil prices are based on a weighted average price of imported low-sulphur oil delivered to US refiners, whereas the IEA forecasts are based on the price of crude oil imports. Natural gas prices are taken from EIA (2008) and are based on average wellhead prices for the US (lower 48 states). Prices are converted into $C at a fixed rate of 0.90 US/C. According to this forecast, the price of conventional oil falls from $91.65 per barrel in 2008 to $65.35 in 2016 and then rises gradually to $75.55 in 2030, where it remains subsequently (all figures $C 2007).

For oil sands, most of Alberta's royalty taxes after 2007 will be based on the price of bitumen, a lower-grade commodity than the benchmark light, sweet grades. For the years 2006 to 2010, Alberta (2007) uses an average price conversion factor between bitumen and the light, sweet benchmark (WTI) of approximately 0.45. Applying this factor to the price for conventional oil yields our forecast of the price of bitumen. The trend of the bitumen price follows that of conventional oil, adjusted by the conversion factor.

The forecast of the natural gas price envisages a fall from $7.02 per thousand cubic feet in 2008 to $5.91 in 2016. It then rises gradually to $7.37 in 2030 ($C 2007). The EIA attributes the softening in price during the first decade to increased supply of liquefied natural gas and demand destruction due to the relatively high near-term prices.

Sensitivity analysis on resource prices is based on the deviation between the reference and low-price forecasts from EIA (2007). The gradual separation of the forecasts, starting from a common value in 2007, results in a 40 percent deviation between the two in 2030. We apply the same deviation pattern to our reference price data (discussed above) to obtain both our low- and high (inverse deviation pattern) price forecasts.

Reserves

Our forecast assumes recoverable reserves in the oil sands of 78 billion barrels as of 2007, which is an average of the values reported in BP (2007) and World Oil Journal (2006). Based on data from CAPP (2007a), we estimate remaining reserves of conventional oil and natural gas of 1.623 billion barrels and 40,300 billion cubic feet respectively. Due to uncertainty, estimates of reserves from coal-bed methane have not been included in our forecast.

Recent experience indicates an average replacement rate of reserves of conventional oil and natural gas from new drilling equal to 60 percent of annual production.[39] But these rates are likely to diminish (Scott 2007). To accommodate this possibility, our forecast begins with a 60 percent replacement rate in 2007 for both conventional oil and natural gas, with conventional oil falling to zero in 2013 and with natural gas falling to 30 percent in 2018 and zero thereafter.

Production

For the oil sands, our forecast follows CAPP (2007b) initially, rising to 1,387 million barrels per year (3.8 million per day) in 2020. We conjecture that the trend continues rising, reaching 1,643 million barrels per year (4.5 million per day) in 2027, where it remains until starting to fall in 2032. We assume a decline rate of three percent per annum for the remainder of the period, which is similar to assumptions made in Segura (2006) and Davoodi (2002) regarding conventional oil. This production profile leads to exhaustion of reserves in 2095.

For conventional oil, we assume a constant rate of decline of production of 9 percent per year, based on data from Alberta (2007) and CAPP (2007a). This value is slightly higher than the actual decline rate over the last 10 years in CAPP (2007a), signifying an ongoing decrease in production as reserves dwindle. The forecast starts at 183 million barrels per year in 2007 and falls thereafter, taking into account the decline rate and the partial replacement of reserves discussed above. Production falls to zero with the exhaustion of reserves in 2026. The same decline rate is used for natural gas. Therefore, following a similar approach, we forecast gas production falling from 5.2 trillion cubic feet in 2007 to exhaustion in 2026.

Sector revenues

The preceding forecasts of prices and production allow us to predict the total sales value of oil and gas production in Alberta during the next century, which we then use as the basis for our forecast of direct and indirect resource revenues for the government.

39 Authors' calculation for the period 2000-2006, based on data from CAPP (2007a).

Direct resource revenues

We base our prediction of direct resource revenues (royalties, leases, rentals and fees) on the sector revenues, using historical absorption rates. In reality, there is an endogenous relationship between royalty rates and sector revenues, as firms' production decisions depend in part on royalty rates. However, a rigorous modelling of these feedbacks is beyond the scope of the paper. Instead we employ sensitivity analysis in Appendix C to test different scenarios.

Royalty rates are set at historical levels for the first two years of our forecast period and then shift upwards in 2009 with the implementation of the new royalty regime announced this year following the report of the Alberta Royalty Review Panel. These shifts were stress tested against the forecasts outlined on p.17 in ARRP (2007).

For natural gas, we assume royalty taxes initially accrue at a rate of 14 percent of production value, shift to 16 percent in 2009, fall to 15 percent in 2012 and finally to 14 percent in 2016, remaining at this level until exhaustion. For conventional oil, we assume royalty taxes initially accrue at 6 percent of production value, shift to 10 percent in 2009, fall to 9 percent in 2016, and then remain at this level thereafter. For oil sands, we assume royalty taxes initially accrue at a rate of 6 percent of production value, shift to 8 percent in 2009, rise to 9 percent in 2026, then gradually drop to 8 percent in 2042, 7 percent in 2055 and 6 percent in 2069 where it remains for the last years before exhaustion in 2095. Reductions in absorption rates over time are due to "low productivity offsets" as the quality of remaining reserves declines.

Based on Alberta budget documents, we note that lease sales amounted on average to 15 percent of royalty taxes from oil and gas during the period 2004-2007. We assume this rate to continue in our forecast. Finally, rentals and fees yielded the government $150 million annually during the period 2000-2006, an amount we assume will continue in our forecast.

Indirect resource revenues

We estimate indirect resource revenues by the application of two multipliers to the forecast sales values. The first is the indirect revenue multiplier (IRM) defined in the historical data. The second, which we call the diversification rate (DR), is intended to capture the shift, in upstream and downstream industries, from servicing and processing domestic oil and gas, to exporting goods and services out-of-province or servicing other unrelated domestic sectors. If these upstream and downstream firms do not achieve any diversification – if they remain completely dependent on the domestic oil and gas industry – then they will dwindle and die as the resource base diminishes and is exhausted. In that event, the government's indirect resource revenues will also diminish to zero along with the resource base. In contrast, if upstream and downstream firms succeed at diversifying from domestic oil and gas, then the government's revenues from these industries will be sustained.

Our view of economic development is that the pressure for diversification becomes particularly acute when the original base for upstream and downstream firms starts to diminish. In this vein, we note that the maximum value of indirect revenues in our reference forecast – and thus the maximum value of oil and gas production — occurred in 2005. Therefore, we use 2005 as the benchmark for defining values of the diversification rate in subsequent years. For example, if indirect resource revenues in 2010 are $5 billion lower than in 2005 and DR = 0.15, then 15 percent of this loss, or $750 million, will be recouped by diversification from domestic oil and gas. In this case, the net loss to the government's coffers will be $4.25 billion.[40] By assumption, the value of DR prior to 2005 is always zero. In this way, the diversification rate directly addresses the question of how much of indirect revenues can be maintained as oil and gas resources diminish.

Unfortunately, we are not aware of any empirical research that can be used to ground our value of DR. Therefore, we use plausible conjectures. We believe it is prudent to err on the low side with this value. First of all, diversification can only occur in upstream or downstream industries, not the primary oil and gas sector itself. While we do not know the relative contributions of the sectors to indirect revenues, we suggest that 50 percent is a reasonable hypothesis on the upper bound of the contribution of the upstream and downstream sectors, leaving the remaining 50 percent for the oil and gas industry itself. Thus complete diversification is represented by a value of DR = 0.5.

Second, we believe that complete diversification is unlikely to occur as domestic oil and gas production diminishes. Complete diversification would imply immediate replacement of lost business with either export sales or new domestic customers. In contrast, anecdotal evidence suggests that diversification is a much slower process, usually following upon a period of crisis and contraction.

Furthermore, some upstream and downstream industries simply may not be diversifiable. In this vein, ARRP (2007, 33) observes that the petrochemical industry "once had access to inexpensive natural gas as feedstock, but as pipeline capacity expanded, the gas was available for export and its price became set by market forces. Low natural gas prices had been this industry's main advantage, but that advantage has disappeared in recent years as North American natural gas prices have strengthened." Mansell and Shlenker (2006, 22) note that the petrochemical industry accounted for "over 20 percent of manufacturing value added in Alberta" in 2003 and further that "it would be hard to argue that the petrochemical industry would exist in Alberta in the absence of the oil and gas industry."

Finally, companies that are diversifying from the Alberta resource market are also likely to relocate some portion of activity to their new markets, with the result that some portion of tax revenues would be lost to other jurisdictions. For example, head office jobs may remain in Alberta while field activities, manufacturing or processing may relocate.

Ultimately, it seems implausible that an economy would experience the decline of a major extractive industry without experiencing some degree of contraction. Accordingly, we suggest 0.25 as a maximum plausible value for DR, and we test lower values of 0.15 and 0 as well, the latter representing the extreme (and also implausible) case of no diversification at all. In the text, we refer to these values as high, medium and low respectively. They are summarized in Table 2.

Inflation

The inflation rate is forecast to be constant at 2.0 percent, which is the central value of the Bank of Canada's present target range.

Rate of return

The real return on investment is forecast to be constant at a rate of 3.5 percent per annum, compared with an average actual rate of 3.4 percent over the period 1948-2007 and 4.8 percent over the more recent period 1990-2007. This real rate is equivalent to a nominal value of 5.57 per cent per annum, given the expected inflation rate. Sensitivity analysis is performed in Appendix C at low and high rates of 3.0 and 4.0 percent respectively.

40 We apply DR to differences in the real value of indirect revenues from the 2005 benchmark, rather than nominal differences.

Population projections

Following C.D. Howe Institute projections, Alberta's population is forecast to grow at a rate of 1.77 percent in 2008, compared with an average actual growth rate of 1.93 percent during the period 2000-2007. The growth rate is forecast to fall gradually in subsequent periods, reaching zero in 2058, yielding a steady-state population of 4.54 million. For sensitivity analysis in Appendix C, a high population scenario forecasts population growth to continue until 2069, yielding a steady-state value of 4.66 million. Meanwhile, a low-population scenario forecasts growth continuing until 2038, for a steady-state value of 3.91 million.

Appendix B: Mechanics of the Permanent Resource Income Model

Most theoretical treatments of the permanent income model deal with constant rates of interest, inflation and population growth. In contrast, given the large historical component of our data set, we have variable rates for over approximately 40 percent of the planning horizon.

A particular challenge concerns how to handle negative real interest rates, which occurred 13 times in our 59-year historical sample (1948-2006). Negative real interest rates have the effect of inflating present values, and they raise important conceptual issues regarding our assumption of complete knowledge or foresight. In particular, is it reasonable to assume that a planner with complete knowledge would hold financial assets during a period of negative real interest rates? Upon reflection, it seems clear that such a planner would switch into commodities during such periods — for example, oil — since their values would be growing faster than financial assets. Therefore, we set the planner's discount rate during the historical period as the maximum of the real interest rate and 0 (equivalently the maximum of the nominal interest rate and the inflation rate).

Further, we note that the duality between constant expenditure and constant wealth is broken when rates of return vary over a subset of the planning period.[41] Therefore, with variable returns, the modeller must choose between holding constant either expenditure or wealth. We choose the former, since we view wealth as the means to an end — expenditure — and not an end in itself. In this approach, fluctuations in wealth can act as a shock absorber to help smooth expenditure during periods of volatility in returns. When we move into our forecast period (2007-2095), rates of return are assumed constant (expected value) and the link between constant expenditure and constant wealth is restored. Thus, in the long run, the interpretation of permanent income as the return on total wealth is valid.

Davoodi (2002) provides a useful presentation of the model with variable rates. However, his formulas are based on smoothing wealth rather than expenditure. In contrast, we present a version of the model for smoothing expenditure. Let i_t, r_t, π_t and n_t represent the nominal interest rate, real interest rate, inflation rate and population growth rate respectively, in period t. Let T denote the last period of extraction (2095 in our forecast); i.e., the resource is exhausted in all periods t>T. During the historical period (1948-2006), i_t, r_t, π_t and n_t are variable, while during the forecast period (they are constant and satisfy the relationship $(1 + i) > (1 + n)(1 + \pi)$ (B1)

or equivalently $r > n$.[42] Assumption (B1) requires that the nominal rate of return is large enough to cover more than the increase in population and the price level — a necessary condition for maintaining a constant real per capita level of expenditure out of savings in steady state (i.e. after T).

Let R_t denote the government's resource revenues at t, G_t^R its expenditure out of resource wealth and At its stock of financial assets. It is important to note that G_t^R is not the only source of spending, as the government also has non-resource tax revenues, which we denote NR_t. However, if our concepts are to be meaningful, then the government can only have one source of borrowing — borrowing to finance G_t^R when it exceeds R_t — and one source of saving — the surplus of R_t when it exceeds G_t^R . These values would not equal net borrowing or net saving if the government offset them in some other account — for example, if the government ran a surplus in a resource account while running a deficit in a general budget account. For this reason, the budgeting process must take a unified view of all government accounts and funds. It follows that, since all saving is resource saving, all financial assets or debts are resource-based as well.

41 This result is proven formally in Shiell and Busby (2008).

42 The absence of a time subscript indicates a constant value.

Due to the integration of accounts, the sustainability rule imposes discipline on all components of the budget. In particular, discipline takes the form of a requirement that total government expenditure is covered by the sum of G^R_t and NR_t; there is no other source of borrowing or revenue on a separate is covered by the sum of G^R_t and NR_t; there is no other source of borrowing or revenue on a separate account. Denoting total government expenditure as G_t, we have $G_t = G^R_t + NR_t$.

Rearranging yields $G_t - NR_t = G^R_t$, (B2)

where the left side is referred to as the non-resource primary deficit (NRPD). This measures the amount by which non-resource tax revenues fall short of covering total government expenditure, and the shortfall is made up by G^R_t.

The literature on fiscal sustainability identifies the NRPD as the target of policy. Permanent income determines G^R_t , which in turn is equal to the allowable annual NRPD. Since G^R_t is constant (in per capita terms in our version), NRPD must also be constant (in per capita terms). The government can meet this target by adjusting total expenditure or non-resource taxation levels. Thus, the setting of G_t, NR_t and G^R_t are integrated in the budgeting process, consistent with a sustainability rule based on equal sharing of resource wealth.

The government's budget constraint is $A_{t+1} = (A_t + R_t + NR_t - G_t)(1 + i_{t+1})$ which upon substituting from (B2) becomes

$A_{t+1} = (A_t + R_t - G^R_t)(1 + i_{t+1})$ (B3)

This equation can be rewritten to show the contribution of the budget's primary and total balances. In particular,

$A_{t+1} - A_t = (R_t - G^R_t) + i_{t+1}(A_t + R_t - G^R_t)$ (B3')

The first term on the right of is the primary balance, the second term is net investment income, and the sum is the total balance. The primary balance provides a measure of saving out of resource revenues, while the total balance provides a measure of net saving, taking account of net investment income (income on financial assets less interest payments on debt). It is the latter measure, total balance, that provides the change in the government's financial position for the year and the most common measure of the government's surplus or deficit.

To demonstrate our solution of the model, it will be useful to consider (B3) in real, per capita terms. For this purpose, let N_t and P_t denote population and price level at t, respectively.

By definition $N_{t+1} = N_t(1 + n_{t+1})$ and $P_{t+1} = P_t(1 + \pi_{t+1})$. Further the Fisher identity defines the relationship between real and nominal interest rates, i.e.

$$1 + r_t = \frac{1 + i_t}{1 + \pi_t}$$

Then dividing through both sides of (B3) by N_{t+1} and P_{t+1} yields

$$a_{t+1} = \left(a_t + \rho_t - g^R_t\right)\left(\frac{1 + r_{t+1}}{1 + n_{t+1}}\right) \qquad \text{(B4)}$$

where lower case letters denote real, per capita values (ρ denotes real resource revenues per capita, to avoid confusion with the real interest rate, r). Note that

$$\left(\frac{1 + r_{t+1}}{1 + n_{t+1}}\right)$$

reflects the real rate of interest, net of adjustment for population growth.

Equation (B4) defines a first-order difference equation that can be solved iteratively to obtain the government's present value budget constraint (in real, per capita terms), i.e.,

$$g_0^R + \sum_{k=1}^{T} \frac{g_k^R}{\prod_{j=1}^{k}\left(\frac{1+r_j}{1+n_j}\right)} + \frac{a_{T+1}}{\prod_{j=1}^{T+1}\left(\frac{1+r_j}{1+n_j}\right)} = a_0 + \rho_0 + \sum_{k=1}^{T} \frac{\rho_k}{\prod_{j=1}^{k}\left(\frac{1+r_j}{1+n_j}\right)} \qquad \text{(B5)}$$

The left-hand side is equal to the present value of resource-based expenditure plus the present value of financial wealth at T+1 (the period after exhaustion of the resource base). The right-hand side is equal to the government's total wealth at time 0, i.e. initial financial assets a_0 plus the present value of the stream of resource revenues.

Let g* represent the maximum level of real, per capita expenditure out of resource wealth which can be sustained indefinitely. By assumption $r_t = r$ and $n_t = n$ for $t \geq T$. Thus, from (B4) we have

$$a_{T+2} = \left(a_{T+1} - g^*\right)\left(\frac{1+r}{1+n}\right) \qquad \text{(B6)}$$

Furthermore, sustainability requires after exhaustion that $a_{T+2} = a_{T+1}$. Substituting into the expression above yields

$$a_{T+1} = \left(a_{T+1} - g^*\right)\left(\frac{1+r}{1+n}\right) \qquad \text{(B6')}$$

which upon solving yields

$$a_{T+1} = g^*\left(\frac{1+r}{r-n}\right) \qquad \text{(B6'')}$$

Note that this expression reflects the standard annuity formula, adjusted for per capita terms. Now substituting for g_k^R and a_{T+1} in (B5), we obtain our solution for g*:

$$g^* = \frac{a_0 + \rho_0 + \sum_{k=1}^{T} \frac{\rho_k}{\prod_{j=1}^{k}\left(\frac{1+r_j}{1+n_j}\right)}}{1 + \sum_{k=1}^{T} \frac{1}{\prod_{j=1}^{k}\left(\frac{1+r_j}{1+n_j}\right)} + \frac{(1+r)/(r-n)}{\prod_{j=1}^{T+1}\left(\frac{1+r_j}{1+n_j}\right)}}$$

Interpretation of this expression is easier in the special case when $r_t=r$ and $n_t=n$ in all periods. In that case,

$$g^* = \left(\frac{r-n}{1+r}\right)\left[a_0 + \sum_{k=0}^{T} \rho_k \left(\frac{1+n}{1+r}\right)^k\right] \qquad \text{(B7)}$$

The expression in square brackets is the government's total wealth at time 0, while the preceding expression in parentheses is the standard annuity formula (adjusted for population growth). Thus we have g* equal to permanent income.

In fact, our calculation of g* is altered by the continued flow of diversified revenues after the exhaustion date. As explained in Appendix A, these are revenues of upstream and downstream industries which have managed to diversify away from dependence on the domestic oil and gas sector. Until T, we include these revenues in the measure of total resource revenues, ρ_t. However, after T, we must account for them separately. We denote these post-exhaustion revenues as v, and we conjecture industries which have managed to diversify away from dependence on the domestic oil and gas sector. Until T, we include these revenues in the measure of total resource revenues, ρ_t. However, after T, we must account for them separately. We denote these post-exhaustion revenues as v, and we conjecture the level to be constant in per capita terms. (In any event, our forecast of population growth is zero after 2058.) In practice, the adjustment is easily made. We replace g* in equations (B6), (B6') and (B6'') with g*-*v* and then proceed as above. The solution for g* is now

$$g^* = \frac{a_0 + \rho_0 + \sum_{k=1}^{T} \frac{\rho_k}{\prod_{j=1}^{k}\left(\frac{1+r_j}{1+n_j}\right)} + v\frac{(1+r)/(r-n)}{\prod_{j=1}^{T+1}\left(\frac{1+r_j}{1+n_j}\right)}}{1+\sum_{k=1}^{T}\frac{1}{\prod_{j=1}^{k}\left(\frac{1+r_j}{1+n_j}\right)} + \frac{(1+r)/(r-n)}{\prod_{j=1}^{T+1}\left(\frac{1+r_j}{1+n_j}\right)}}$$

the only difference being the addition of the term

$$v\frac{(1+r)/(r-n)}{\prod_{j=1}^{T+1}\left(\frac{1+r_j}{1+n_j}\right)}$$

to the numerator. This term is simply the present value of the indefinite stream of *v*, starting at T and discounted back to 0. Thus the government's total resource wealth (the numerator) is increased by this amount.

The exercises we perform are purely partial in nature, in that they do not take into account the feedback that alternative savings policies would have on the economy. It is not clear to us that this represents a major omission. The main effect of alternative policies would be to impose greater restraint on government spending in some periods and less restraint in others. Since the Alberta economy is largely export driven, it is not clear that the real growth rate would be much affected by these changes.

Appendix C: Sensitivity Analysis

Our estimate of the fiscal plan under the Permanent Resource Income Model (PRIM) depends upon the forecasted values of uncertain variables, including resource prices, reserve size, annual production rates, royalty rates, the indirect revenue multiplier (IRM), the diversification rate (DR), the real interest rate and annual population growth. Appendix A presents reference forecasts for these variables, as well as high and low forecasts for selected variables to be subjected to sensitivity analysis. We have presented the results based upon the reference forecast in the main body of the text. Here we consider the impacts of adopting the higher or lower forecasts.

Certain regularities emerge. For example, resource prices, reserve size, production rates and royalty rates affect the fiscal plan symmetrically through their role in determining the government's resource revenues. Therefore, it is not necessary to subject them to sensitivity analysis separately. For our purposes, we focus on resource prices within this group. In addition, we test the impact of IRM, DR, the real interest rate and population growth.

Table C1 shows the impacts of high and low forecasts of the variables individually (partial sensitivity analysis) as well as two combined scenarios. The impacts are summarized both in terms of the constant value of G^R per capita that the model generates and in the near-term savings required. Savings are expressed as a percent of direct resource revenues during the five-year period 2007-2011. The "highest G^R case" corresponds with high resource prices, high IRM, high DR, high rate of return and low population growth. The "lowest G^R case" is defined symmetrically.

Table C1: Permanent Resource Income Model

	GR per capita ($C 2007)	Required savings 2007-11 (% of direct resource revenue)
reference case	4,501	139
partial sensitivity analysis		
resource prices — high	5,439	111
resource prices — low	3,564	171
IRM — high	4,872	150
IRM — low	3,870	119
DR — high	4,713	134
DR — low	4,185	145
real interest rate — high	5,015	124
real interest rate — low	3,832	158
pop — high	4,449	141
pop — low	4,933	123
highest G^R case	6,884	87
lowest G^R case	2,339	158

High prices, high IRM and high DR all contribute to high wealth through the present value of resource revenues. The rate of return has two opposite influences. First, a higher rate of return translates into lower present values ceteris paribus and thus lower wealth at any given time. Second, a higher rate of return increases the expenditure possibilities from any given level of wealth. From our experiments, we see that the second effect dominates, as a higher rate of return generates a higher value of G^R per capita in the model. Finally, population growth affects G^R per capita in an inverse fashion, as expected.

Table C1 indicates that, while numerical values vary, the qualitative features of our results are quite robust. In particular, the required near-term savings under PRIM (2007-2011) exceeds direct resource revenues in all cases except the highest G^R case. This exception is not surprising, since it corresponds with a case in which government wealth is extremely high and much of it accrues in the future. It follows that some of the burden of saving is shifted forward in this case. Yet, even this scenario implies an aggressive near-term savings program by historical standards (87 percent of direct resource revenues). In contrast, we noted earlier that in the reference case the *Fiscal Responsibility Act* entails a near-term savings rate of only 47 percent of direct revenues. Thus, we conclude that the requirement of an aggressive savings program under PRIM is robust to changes in the underlying variables.

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