UNIVERSITY OF ALBERTA
FACULTY OF ARTS
Department of Economics

Working Paper No. 2015-13

The Welfare and Stabilization Benefits of Fiscal Rules: Evidence from Canadian Provinces

Stuart Landon
University of Alberta

Constance Smith
University of Alberta

September 2015

The Welfare and Stabilization Benefits of Fiscal Rules: Evidence from Canadian Provinces

Stuart Landon and Constance Smith
University of Alberta

11 September 2015

Abstract

The growth of debt and deficits in developed countries has led many states to consider the adoption of fiscal rules. There is little evidence on the benefits of different types of rules. This study uses Monte Carlo techniques to examine the impact on welfare and government spending stabilization of five types of government expenditure rules. The simulation employs a three-variable VAR estimated using data for the Canadian provinces. The use of a VAR captures the interactive effects between spending under the fiscal rule, output and revenue.

The best fiscal rules reduce government expenditure volatility by about half relative to a balanced budget rule. The stabilization benefit is about twice as great for the three provinces with more resource-based and volatile revenue — Alberta, Saskatchewan and Newfoundland. Some fiscal rules lead to an unsustainable path for government debt or assets under many simulations due to an absence of feedback from the stock of debt or assets to current expenditure. We find that a simple rule, where government expenditure is based on the moving average of past government revenue, is one of the better performing rules and yields a level of expenditure stabilization and a welfare gain similar to the more complicated "debt brake" rule adopted by Switzerland and other countries. The Swiss rule requires forecasts for revenue and output, and its greater complexity may make it more difficult to implement, monitor, and communicate to the public.

Keywords: fiscal rules; fiscal policy; stabilization; government spending; Canadian government economic policy.

JEL codes: E61, E62, E63, H61, H62, H63

1. Introduction

The growth of debt and deficits across Europe and elsewhere has caused many countries to recognize the need for fiscal consolidation. According to the IMF (2010), a fiscal rule may be part of a strategy to stabilize spending and to maintain longer term fiscal sustainability. [1] For Canada, the OECD (2010, p. 8) argues well-designed fiscal rules can help achieve fiscal consolidation and counteract the tendency shown by some Canadian governments to run pro-cyclical fiscal policies. [2] While some provinces have adopted fiscal rules (Tapp, 2010), their use remains less prevalent than, for example, in US states. Part of the reason for the slow adoption of fiscal rules by Canadian provincial governments may be the lack of understanding of the connection between fiscal rules, fiscal stabilization, and welfare. This paper aims to fill this gap using data for the Canadian provinces.

There is some evidence that national fiscal rules have led to improved fiscal performance in the European Union (Debrun, et al, 2008; Iara and Wolff, 2011), in OECD countries (Sutherland, Price, Joumard, 2005), and in US states (Lutz and Follette, 2012). Also, using data for 79 countries, Schaechter, Kinda, Budina and Weber (2012) provide suggestive evidence that fiscal rules with more encompassing design features are associated with a greater improvement in the government debt to GDP ratio. While there is considerable interest in fiscal rules, there is relatively little understanding of the benefits of different types of fiscal rules, and whether some rule designs increase welfare more than others. This study ranks five types of government expenditure rules in terms of their impact on welfare and their effectiveness in stabilizing government spending, while maintaining sustainability in terms of the avoidance of excessive debt or asset accumulation.

As the future path of revenue is unknown when a rule is chosen, we evaluate the rules using a Monte Carlo simulation. To allow for interaction effects between the spending, revenue and output effects that may differ across the different rules, we employ a three-variable VAR model in the simulations. The parameters in this model are estimated using a panel of data for the Canadian provinces. We use data for Canadian provinces since the provinces in Canada are the level of government that is responsible for most government program expenditure, including health care, education, welfare, and major infrastructure spending. The relative effectiveness of a fiscal rule is measured by how it reduces government expenditure volatility as well as by the impact of the rule on intertemporal welfare. The welfare gain is quantified by comparing expected utility from

[1] See also Bernanke (2010), who recommends that fiscal rules be considered in the US.
[2] More specifically, the OECD (2010, p.8) notes "the lack of spending guidelines made it possible to treat recurrent positive revenue surprises (often related to the commodity cycle) as permanent, leading to spending increases that proved unsustainable."

government expenditure under the rule to expected utility under a balanced budget rule. The balanced budget rule, where all revenue is spent as it is received, is chosen as the baseline since it involves no stabilization and generates a level of welfare that any fiscal rule would be expected to meet or exceed.

Our first finding is that all types of fiscal rules increase government expenditure stability and the welfare of a representative agent who prefers a smoother path of government services. With the best of each type of fiscal rule, government expenditure volatility is reduced to about half of what it would be if spending equaled revenue every period. Further, the stabilization benefit is about twice as great for the three provinces with more resource-based economies and, thus, with more volatile revenue — Alberta, Saskatchewan and Newfoundland.

A second major result is that some fiscal rules lead to an unsustainable path for government debt or assets under many simulations. The accumulation of considerable debt may be unsustainable if it means borrowing becomes infeasible. A very large government debt is likely to lead to significant interest rate hikes or complete exclusion from capital markets. Further, accumulation of a very large asset stock may be politically unsustainable. The critical design shortcoming of these unsustainable fiscal rules is the absence of feedback from the stock of debt or assets to current expenditure. Examples of fiscal rules with no feedback are those that fix government spending at a constant level, or that base expenditure only on a moving average of past revenue. Feedback can, however, be introduced through a borrowing constraint or by the use of a rule that adjusts expenditure by an amount equal to debt interest payments (or interest earnings).

Another problem with some of the fiscal rules examined is that they are quite sensitive to small changes in the structure of the rule. For example, in one variation of a "rainy day" rule, which is a type of rule employed in many US states, welfare rises if borrowing occurs (or assets are reduced) to support government spending equivalent to 99 percent of the previous period's expenditure, but welfare falls if the lower bound is set at 98 percent. That is, a one percent reduction in the spending floor leads to a sufficiently large fall in current consumption (and a large rise in asset accumulation) to cause a welfare decrease. These simulations suggest it may be helpful to identify and avoid rules that are highly sensitive to small variations in the rule structure.

Our results also show that a simple rule may perform as well as a more complex rule. For example, the government of Switzerland employs a rule that sets the level of government spending equal to forecast revenue multiplied by trend output divided by forecast output. This involves two forecasts and a trend calculation (the Swiss use an HP filter). This relatively complicated fiscal rule yields a welfare gain that is a bit lower than a rule based on a moving average of past revenue (modified to include interest earnings). Given the greater simplicity of a rule based on the moving average of past revenue, and the need for policymakers to communicate the form and method of operation of a fiscal rule to the public, our findings suggest that a simpler rule may be preferred.

The next section discusses the characteristics of the five fiscal rules. Section 3 outlines the methodology used to compare the performance of the fiscal rules. In Section 4 the rules are assessed, and the final section provides an overview of the results and discusses implementation issues.

2. The Fiscal Rules

We consider five major types of government expenditure rules.[3] These rules encompass the most common types of rules adopted by central and sub-central governments around the world. We denote the five categories of fiscal rules as the *moving average* rule, the *Swiss* rule, the *no structural deficit* rule, the *rainy day* rule and the *fixed deposit — fixed withdrawal* rule.

2.1 A *moving average* rule

The most simple rule considered requires current government program expenditure to be determined by a moving average of past government revenue. That is:

$$G_t = \frac{1}{n}\sum_{j=1}^{n} R_{t-j} , \qquad (1)$$

where n is the length of the moving average in years , G_t is real per capita program spending in period t, R_t is real per capita revenue in period t, and variables are expressed in per capita terms to facilitate interpretation of the results. The simulations below employ fiscal rules that use values for n of 2, 5, 7, 10, 12, and 15. Russia created a fiscal rule for resource revenue with characteristics similar to the *moving average* rule (Bacon and Tordo, 2006), while Algeria employed a similar rule that incorporated a borrowing constraint (Ossowski, et al., 2008).

With the moving average fiscal rule, current government spending depends only on past revenue, so debt can grow indefinitely since there is no feedback to current spending from accumulated debt. As we discuss in more detail in Section 4, with some simulations, the level of debt or assets generated with this rule over the simulation period are greater than 100 percent of GDP, or more than five times average government revenue. To prevent the accumulation of financially or

[3] We focus on government expenditure rules, but fiscal rules can be designed to constrain government debt or revenue as well (Schaechter, Kinda, Budina and Weber, 2012).

politically unsustainable debt or asset stocks, the *moving average* rule is adjusted by adding to government program expenditure the real interest earnings on assets, or subtracting interest payments on debt. Government program spending in period t is then given by:

$$G_t = \frac{1}{n}\sum_{j=1}^{n} R_{t-j} + r^r A_{t-1}, \qquad (1')$$

where r^r is the real per capita rate of interest and A_{t-1} is the real per capita stock of assets held by the government at the end of period $t-1$.

2.2 The *Swiss* rule

Since 2003, Switzerland has imposed a government "debt brake" or "debt containment rule" that is designed to yield a structurally balanced budget (Geier, 2011).[4] The rule aims to be compatible with debt stabilization and output stabilization. The *Swiss* fiscal rule takes the form:

$$G_t = \frac{Y_t^T}{Y_t^F} R_t^F \, , \qquad (2)$$

where R_t^F is a forecast of revenue in period t based on revenue through $t-1$, Y_t^T is trend output (GDP) in period t, obtained using a Hodrick-Prescott (HP) filter, and Y_t^F is a forecast of output in period t based on output through $t-1$. In Section 3 we discuss the mechanics of how Y^T, Y^F, and R^F are determined. As well as being employed by the Swiss federal government, variations on the *Swiss* fiscal rule have been adopted in Germany (Kastrop, et al., 2009) and Austria (Steger, 2010).

2.3 The *no structural deficit* rule

The *no structural deficit* rule follows the *Swiss* rule in that it is designed to produce a structurally balanced budget. However, this rule is much simpler as it sets spending equal to trend revenue directly. Since spending follows trend revenue, in cyclical downturns spending levels are maintained, and during cyclical booms, government saving occurs. Under this rule, program spending is:

[4] The Swiss fiscal rule was approved in a referendum by 85 percent of voters. It is anchored in the Swiss constitution and cannot be changed without a popular vote. The rule employed in equation (2) is simplified since Switzerland's rule offers an escape clause for uncontrollable situations. In this case, a record of deviations from the rule is kept in a notional compensation account and deficits in that account must be subsequently eliminated.

$$G_t = R_t^T , \tag{3}$$

where R_t^T is the trend level of government revenue in period *t*.

2.4 The *rainy day* rule

The purpose of a rainy day fiscal rule is to smooth spending by preventing a large decline in government expenditure when current revenue declines. With this rule, unless revenue falls below a lower bound, all revenue is spent except for a fixed fraction that is saved. When revenue falls below the lower bound, a "rainy day" has occurred, so assets are reduced or borrowing is undertaken to maintain expenditure at the specified lower bound. Government spending under this rule is defined by:

$$G_t = (1-s)R_t \quad \text{if } (1-s)R_t \geq bG_{t-1}, \tag{4a}$$

$$G_t = bG_{t-1} \quad \text{if } (1-s)R_t < bG_{t-1}, \tag{4b}$$

where the lower bound is a percent of last period's spending, with *b* set equal to 1.00, .99, .97, or .95, while the savings rate out of current revenue, *s*, is .01, .03, .05 or .10. In the US, 47 states use some type of rainy day rule (Filipowich and McNichol, 2007; Rueben and Rosenberg, 2009). Alberta's *Sustainability Fund* has similar, although more discretionary, characteristics (Alberta, 2012b).

The *rainy day* rule may lead to an unsustainable accumulation of debt or assets since this rule has no feedback to current spending from accumulated debt. To prevent unsustainable debt accumulation, following the practice in many US states that have constitutional prohibitions on government deficits, this rule is specified to incorporate a "no borrowing" constraint.

2.5 A *fixed deposit — fixed withdrawal* rule

With the *fixed deposit — fixed withdrawal* rule, a given fraction, *d*, of revenue is deposited in a fund each year and a fixed proportion of the assets, *w*, is withdrawn at the beginning of the year before that year's deposit. As a result, government spending follows:

$$G_t = (1-d)R_t + wA_{t-1}, \; 0 < d < 1, \; 0 < w < 1. \tag{5}$$

This type of rule is more often employed by jurisdictions with commodity or resource revenue that is highly volatile. For example, in Norway the *Norwegian Government Pension Fund – Global* receives 100 percent of petroleum revenue, and each year 4 percent of assets are withdrawn and added to government expenditure (Jafarov and Leigh, 2007).[5] The *Alberta Heritage Savings Trust Fund* initially had a fixed deposit rule and no withdrawal rule, but since 1996 real earnings have been withdrawn and only occasional deposits have been made (Alberta, 2012a). The *Alaska Permanent Fund* has a fixed deposit rule out of resource revenue but withdrawals go chiefly to pay "dividends" directly to residents, rather than to government revenue (Davis, et al., 2003).

The *fixed deposit — fixed withdrawal* rule stabilizes expenditure because current government expenditure depends only partially on current revenue. Current expenditure also depends on revenue collected since the fund was created, where the weight on past revenue falls the farther in the past the revenue was received. A desirable feature of this rule is that, since the amount withdrawn from the fund is larger (smaller) when the stock of assets is larger (smaller), the rule incorporates feedback from the assets in the fund to current spending. Theoretical and empirical studies show that fiscal rules with sufficiently strong feedback mechanisms tend to be stabilizing (Bohn, 2007; Budina and Wijnbergen, 2007; Wijnbergen and Budina, 2010; Celasun, Debrun and Ostry, 2007). Furthermore, with the the *fixed deposit — fixed withdrawal* rule there cannot be excessive debt accumulation since there is no borrowing, and accumulation of assets is limited because spending is a fraction of assets, due to the feedback from a higher asset stock to higher current spending.[6]

The *fixed deposit—fixed withdrawal* rule can lead to a large decline in government expenditure in the years immediately following the establishment of the fund. This occurs because withdrawals are initially small and, thus, are unable to counteract the negative effect on government spending of the required deposits. To counter this effect, we employ a 10-year transition during which the deposit rate is increased to the target rate in 10 equal annual percentage point increments.

3. Methodology

We compare different fiscal rules in terms of how each rule contributes to welfare, government expenditure stabilization, and sustainability. Sustainability is assessed in terms of whether excessive debt or assets are accumulated. The effectiveness in terms of stabilization is measured by the variability of government spending over the simulation period. A drawback of this measure is that government spending could be stabilized, but at a very low level. Therefore, we also

[5] Four percent was chosen as this rate is viewed as equal to the long term real interest rate.
[6] With the *fixed deposit — fixed withdrawal* rule, for a constant revenue stream, the stock of assets will eventually converge to $d/[1-(1+r^r)(1-w)]$ for each dollar of revenue.

employ an explicit intertemporal welfare measure in which welfare depends on both the level and volatility of government spending.

The methodology used to compare alternative fiscal rules involves several steps. First, we estimate a three-variable VAR using Canadian provincial-level data for output, provincial government revenue and provincial government program expenditure. We then draw three sets of 1000 samples of length 200 from normal distributions with standard deviations equal to the standard deviation of the sample structural errors estimated from the VAR for, respectively, output, revenue and expenditure. Using these randomly generated shocks, we simulate the paths for government spending, output and government revenue employing the estimated VAR with the expenditure equation replaced by the fiscal rule. The VAR captures possible interaction effects that arise if changes in government expenditure resulting from the fiscal rule alter output and government revenue and, thereby, feed back onto government expenditure. The use of the VAR also incorporates revenue uncertainty arising directly from revenue shocks and, indirectly, from changes in output that then lead to revenue variation.[7] The measure of variability of government expenditure under each rule is given by the average of the standard deviation of expenditure over each of the 1000 simulated expenditure paths.

3.1 Calculation of the welfare benefits

We calculate the welfare of the fiscal rule relative to the welfare of the baseline, where the baseline is a *balanced budget* policy of spending all revenue as it is received. As the baseline involves no stabilization, it is a useful benchmark to compare the performance of the fiscal rules because it generates a level of welfare that any fiscal rule would be expected to meet or exceed. We follow standard methods to measure welfare when income is uncertain (Lucas, 2003; Barro, 2009; Borensztein, et al., 2009). The welfare gain is measured as the percentage reduction in government expenditure under the fiscal rule that equates welfare with the rule to welfare under the baseline (*balanced budget*) expenditure path. That is, the welfare measure is the proportion of government expenditure (sometimes called the "tax") that the representative individual would be willing to give up in every period to be guaranteed the expenditure path associated with the fiscal rule rather than the baseline path. More formally, the welfare gain from the fiscal rule is the value of τ that makes expected utility under the baseline equal to expected utility under the fiscal rule, so τ, measured as a percent of government expenditure, is the solution to:

[7] We assume that the parameters in the equations for output and government revenue in the VAR do not depend on the fiscal rule. This means the results are subject to the Lucas critique, but there is no obvious way to deal with this issue without imposing much more structure on the model.

$$\sum_{j=1}^{1000} P_j \left(\sum_{t=0}^{\infty} \frac{U(G_{tj}^{BL})}{(1-\rho)^t} \right) = \sum_{j=1}^{1000} P_j \left(\sum_{t=0}^{\infty} \frac{U((1-(\tau/100))G_{tj}^{FR})}{(1-\rho)^t} \right), \tag{6}$$

where the superscript *BL* denotes the baseline path of *G*, *FR* denotes the fiscal rule expenditure path, P_j is the probability of path *j*, and ρ is the discount rate. This procedure yields one value of τ for each permutation of each fiscal rule. If the fiscal rule is no better than the baseline policy of spending all revenue as it is received, τ will be zero. The larger the value of τ the greater the relative welfare gain from the fiscal rule.

The utility function for each period is assumed to have the standard constant relative risk aversion (CRRA) form:[8]

$$U(G_t) = \frac{G_t^{1-\gamma}}{1-\gamma}. \tag{7}$$

In the simulations, the coefficient of relative risk aversion, γ, is set equal to 2, a value commonly used in other studies.[9] The value of ρ, the discount rate, is set to .02 and is assumed equal to the real per capita interest rate, r^r.

3.2 Modeling the path of government revenue and output

To incorporate the stochastic nature of government revenue and output, we generate 1000 different paths for revenue and output. The processes determining the paths for these variables are derived using a three variable VAR of the log of output, *y*, the log of government revenue, *r*, and the log of government program expenditure, *g*, with the expenditure equation replaced by the fiscal rule. Revenue includes federal government transfers to the province since, like other revenue sources,

---

[8] This form of utility function is tractable and has been used in many studies that assess the benefit of a reduction in consumption volatility or the welfare consequences of uncertainty. See, for example, Morduch (1995), Ghosh and Ostry (1997), Engel and Valdés (2000), Lucas (2003), Pallage and Robe (2003), Barlevy (2004), Borensztein, *et al*. (2009), Durdu, *et al*. (2009), Maliszewski (2009), Barro (2009), Bems and Carvalho Filho (2011) and Céspedes and Velasco (2011). The specification in equation (7) assumes utility is separable in private and government-provided goods, so the level of private consumption does not affect the welfare of government-provided goods. There are also no economies of scale associated with government spending and no public good aspects to spending. A shortcoming of the CRRA utility function is that it links the values of the coefficient of relative risk aversion and the intertemporal elasticity of substitution, unlike the Epstein-Zin utility function used by Obstfeld (1994) and Barro (2009). However, the Epstein-Zin utility function is much less tractable than the CRRA. Further, the revenue generating process used here is stationary, while Barro (2009) finds the CRRA and Epstein-Zin functional forms yield different welfare results only if income shocks follow a random walk.

[9] See, for example, Arrau and Claessens (1992), Durdu, Mendoza, Terrones (2009), Ghosh and Ostry (1997), Bartsch (2006), and Borensztein, Jeanne, Sandri (2009). For a CRRA utility function, a value of 2 for γ implies an intertemporal elasticity of substitution of .5. Obstfeld (1994, 1484) notes that an elasticity of substitution of .5 and a coefficient of relative risk aversion of 2, as used here, are close to the estimates provided by Epstein and Zin.

these are subject to exogenous shocks. All variables are measured in real per capita to facilitate interpretation of the results.

Our identifying scheme for the VAR is based on a lower-triangular Cholesky decomposition. We assume output, y, affects revenue, r, and government spending, g, contemporaneously, but y is not affected contemporaneously by r or g. This ordering is based on the view that provinces are relatively small economic entities so output variation is determined to a great extent by factors outside the province's borders. However, automatic stabilizers could cause both government revenue and expenditure to respond immediately to changes in output. In our setup, r affects g contemporaneously, but r is not affected by g in the same period. This follows since tax rate changes typically occur infrequently, so within a year, revenue can be viewed as exogenous to government spending.

Our estimated VAR takes the form:

$$z_t = \Theta z_{t-1} + u_t , \tag{8}$$

where z is a vector consisting of y, r, and g, and Θ is a matrix of coefficients. The values for $\hat{u}_t$ from this VAR can be used to derive the estimated structural errors, $\hat{e}_t$, assuming the identification scheme given above. The structural VAR is:

$$Az_t = Bz_{t-1} + e_t , \tag{9}$$

where A and B are parameter matrices, A is lower triangular, and e is a vector of structural errors. The simulations are undertaken using:

$$z_t = \hat{\Theta} z_{t-1} + \hat{A}^{-1} \tilde{e}_t , \tag{10}$$

where the values of $\tilde{e}_t$ are the shocks drawn using a random number generator, and the standard deviation of the distribution from which the shocks are drawn is the same as that of the estimated structural shocks, while $\hat{\Theta}$ and $\hat{A}$ are matrices of the estimated VAR parameters.

3.3 Data and implementation

We estimate the VAR using a panel of annual data for the ten Canadian provinces over the period 1983 to 2009. The sample period was chosen since the required data are available only from 1981-2009, and two lags of each variable are included in the VAR, as this should be sufficient to eliminate serial correlation in the residuals (Beetsma, Giuliodori, Klaassen, 2008). Both r and g are deflated by the provincial government expenditure deflator, while y is deflated by the provincial consumer price index (CPI). For more detail on the data and sources, see the Data Appendix.

To increase the precision of our estimates, we estimate the model as a panel. To address possible heterogeneity, we include province fixed effects, province-specific time trends, and time fixed effects, following the methodology of Beetsma, Giuliodori and Klassen (2008) who estimate a VAR model using a panel of 14 European countries. Finally, to allow for the possibility of different behaviour and outcomes for provinces with resource-intensive economies and, therefore, greater revenue volatility, we estimate the VAR and calculate all the simulations for a smaller sample that consists of Alberta, Saskatchewan and Newfoundland.[10] [11] Impulse response functions for all ten provinces and for the three resource provinces are shown in Figures 1 and 2, respectively. Figure 1 shows, consistent with the observations of the OECD (2010), provincial government expenditure tends to be pro-cyclical, and to increase when revenue rises. This suggests that a fiscal rule has the potential to improve provincial government expenditure stability.

To generate the 1000 revenue and output series, a random number generator is used to draw values from a normal distribution with standard deviation equal to the standard deviation of the estimated structural errors from the VAR. The standard deviations for the values of y, r and g are .031, .057, and .025, respectively. For the resource province sample, the comparable values are .029, .082, and .027, indicating a somewhat higher volatility of r. We draw shocks for y, r and g to obtain 1000 series, each of length 200. The 100-period simulation begins in period 101, since the first 100 years are used to provide a history which will be needed to employ the HP filter and calculate the forecasts required for the *Swiss* and *no structural deficit* rules. Beginning in year 101 also means the values at the start of the simulation period are less dependent on the initial starting values. We

[10] For each of Alberta, Saskatchewan and Newfoundland, the standard deviation of the structural revenue shock is greater than .043, while this standard deviation takes a value of .023 for New Brunswick, .033 for PEI, and is below .02 for all other provinces.

[11] When the sample is split into resource and non-resource provinces, there is considerably less kurtosis in the estimated structural VAR errors. The estimated structural shocks also tend to be much closer to normally distributed. We drew the random shocks assuming a normal distribution with standard deviation given by that of the in-sample estimates of the structural shocks. These in-sample estimates show some skewness and kurtosis. Another method of drawing a random sample of shocks is to take draws with replacement from the in-sample estimates of the structural shocks assuming each of these structural shocks has an equal probability of being drawn. If we do this, the averages of the first four moments of the 1000 shocks are very similar to the first four moments of the in-sample estimated structural shocks. However, with the use of these shocks, preliminary estimates of the value of the standard deviation of simulated expenditure and of τ are very similar to those with the normal errors. This suggests that the assumption of normality of the simulated errors is not key to the results.

impose zero debt/assets at the start of the simulation. We repeat this procedure for the resource provinces, since the standard deviations of the shocks differ for this subsample.[12]

To make the calculation of the welfare gains tractable, output and government revenue and expenditure are assumed to be stochastic for only 200 periods, with the fiscal rule imposed and the simulation run on the final 100 of these observations. After the end of the 100 period simulation, revenue and output become non-stochastic. From period 201 onward, government revenue is set equal to $\bar{r}$, the average value of r over the simulation for the *balanced budget* fiscal rule. For each of the 1000 cases, government spending is then set equal to $\bar{r}$ plus the income from an annuity, where this annuity is the income that is generated each year forever by the assets accumulated at the end of the simulation. This specification incorporates a sufficiently long period of uncertainty to make useful comparisons of the different fiscal rules, but makes the determination of τ feasible.

As noted in Section 2, implementation of the *Swiss* and *no structural deficit* rules requires determination of the trend and forecast components of output and revenue, Y^T, R^T, Y^F and R^F in equations (2) and (3). To determine trends, we use a Hodrick-Prescott (HP) filter. To deal with the endpoint problem with the HP filter, we forecast for five periods, periods t to $t+4$.[13] The forecasts are conducted by estimating a second-order autoregressive process on the 50 observations up to and including period $t-1$, and using the estimates of that process to dynamically forecast the next five periods. We then apply the HP filter to the sample that consists of these five periods and the previous 50 periods (55 observations in total). The period t value of the HP filter-smoothed series is used as the trend value in period t.[14] For the *Swiss* rule we require forecasts for output, Y_t^F, and revenue, R_t^F. These are calculated using the same forecast methodology described above.

With the *balanced budget*, *rainy day* and *fixed deposit — fixed withdrawal rules*, spending is determined assuming current revenue is known. The justification for this information assumption is that, with these simple rules, the government can spend or save revenue as it is received. With the *moving average*, *Swiss*, and *no structural deficit* rules, the level of spending is set at the beginning of the period, so spending is based on revenue and output forecasts for period t.

[12] We use as starting values in the simulated VAR the average of the logs of the actual data for the sample. The constant terms used in the VAR simulation are the averages of the constant term for each observation implied by the estimated VAR (where the constant term for each observation incorporates the year effect, the province effect and the trend effect).
[13] See Mise, Kim, Newbold (2005) on the endpoint problem. Changing the magnitude of the weight in the HP filter was not found to be important to the results. We applied the forecasts and filters to the logs of the variables and then took exponentials, but the results did not change if the HP filter was used in level form.
[14] We also tried a quadratic trend, but it did considerably worse than the HP filter for all provinces and resource provinces in terms of the value of τ and the standard deviation of government spending.

4. Results

Tables 1 to 3 report the standard deviation of government spending and the value of τ from the simulations for the *moving average*, *rainy day* and *fixed deposit — fixed withdrawal* fiscal rules. Table 4 reports these results for the *Swiss* and *no structural deficit* rules, and for the best iteration of the other three types of rules. Also, as a general indication of how government spending varies with the different fiscal rules, Figures 3 and 4 graph the level of government expenditure for one of the 1000 simulations (the first simulation) for the *balanced budget*, *Swiss*, *no structural deficit*, and the best *moving average*, *rainy day*, and *fixed deposit — fixed withdrawal* rules. The figure shows that the path of government spending varies considerably across the different rules, even when the volatility or welfare, as captured by the standard deviation or by τ, does not differ greatly.

4.1 The *moving average* rule

The simple moving average rule described in section 2.1 implies government expenditure is determined by a moving average of past revenue without borrowing or asset accumulation constraints. Since current expenditure is not related to debt or asset stocks, debt or asset accumulation can grow without limit and reach an unsustainable level. For example, simulations show the range of asset accumulation for the 15-year *moving average* rule after 100 years is from -\$38,749 to \$30,773 per person. This is considerable, given that average annual government expenditure per person is just \$7168 (measured in 2002 dollars).

It is possible to prevent the accumulation of excessive debt or assets by adjusting expenditure in an amount equal to debt interest payments or interest earnings, as in equation (1'). When expenditure is adjusted to include interest payments, with the 15-year *moving average* fiscal rule, across the 1000 simulations the range of assets accumulated by the end of the 100 year simulation period is similar to the level of annual spending, and ranges from \$6951 to -\$7426.[15] Table 1 presents the welfare benefit, relative to the baseline case of a *balanced budget*, of a *moving average* fiscal rule adjusted for interest earnings. The welfare gains increase with a longer moving average process, which is not unexpected since it implies spending is smoothed over a longer period. With the 15-year moving average, the welfare gain as measured by τ is .280. This implies .280 percent of government spending would be given up each year forever to achieve the level of stabilization of government spending under the 15-year *moving average* fiscal rule, compared to having government

[15] In constructing the rule modified to include interest payments, assets are accumulated according to the formula $A_t=(1+r^r)(A_{t-1}+R_t-G_t)$, where r^r is the real per capita interest rate, $1+r_t=(1+i_t)/[(1+\pi_{t+1})(1+n_{t+1})]$, $\pi_{t+1}=(P_{t+1}-P_t)/P_t$, $n_{t+1}=(Pop_{t+1}-Pop_t)/Pop_t$, P_t is the price index in period t and Pop_t is the population of the province in period t. The real per capita interest rate is used since spending, revenue and assets are measured in per capita terms.

spending equal to revenue each period. This value is in the range of estimates from other studies of business cycle stabilization (Barro, 2009; Pallage and Robe, 2003). Also, the benefits of stabilization are likely to be greater than the amounts calculated here since our welfare measure includes only the consumption benefits and, therefore, it does not include the costs of re-allocating resources (ie., hiring and firing costs), or the potential negative effects on private sector investment arising from uncertainty associated with government spending volatility.

With the 15-year *moving average* rule adjusted to include interest payments, the standard deviation of government spending is .0267, which is less than half of .0645, the value with the *balanced budget* rule (Table 4). A similar reduction in volatility is observed for the three resource-dependent provinces, where the standard deviation of government spending is .0422 compared to .0877 with the *balanced budget* rule. These results show that a longer term *moving average* rule that incorporates interest payments or receipts can increase considerably the stability of government expenditure.

4.2 The *Swiss* and *no structural deficit* rules

The comparison of fiscal rules in Table 4 shows that the *Swiss* and the *no structural deficit* rules are very similar in terms of both the standard deviation of government expenditure and the value of τ. Also, these two rules are similar to the 15-year *moving average* rule (with interest payments), in terms of the standard deviation of government spending. However, the value of the welfare gain, τ, is greater for the 15-year *moving average* rule, a difference that is more apparent for the resource-dependent provinces. The explanation for this result is that, for the resource provinces, the *Swiss* and *no structural deficit* rules, on average, lead to real per capita debt accumulation of $9507 and $3118, respectively, by the end of the simulation period while the 15-year *moving average* rule leads to smaller debt accumulation of just $1420. As a consequence, real per capita spending after the simulation period is higher at $7639 with the 15-year *moving average* rule, compared to $7480 and $7606, respectively, with the *Swiss* and *no structural deficit* rules. For all provinces, relative to the 15-year moving average rule, the value of τ is only a bit lower with the *Swiss* and *no structural deficit* rules and the standard deviation of government spending is just slightly higher. The higher value of τ must result from the greater stabilization with the 15-year *moving average* rule, since future spending is a bit higher with the *Swiss* and *no structural deficit* rules, at $7203 and $7211, respectively, compared to $7165 with the 15-year *moving average* rule.[16]

[16] Debt accumulated for all provinces with the 15-year *moving average* rule is $164, compared to assets of $1802 and $2204 with the *Swiss* and *no structural deficit* rules.

The results in Table 4 suggest that the more simple and equally effective, 15-year *moving average* rule may be preferable to the more complicated *Swiss* and *no structural deficit* rules that require an understanding of the concept of a "structural" deficit. These other rules also involve forecasts and the need to determine trends, which make them more difficult to implement and explain to the public.

4.3 The *rainy day* rule with a borrowing constraint

The *rainy day* rule does not incorporate feedback from debt to current spending, so this fiscal rule can amass a large stock of debt. To prevent unsustainable debt accumulation, and following the requirements in many US states with rainy day-type fiscal rules, we impose a borrowing constraint. This implies the rule is modified so that asset accumulation is allowed, but if the fiscal rule from equation (4b) requires borrowing when accumulated government assets are zero, then current government spending equals current revenue.

One of the striking features of the *rainy day* rule with a borrowing constraint is that, in many cases, welfare is lower than with a *balanced budget* rule (Table 2). This is particularly observed when saving is high, so consumption is moved strongly to the future. For example, τ falls as low as -6.285 for a deposit rate of 15 percent of revenue and a lower bound of 93 percent of last period's revenue. The effect of considerable saving is also observed for the resource provinces, although it is weaker, presumably because of the greater need for saving due to higher volatility and persistence of shocks in resource-dependent provinces.

While the *rainy day* fiscal rule sometimes leads to welfare losses, as captured by the value of τ, Tables 2.A.1 and 2.B.1 show this rule always reduces the standard deviation of government expenditure. For all the provinces the standard deviation of government spending is around .05 in most cases, compared to .0645 with the *balanced budget* rule. In the best case, with a deposit rate of 15 percent and a lower bound of 100 percent of last period's revenue, it is just .0234.

The chief drawback of the *rainy day* rule, however, is that the welfare gain tends to change markedly with a small change in the deposit rate or the bound. Table 2.A.2 shows that, with the best rule, which implies a deposit rate of 10 percent and a lower bound of 100 percent, the value of τ is .204. However, if the bound is reduced to 99 percent of last period's revenue, τ falls to -.557. Reducing the bound to 99 percent from 100 percent leads to lower welfare since it means greater saving and a larger transfer of consumption to the future. Similarly, with the 100 percent bound a higher deposit rate of 15 percent also leads to a negative value for τ since, in this case, the higher rate of saving generates an unnecessarily large asset stock.

4.4 The *fixed deposit — fixed withdrawal* rule

Consistent with the *rainy day* rule, the *fixed deposit — fixed withdrawal* rule yields a welfare loss if saving and asset accumulation are too high. The rule tends to yield a positive value for τ when the deposit rate is somewhat lower, and the withdrawal rate is higher (Table 3). The highest welfare gain occurs with a deposit rate of 50 percent and a withdrawal rate of 90 percent. A higher saving rate is warranted, however, for the resource provinces where shocks are more variable and persistent. For resource provinces, the best withdrawal rate is 50 percent combined with a deposit rate of 50 percent.

The comparisons of the standard deviation of government expenditure yield the same relative pattern of benefits as with the welfare change measured by τ. The greatest stabilization, as indicated by the smallest measure of the standard deviation, results with a deposit rate of 50 percent and a withdrawal rate of 75 percent, which is not much lower than the 90 percent withdrawal rate that characterised the best case as measured by τ (Table 3.A.2). Also, Tables 3.A.1 and 3.B.1 show that the standard deviation of government expenditure increases considerably for low withdrawal rates, particularly rates of 10 percent or less. For example, the standard deviation of government spending is approximately seven times as great when the deposit rate is 100 percent and the withdrawal rate is 5 percent (.4557) compared to the *balanced budget* rule (.0645). This follows from the large fall in spending in early periods that is required with a 100 percent deposit rate even when there is a 10-year transition.

4.5 Policy discretion and "perfect foresight" rules

To put the comparison of the fiscal rules in context, it is useful to first compare the *balanced budget* rule (where spending each period is equal to revenue) with spending that is predicted by the estimated VAR model since the VAR estimates reflect the actual path of the data. This can be interpreted as a comparison of policy discretion with a *balanced budget* rule. The "discretionary" policy is modelled as the level of government spending found by solving the VAR dynamically when it is subject to random structural shocks where the shocks are based on our estimates as described in Section 3.

Rows 6 and 7 of Table 4 show that the simulations imply that discretionary policy has stabilized government spending since the standard deviation of spending is reduced by about 38 percent (from .0645 to .0397). Hence, even though the estimates from the VAR indicate government spending rises with output, thereby suggesting a pro-cyclical movement of government spending, the

VAR also shows government spending is quite persistent and stable (Figures 1 and 2). By contrast, with a *balanced budget* rule, government spending must follow revenue, which is highly volatile. Although the discretionary policy reduces government spending volatility, the share of government spending that would be willingly given up to have the discretionary policy rather than a *balanced budget* rule, τ, is negative and equal to -.328. The reason for this is that, with the VAR process, there is a tendency to accumulate significant assets, which implies lower current spending. Further, Table 4 and Figures 3 and 4 show that while discretionary spending, as shown by the VAR, stabilizes spending relative to the *balanced budget* rule, it does not stabilize expenditure as much with the 15-year *moving average*, *Swiss*, or *no structural deficit* rules.

Another useful comparison is the *balanced budget* rule with a "perfect foresight" rule that implies constant spending. Since it is not possible to know the path of future shocks to the economy, this path is not attainable, but it is useful to examine since it provides an upper benchmark against which to evaluate the fiscal rules. In this case, we assume the province has knowledge of the future path of revenue under the *balanced budget* rule. It uses this information to set government spending equal to average revenue over the course of the *balanced budget* simulation. This level differs for every one of the 1000 simulations. The welfare gain in this case, as indicated by the measure of τ, is .32 for all provinces and .55 for the resource provinces. This implies that the 15-year *moving average* rule does rather well, since the welfare gain, as measured by τ, is .280 which is 88 percent of the .32 value for τ obtained with constant government expenditure in the "perfect foresight" case. Similarly, for the resource provinces the value for τ with the *moving average* rule is large, at 80 percent of the "perfect foresight" value.

5. Discussion and Conclusions

The need for fiscal consolidation in many jurisdictions has led to increased consideration of fiscal rules. This study aims to improve our understanding of the benefits of different types of rules and to determine whether some rules increase welfare more than others. We use Monte Carlo methods to evaluate the welfare and stabilization performance of five types of fiscal rules. While the analysis uses data for Canadian provinces, the results may be applicable more broadly to any government that faces an uncertain revenue stream.

With all five types of fiscal rules considered, it is possible to increase welfare and government expenditure stability, relative to a policy of balancing the budget each period. The best fiscal rules reduce government expenditure volatility to about half of what it would be if spending equalled revenue every period. The stabilization benefit is greater for the three provinces with more resource-based economies — Alberta, Saskatchewan and Newfoundland. This is likely because of the greater revenue volatility in these provinces. While none of the rules completely stabilize government spending, a rule based on spending the 15-year the moving average of past revenue provides a welfare gain that is 88 percent of the welfare gain with constant government expenditure in the "perfect foresight" case.

Of all the government expenditure rules considered, the rule that provides the greatest stabilization and welfare gain — where government expenditure equals a 15-year moving average of past revenue — is arguably also the most simple. The rule must, however, incorporate interest payments on debt or receipts on assets, since this creates feedback from government debt or assets to spending and, thereby, prevents excess debt or asset accumulation.

Rules that require no structural deficit, including the type of rule employed in Switzerland, Austria and Germany, are more complicated than the 15-year moving average rule, but perform no better. Further, these rules require forecasts for revenue and output, and their greater complexity may mean they are more difficult to implement, and for the public to understand. In their review of fiscal rules, Schaechter, Kinda, Budina and Weber (8, 2012) note that, with a structural budget balance rule, "correction for cycle is complicated, especially for countries undergoing structural changes" and "complexity makes it more difficult to communicate and monitor."

The analysis above abstracts from political economy issues associated with the implementation of a fiscal rule, but these may make the moving average rule more attractive. The moving average rule is quite simple and easy to understand. A simple rule may give politicians less room for discretion which could help insulate policymakers from short-term political pressure – say to increase spending during booms. A simple fiscal rule may also increase clarity and transparency in fiscal policy decision making, and this may facilitate monitoring by the public, which may be an important component of a successful rule.

References

Alberta, Alberta Treasury Board and Finance. 2012a. *Alberta Heritage Savings Trust Fund, Annual Report 2011-12*.

Alberta, Treasury Board and Finance. 2012b. *Dollars and Sense, Backgrounder B: Alberta's Current Savings Framework and Savings Accounts*. http://finance.alberta.ca/business/budget/BackgrounderB-Alberta-Current-Savings-Framework-and-Savings-Accounts.pdf

Barro, Robert. 2009. "Rare Disasters, Asset Prices, and Welfare Costs," *American Economic Review*, 99:1, 243-264.

Beetsma, Roel, Massimo Giuliodori, and Franc Klaassen. 2008. "The Effects of Public Spending Shocks on Trade Balances and Budget Deficits in the European Union," *Journal of The European Economic Association*, April-May 6(2-3),: 414-423

Bernanke, Ben, 2012, "Fiscal Sustainability and Fiscal Rules," Comments at the Annual Meeting of the Rhode Island Pubic Expenditure Council, Providence, Rhode Island, 4 October 2010.

Bohn, Henning. 2007. "Are stationarity and cointegration restrictions really necessary for the intertemporal budget constraint?" *Journal of Monetary Economics* 54, 1837-1847.

Budina, Nina and Sweder van Wijnbergen. 2007. "Quantitative approaches to fiscal sustainability analysis: A new World Bank tool applied to Turkey." World Bank Policy Research Working Paper 4169, March.

Celasun, Oya, Xavier Debrun, and Jonathan D. Ostry, 2007. "Primary surplus behavior and risks to fiscal sustainability in emerging market countries: A 'fan-chart' approach," *IMF Staff Papers* 53:3, 401-425.
Daniel, James A. 2001. "Hedging government oil price risk," IMF Working Paper WP/01/185, November.

Davis, Jeffrey, Rolando Ossowski, James A. Daniel and Steven Barnett. 2003. "Stabilization and savings funds for non-renewable resources: Experience and fiscal policy implications," in J. M. Davis, R. Ossowski and A. Fedelino, editors, *Fiscal Policy Formulation and Implementation in Oil-Producing Countries*, International Monetary Fund.

Debrun, Xavier, Laurent Moulin, Alessandro Turrini, Joaquim Ayuso-i-Casals and Manmohan S. Kumar, 2008, "Tied to the Mast? National Fiscal Rules in the European Union," *Economic Policy*, April, 299-362.

Iara, Anna and Guntram B. Wolff, 2011, "Rules and Risk in the Euro Area," October, Bruegel Working Paper 2011/10.

IMF, 2010, "Strategies for Fiscal Consolidation in the Post-Crisis World," February.

Kastrop, Christian, Helmut Herres, Jürgen Schnieder, Bernd Hanke, Elke Baumann, Martin Snelting and Elmar Dönnebrink. 2009. *Reforming the Constitutional Budget Rules in Germany*. Deficit Rule Reform Team. Federal Ministry of Finance — Economics Department Public Finance and Economic Affairs Directorate.
OECD, 2010, *OECD Economic Surveys: Canada. Overview*. September.

Lucas, Robert E. 2003. "Macroeconomic priorities," *American Economic Review*, 93:1, 1-14.

Mise, Emi, Tai-Hwan Kim, Paul Newbold, 2005. "On suboptimality of the Hodrick-Prescott filter at time series endpoints," *Journal of Macroeconomics*, Vol. 27, 53-67.

Ossowski, Rolando, Mauricio Villafuerte, Paulo A. Medas and Theo Thomas. 2008. *Managing the Oil Revenue Boom: The Role of Fiscal Institutions*, Occasional Paper 260, International Monetary Fund, Washington, D.C.

Pallage, Stephane and Michel Robe. 2003. "On the welfare cost of business cycles in developing countries," *International Economic Review* 44:2, 677-98.

Schaechter Andrea, Tidiane Kinda, Nina Budina, and Anke Weber (2012) "Fiscal Rules in Response to the Crisis — Toward the "Next-Generation" Rules. A New Dataset." IMF Working Paper WP/12/187.

Steger, Gerhard, 2010, "Austria's Budget Reform: How to Create Consensus for a Decisive Change of Fiscal Rules." *OECD Journal of Budgeting*, Volume 2010/1.

Sutherland, Douglas, Robert Price and Isabelle Joumard, 2005, "Fiscal Rules for Sub-Central Governments: Design and Impact," OECD Working Paper No 1. COM/CTPA/ECO/GOV/WP(2006)/1.

Tapp, Stephen, 2010, "Canadian Experiences with Fiscal Consolidations and Fiscal Rules," Office of the Parliamentary Budget Officer, Ottawa, Canada. 21 October 2010.

Wijnbergen, Sweder van and Nina Budina. 2011. "Fiscal sustainability, volatility and oil wealth: A stochastic analysis of fiscal spending rules." Tinbergen Institute Discussion Paper TI 2011-068/2.

Data Appendix

All the data are derived from Statistics Canada *Cansim* database. The output, government expenditure and government revenue data are from the *Provincial Economic Accounts*. The data are for the 10 provinces of Canada and are converted to real per capita terms. The variables are:

Population: Source Table 510001, Series V466983, V467298, V467613, V467928, V468243, V468558, V468873, V469188, V469503, V469818.

Output: Provincial GDP. Source Table 3840002, Series V687375, V687409, V687443, V687477, V687511, V687545, V687579, V687613, V687647, V687681.

Consumer Price Index: This is used to deflate output. Source: Table 3260021, Series V41693542, V41693677, V41693811, V41693946, V41694081, V41694217, V41694353, V41694489, V41694625, V41694760.

Government Price Index: Implicit price index for net government current expenditure on goods and services. This is used to deflate government expenditure and government revenue. Table 3840036, Series V3840600, V3840629, V3840658, V3840687, V3840716, V3840745, V3840774, V3840803, V3840832, V3840861

Revenue: Total provincial revenue from all sources. Table 3840004, Series V689282, V689305, V689328, V689351, V689374, V689397, V689420, V689443, V689466, V689489.

Expenditure: Provincial government current expenditure plus provincial government investment in fixed capital and inventories minus provincial government debt interest payments. Source: Current Expenditure: Table 3840004, Series V689291, V689314, V689337, V689360, V689383, V689406, V689429, V689452, V689475, V689498; Investment: Table 3840004, Series V689301, V689324, V689347, V689370, V689393, V689416, V689439, V689462, V689485, V689508; Debt Interest: Table 3840004, Series V689297, V689320, V689343, V689366, V689389, V689412, V689435, V689458, V689481, V689504.

The base year for both price indexes is 2002.

Table 1: The *Moving Average* Fiscal Rule (Adjusted for Interest Earnings or Payments)

	Standard deviation of government spending		**Value of τ**	
	All Provinces	Resource Provinces	All Provinces	Resource Provinces
Moving average length				
2-years	.0510	.0731	.121	.180
5-years	.0396	.0600	.208	.310
7-years	.0356	.0549	.234	.354
10-years	.0313	.0490	.258	.399
12-years	.0292	.0458	.269	.420
15-years	.0267	.0422	.280	.441

Table 2: The *Rainy Day* Fiscal Rule with a Borrowing Constraint

2.A.1: Values for the Standard Deviation of Government Spending, All Provinces

	Deposit Amount (% of revenue)				
Bound	1%	3%	5%	10%	15%
93%	.0576	.0571	.0570	.0569	.0569
95%	.0570	.0544	.0543	.0542	.0542
97%	.0579	.0508	.0502	.0500	.0501
99%	.0592	.0522	.0453	.0412	.0410
100%	.0597	.0541	.0509	.0383	**.0234**

2.A.2: Values for τ, All Provinces

	Deposit Amount (% of revenue)				
Bound	1%	3%	5%	10%	15%
93%	.074	-.026	-.487	-2.790	-6.285
95%	.070	.064	-.298	-2.430	-5.797
97%	.062	.134	-.029	-1.811	-4.921
99%	.051	.111	.168	- .557	-2.906
100%	.047	.095	.123	**.204**	- .139

2.B.1: Values for the Standard Deviation of Government Spending, Resource Provinces

	Deposit Amount (% of revenue)				
Bound	1%	3%	5%	10%	15%
93%	.0808	.0769	.0767	.0765	.0764
95%	.0817	.0740	.0730	.0727	.0725
97%	.0827	.0749	.0687	.0668	.0665
99%	.0835	.0780	.0734	.0572	.0542
100%	.0839	.0792	.0766	.0679	**.0515**

2.B.2: Values for τ, Resource Provinces

	Deposit Amount (% of revenue)				
Bound	1%	3%	5%	10%	15%
93%	.089	.337	.394	-.630	-2.814
95%	.075	.255	.443	-.284	-2.229
97%	.063	.161	.356	.195	-1.441
99%	.053	.121	.180	**.539**	.054
100%	.049	.107	.143	.263	.507

Table 3: The *Fixed Deposit — Fixed Withdrawal* Rule

3.A.1 The Standard Deviation of Government Spending, All Provinces

Deposit Rate (d)	Withdrawal Rate (w) 5%	10%	25%	50%	75%	90%
5%	.0637	.0622	.0617	.0617	.0617	.0616
10%	.0684	.0622	.0600	.0592	.0591	.0590
25%	.1054	.0755	.0574	.0537	.0531	.0530
50%	.1973	.1251	.0688	.0523	**.0499**	.0503
75%	.3092	.1913	.0935	.0606	.0551	.0560
100%	.4557	.2727	.1258	.0755	.0665	.0675

3.A.2 Values of τ, All Provinces

Deposit Rate (d)	Withdrawal Rate (w) 5%	10%	25%	50%	75%	90%
5%	.018	.026	.028	.028	.028	.028
10%	-.052	.016	.046	.050	.051	.052
25%	-.812	-.240	.032	.089	.099	.100
50%	-4.203	-1.548	-.228	.058	.106	**.110**
75%	-11.583	-4.371	-.831	-.095	.028	.040
100%	-28.544	-9.819	-1.864	-.376	-.131	-.103

3.B.1 The Standard Deviation of Government Spending, Resource Provinces

Deposit Rate (d)	Withdrawal Rate (w) 5%	10%	25%	50%	75%	90%
10%	.0837	.0809	.0804	.0808	.0812	.0813
25%	.0995	.0809	.0726	.0724	.0733	.0739
50%	.1651	.1085	.0717	**.0651**	.0667	.0686
75%	.2596	.1611	.0871	.0684	.0699	.0735

3.B.2 Values for τ, Resource Provinces

Deposit Rate (d)	Withdrawal Rate (w) 5%	10%	25%	50%	75%	90%
10%	.220	.152	.114	.096	.088	.084
25%	.084	.193	.220	.204	.186	.178
50%	-1.555	-.340	.206	**.285**	.267	.247
75%	-5.916	-1.969	-.091	.241	.244	.210

Table 4: Comparison of Selected Fiscal Rules

	Standard deviation of government spending		**Value of τ**	
	All Provinces (1)	Resource Provinces (2)	All Provinces (3)	Resource Provinces (4)
1. 15-year *moving average* rule, includes interest	.0267	.0422	.280	.441
2. *Swiss* rule	.0270	.0449	.269	.294
3. *No structural deficit* rule	.0287	.0446	.268	.383
4. *Rainy day* rule, with borrowing constraint. Deposit 10%; Bound: 100% for All Provinces, 99% for Resource Provinces.	.0383	.0573	.204	.539
5. *Fixed deposit — fixed withdrawal* rule. Deposit 50%, Withdraw: 90% for All Provinces, 50% for Resource Provinces.	.0503	.0651	.110	.285
6. VAR	.0397	.0456	-.328	-.343
7. *Balanced budget* rule	.0645	.0877		

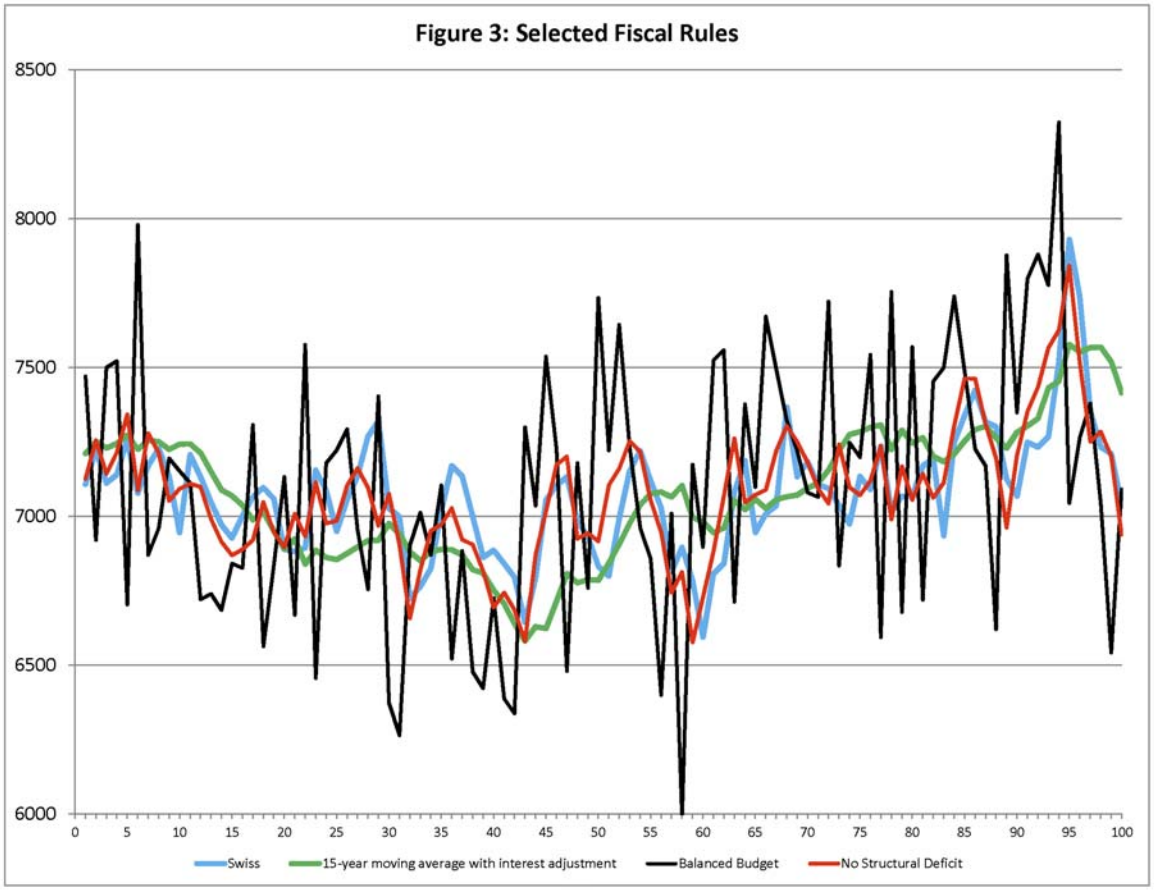
Figure 3: Selected Fiscal Rules
8500
8000
7500
7000
6500
6000
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
Swiss
15-year moving average with interest adjustment
Balanced Budget
No Structural Deficit

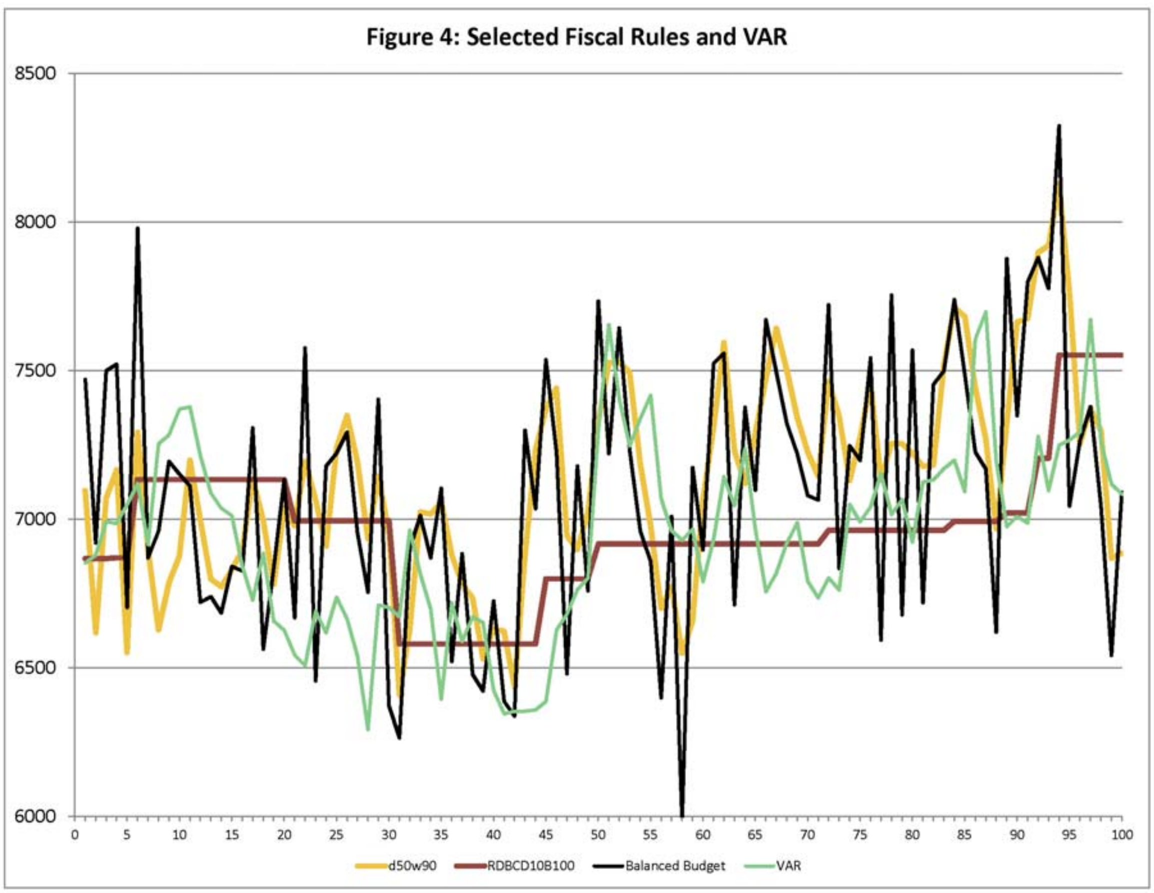
Figure 4: Selected Fiscal Rules and VAR
8500
8000
7500
7000
6500
6000
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
d50w90
RDBCD10B100
Balanced Budget
VAR

Department of Economics, University of Alberta
Working Paper Series

2015-12: Law and Economics and Tort Litigation Institutions: Theory and Experiments - **Landeo, C.**
2015-11: Effective Labor Relations Laws and Social Welfare - **Landeo, C.,** Nikitin, M.
2015-10: Stipulated Damages as a Rent-Extraction Mechanism: Experimental Evidence - **Landeo, C.,** Spier, K.
2015-09: Incentive Contracts for Teams: Experimental Evidence - **Landeo, C.,** Spier, K.
2015-08: Financially-Constrained Lawyers - **Landeo, C.,** Nikitin, M.
2015-07: Plant Breeders' Rights, Patents and Incentives to Innovate - Hervouet, A., **Langinier, C.**
2015-06: Physical Activity, Present Bias, and Habit Formation: Theory and Evidence from Longitudinal Data - Humphreys, B., Ruseski, J., **Zhou, L.**
2015-05: The Impact of Female Education on Teenage Fertility: Evidence from Turkey – **Günes, P.**
2015-04: Credit Constraints, Technology Upgrading, and the Environment – **Andersen, D.**
2015-03: On the Optimal Design of Demand Response Policies – **Brown, D.,** Sappington, D.
2015-02: Fiscal Transparency, Measurement and Determinants: Evidence from 27 Developing Countries – Tehou, Y., **Sharaf, M.**
2015-01: Trends in Earnings Inequality and Earnings Instability among U.S. Couples: How Important is Assortative Matching? – **Hryshko, D.,** Juhn, C., McCue, K.
2014-13: Capacity Payment Mechanisms and Investment Incentives in Restructured Electricity Markets – **Brown, D.**
2014-12: On the Optimal Design of Distributed Generation Policies: Is Net Metering Ever Optimal? – **Brown, D.,** Sappington, D.
2014-11: Output Growth and Commodity Prices in Latin America: What Has Changed? – **Fossati, S.**
2014-10: A Survey of the Economics of Patent Systems and Procedures – **Eckert, A., Langinier, C.**
2014-09: Using Bayesian Imputation to Assess Racial and Ethnic Disparities in Pediatric Performance Measures – **Brown, D.,** Knapp, C., Baker, K., Kaufmann, M.
2014-08: Effects of an Integrated Care System on Children with Special Heath Care Needs' Medicaid Expenditures – Marcu, M., Knapp, C., Madden, V., **Brown, D.,** Wang, H., Sloyer, P.
2014-07: The Effect of Subsidized Entry on Capacity Auctions and the Long-Run Resource Adequacy of Electricity Markets – **Brown, D.**
2014-06: The Impact of Place-Based Employment Tax Credits on Local Labor: Evidence from Tax Data – Tong, P., **Zhou, L.**
2014-05: The Louis-Schmelling Paradox and the League Standing Effect Reconsidered – Humphreys, B., **Zhou, L.**
2014-04: Urban Casinos and Local Housing Markets: Evidence from the US – **Huang, H.,** Humphreys, B., **Zhou, L.**
2014-03: Loss Aversion, Team Relocations, and Major League Expansion – Humphreys, B., **Zhou, L.**
2014-02: Do Urban Casinos Affect Nearby Neighborhoods? Evidence from Canada – **Huang, H.,** Humphreys, B., **Zhou, L.**
2014-01: Rule-Based Resource Revenue Stabilization Funds: A Welfare Comparison – **Landon, S., Smith, C.**