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# Does the Design of a Fiscal Rule Matter for Welfare?

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**Abstract**

This study uses Monte Carlo methods to examine the impact on welfare of several types of commonly used fiscal rules. The simulations employ an expected intertemporal welfare function and the parameters from a three-variable structural VAR estimated using data for sixteen European countries. The VAR captures the potential interaction effects between output, government spending and revenue. We find welfare gains from many, but not all, of the fiscal rules. The best rules target a zero structural deficit and cause government spending volatility to fall by about one third. However, a simple rule, where government expenditure is set equal to a one-period ahead forecast of revenue, performs almost as well. In particular, this simple rule yields a welfare gain and a reduction in volatility similar to that of the more complicated zero structural deficit rule adopted by Switzerland and several other countries. Balanced budget rules perform less well than rules that target the structural deficit. A rule that keeps real per capita government spending equal to a constant—a type of rule adopted by some U.S. states—yields relatively low welfare and often leads to significant debt accumulation. These results highlight the importance of the appropriate design of a fiscal rule.

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

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

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## 1. Introduction

Over the past decade, a growing number of governments have adopted fiscal rules (Bova et al., 2015). European countries are at the forefront of this trend and, in 2014, 25 European Union member states ratified a "fiscal compact" that commits them to introduce a fiscal rule. While there is a large empirical literature on fiscal rules (see the survey by Auerbach (2013)), there is no consensus on the welfare consequences of rules or whether fiscal rules provide stabilization benefits. This inconclusiveness may be due to differences in the types of rules studied.[1] Our analysis complements the growing empirical literature on fiscal rules by combining estimates for a panel of European countries with simulation methods to evaluate several rule types. We focus on welfare and the ability of a fiscal rule to stabilize government spending while, at the same time, avoiding excessive debt accumulation. The impact of a rule on these factors is found to differ across the rules considered, a result that highlights the importance of fiscal rule design.

One of our principal findings is that with several, but not all, of the commonly-used fiscal rules, it is possible to increase both welfare and government expenditure stability relative to the baseline of discretion. Expenditure volatility is an important issue for governments, not only because unpredictable levels of government services reduce welfare for risk averse individuals, but also because volatility can lead to higher government operating costs (Crain, 2003), and may reduce economic activity by causing greater uncertainty about future returns to capital (Born and Pfeifer, 2014; Fernández-Villaverde et al., 2015). With the best rules, government expenditure volatility is reduced by about a third. The gains are significantly greater when compared to spending under a dysfunctional or “profligate” government scenario, where the government has a spending bias and exhibits restraint only if debt becomes too large. Passarelli and Tabellini (forthcoming) argue that this type of behaviour may explain government expenditure in some countries, and our findings indicate that a well-designed fiscal rule can be particularly helpful in these cases.

Our results also show that a good rule need not be complex. 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 (Geier, 2011). This rule is relatively complicated – it involves two forecasts and a trend calculation – and yields a welfare gain that is slightly lower than a simpler rule that sets spending equal to trend revenue. An even more straightforward rule, where government spending depends only on a one-period ahead univariate forecast of revenue, yields the same welfare gain as the rule employed by Switzerland. The greater simplicity of the univariate

[1] For a discussion of different types of fiscal rules, procedures and institutions, see Hallerberg et al. (2007), Debrun et al. (2008), and Schaechter et al. (2012).

forecast-based rule may be a consideration for policymakers who must communicate the form and operation of a rule to the public.

A third major result is that some fiscal rules, although not those that yield the greatest welfare, generate high levels of government debt. The accumulation of considerable debt may be unsustainable if it leads to overly burdensome interest payments, significant interest rate hikes or complete exclusion from capital markets. An example of a fiscal rule that often leads to high debt and lower welfare is a rule that sets government real per capita expenditure equal to a constant, such as the historical average of real per capita government revenue. This type of rule has been employed by some U.S. states.

With the best rules, our findings reveal that government spending responds to changes in revenues, but does not respond so quickly that little expenditure stabilization is provided. A balanced budget rule, where program spending equals observed revenue from the previous period, with any accumulated debt repaid in the following period, prevents excessive debt accumulation, but provides virtually no expenditure stabilization and, as a result, yields lower welfare than most of the other rules.

As the future paths of output and revenues are unknown when a rule is chosen, we assess the fiscal rules using Monte Carlo simulations. Welfare is given by a standard expected intertemporal utility function in which utility in each period depends on both the level and volatility of government spending and private consumption, where the latter depends on total output and government revenue. The interaction between output, government revenue and government spending is represented by a three-variable structural vector autoregression (VAR). Given the impetus toward reform of fiscal institutions in Europe, we estimate the parameters of the structural VAR using a panel of data for sixteen European countries. The welfare gain from a rule is quantified by comparing expected welfare under the rule to expected welfare when government spending and private consumption are simulated using the estimates of a structural VAR – interpreted as the baseline *discretionary* policy.

Many studies have examined the operation of fiscal rules in U.S. states, some of which have employed fiscal rules since the 1800s. These studies typically focus on a specific type of rule — a balanced budget rule — and emphasize the technical and political characteristics of various forms of balanced budget rules and the effect of these on the size and persistence of state budget deficits (Poterba, 1995; Bohn and Inman, 1996; Hou and Smith, 2010; Smith and Hou, 2013). In Europe, concern about debt growth in the euro area has led to a number of studies on the efficacy of fiscal rules (Brück and Zwiener, 2006; Hauptmeier et al., 2011; Maltritz and Wuste, 2015; Grembi et al., 2016). Some studies find that fiscal rules reduce government expenditure volatility (Badinger, 2009;

Holm-Hadulla et al., 2012), but others conclude that rules lead to an increase in volatility (Bayoumi and Eichengreen, 1995; St. Clair, 2012; Staley, 2015). While the existing empirical studies are useful to assess the prudence (or lack thereof) of specific fiscal outcomes over particular historical periods, a key innovation of our study is that, through the use of empirical estimates and simulation methods, we can simulate the performance of any type of fiscal rule under comparable revenue and output shock conditions. This allows us to compare welfare under different fiscal rule designs, such as various types of balanced budget rules, which have been popular in the U.S., and rules that maintain a structurally balanced budget, which tend to be favoured in Europe.

Another literature related to the current study employs dynamic stochastic general equilibrium (DSGE) models to examine the benefits of fiscal rules. Pieschacón (2012) finds that fiscal discipline can smooth consumption and increase welfare following oil price shocks, but she does not evaluate or compare different fiscal rules. Medina and Soto (2016) compare a small number of rules in a DSGE model for Chile, but examine only the impact on macroeconomic variables, not the impact on welfare. Kumhof and Laxton (2013) and Snudden (2016) find that a counter-cyclical rule can increase welfare by more than a balanced budget rule, but may do so only at the cost of greater instrument (tax rate) volatility. According to Vogel et al. (2013) and Ojeda-Joya et al. (2016), the potential welfare gains from a fiscal rule are large, but only if households are liquidity-constrained. Although they use a very different methodology than we employ, Mayer and Stähler (2013) observe welfare gains from switching to a Swiss-style "debt brake" rule from a balanced budget rule, a result that is consistent with our findings. Using an endogenous growth model, Groneck (2010) finds that the welfare implications of a deficit spending rule, relative to a balanced budget rule, depend on whether the increase in spending that generates the deficit goes on public consumption or public investment. The general differences between our study and these studies are that we employ the estimates of a structural VAR model in our simulations, examine a greater variety of rules and investigate the relative welfare impact of the different rules.

Some insight into the potential welfare benefits of fiscal rules can be gained from studies that focus on resource revenue stabilization funds in commodity-producing countries. These jurisdictions experience highly volatile revenues and are, therefore, more likely to benefit from a rule (Céspedes and Velasco, 2014). Using numerical simulations for a stylized oil-producing country, Maliszewski (2009) concludes that *ad hoc* savings rules perform poorly, but Engel et al. (2011) and Landon and Smith (2015) find considerable benefit from the use of simple savings rules for commodity exporters. While these studies focus on resource producers and resource revenue savings funds, they show that the design of a rule is important for welfare.

A government with complete information and no political constraints could choose the welfare maximizing path for government expenditures and would have no need for a fiscal rule to constrain government behavior. However, the structure of political decision making can generate an expenditure and deficit bias when different groups with influence over expenditure differ in their spending preferences and treat government resources as common property. Deficit bias may also arise due to information asymmetries and the delegation of decision making power to government representatives by the electorate, which allows the government to exploit the incomplete information of the electorate to increase the chances of re-election. As well, deficit bias can arise if, because they may lose office in an election, politicians discount the future using a higher discount rate than the electorate.[2] In such cases, a fiscal rule is a means to impose discipline on government and control expenditure and deficit bias.

Fiscal rules can be used to target government debt, deficits, expenditure, or other fiscal objectives. To reach these targets, governments must adjust revenue or expenditure. For all the rules we consider, the *instrument* we employ is government expenditure.[3] We focus solely on expenditure as the instrument since this allows tax rates to remain constant, which Barro (1979) argues can improve economic efficiency.[4] Further, Ayuso-i-Casals (2012) argues that expenditure is the part of the budget that governments can most easily control, and Anderson and Minarik (2006, 194) note that violations of constraints on expenditure are "transparent and incontrovertible." Finally, Hauptmeier et al. (2011) focus on expenditure since they find that virtually the whole deterioration of fiscal deficits in the euro area countries examined since the start of EMU (of about 5 percent of GDP) was due to an increase in the primary expenditure ratio.[5]

The fiscal rules we analyse differ from the "rainy day" funds employed by some U.S.

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[2] Calmfors and Wren-Lewis (2011) and Wyplosz (2013) discuss institutions aimed at overcoming deficit bias, including "fiscal councils" and independent fiscal policy committees such as Britain's *Office for Budget Responsibility.* On deficit bias see also Alesina and Perotti (1995), von Hagen and Harden (1995), Kontopoulos and Perotti (1999), Velasco (2000) and Lockwood et al. (2001).

[3] With a single policy target, if we had specified both revenues and expenditures as instruments, the levels of these instruments would have been indeterminate. For example, high spending and high revenues or low spending and low revenues can both generate a balanced budget.

[4] Boije et al. (2010) and Calmfors et al. (2012) argue that governments aim to adjust expenditure to "allow (marginal) tax rates to remain constant" and to "avoid a situation in which poor expenditure necessitates gradually higher taxes" (Boije et al., 2010, 207).

[5] A large literature examines the relative impact on output of discretionary deficit financed tax cuts and spending increases, with tax cuts found by several studies to be more expansionary than spending increases (see, for example, Mountford and Uhlig (2009) and Jha et al. (2014), and the references cited therein). This evidence might suggest that the policy instrument determined by a fiscal rule should be government revenues rather than expenditures. On the other hand, if revenues rather than expenditures were adjusted to make a fiscal rule hold (such as a balanced budget rule), this would likely imply frequent tax rate changes and, given the larger multiplier associated with these changes, greater output volatility. Frequent tax rate changes may also be difficult to administer, may involve long lags in implementation and, importantly, may have negative efficiency implications as suggested by Barro (1979).

states. With rainy day funds, the proportion of government revenue saved each year is determined *ex ante* by a rule, while the choice of withdrawals from the fund are typically left to the discretion of the government. Thus, with a rainy day fund, the amount saved in the fund is set by a rule, but expenditures are not rule-based.

In the next section, we describe the fiscal rules and, in Section 3, we outline the methodology used to compare the performance of the rules. We present the results in Section 4, robustness tests in Section 5 and, in the final section, we discuss our findings.

## 2. The Fiscal Rules

The fiscal rules we analyze are similar to rules that have been adopted by central and sub-central governments around the world. We examine three types of balanced budget rules, as well as a rule based on the moving average of past revenue, and two rules that target a zero structural deficit. We also consider a rule based on historical average revenue and, for comparison purposes, a "profligate" government spending path. For all the rules, government debt accumulation is given by:

$$D_t = (1+r)(D_{t-1} - R_t + G_t), \tag{1}$$

where $G_t$ is real per capita program spending in period $t$, $R_t$ represents real per capita revenue in period $t$, $D_{t-1}$ is real per capita debt at the end of period $t\text{-}1$, and $r$ is the real interest rate. The form of equation (1) implies that the government pays interest in period $t$ on new debt accumulated in period $t$. All variables are expressed in real per capita terms to facilitate the interpretation of the results.

### 2.1 *Current period balanced budget*, *forecast balanced budget*, and *one-lag balanced budget* rules

Many central and sub-central governments, including most U.S. states, employ variations of rules that target a balanced budget. The most straightforward rule of this type requires government program spending plus debt interest payments to equal revenue in every period:

$$G_t = R_t - \tfrac{r}{1+r}\overline{D}, \tag{2}$$

where $\overline{D}$ is debt accumulated at the time the rule is adopted. Since this rule implies a deficit of zero in every period, once the rule is implemented, the stock of debt is constant. A difficulty with implementing this simple *current period balanced budget* rule is that it sets current spending equal to current revenue (less debt interest costs), but current revenue is generally not known in the current period, which makes this rule infeasible to implement. A variation of this rule, termed the *forecast* *balanced budget* rule, relaxes this strong informational requirement and sets total spending equal to a forecast of current revenue:

$$G_t = R_t^F - \tfrac{r}{1+r} D_{t-1}, \tag{3}$$

where $R_t^F$ is a forecast of revenue in period $t$ based on revenue and, potentially, other information from period $t$-1 and before. Since the forecast is based on past revenue, movements in $R_t^F$ tend to be smoother than movements in actual revenue, so government spending will also tend to be less volatile with this rule than with the rule described in (2). Since $R_t^F$ need not equal $R_t$, the budget need not be balanced in every period and the level of government debt will vary through time. A rule that is similar to this *forecast balanced budget* rule is employed by Sweden.[6]

An alternative type of balanced budget rule, similar to the rules used by some U.S. states, avoids debt of longer than one period in duration. Unlike the *current period balanced budget* rule of equation (2), this rule does not require knowledge of the level of current period revenue when current period program spending is set. Rather, this *one-lag balanced budget* rule requires only that total spending equal observable revenue from the previous period and that any debt accumulated in one period be paid off in the next period. Hence, under the *one-lag balanced budget* rule, $G$ follows:[7]

$$G_t = R_{t-1} - (D_{t-1} - \overline{D}) - \tfrac{r}{1+r}\overline{D}. \tag{4}$$

Equation (4), in conjunction with equation (1), ensures that, if $R_{t-1}$ equals $R_t$, the level of debt will not change and $D_t$ will equal $\overline{D}$.

## 2.2 *Moving average* and *average revenue* rules

A moving average of revenue is more stable than actual revenue, so government spending will be less volatile if it is set equal to a moving average of past revenue. One shortcoming of a rule in which spending is based on a moving average of revenue is that, if current government spending depends only on past revenue, debt can grow indefinitely since there is no feedback to current spending from accumulated debt. Theoretical and empirical studies show that a fiscal rule can be

[6] The rule used by Sweden differs from equation (3) in that the Swedish government employs a forecast of revenue three years in the future, rather than just one year. As well, rather than a balanced budget, the Swedish fiscal target is a 1 percent (reduced from 2 percent in 2007) surplus of government spending as a share of GDP (Anderson and Minarik, 2006; Boije et al., 2010).

[7] Hou and Smith (2006) discuss the technical and political methods U.S. states employ to make balanced budget rules operational. For example, they note (p.39) that Illinois state law allows debt to be incurred, but it must be repaid within one year, which is similar to the rule described by equation (4).

stabilizing if it incorporates a sufficiently strong feedback mechanism (Bohn, 2007; Celasun et al., 2007; Wijnbergen and Budina, 2011). To reduce the likelihood of unsustainable debt (or asset) accumulation, the *moving average* rule employed here incorporates feedback by setting program spending equal to the moving average of revenue less interest payments on government debt:

$$G_t = \frac{1}{n}\sum_{j=1}^{n} R_{t-j} - \tfrac{r}{1+r} D_{t-1}, \tag{5}$$

where *n* is the length of the moving average in years. The simulations below employ values for *n* of 2, 5, 7 and 10. Russia and Algeria employed fiscal rules for resource revenue with characteristics similar to the *moving average* rule (Ossowski et al., 2008), while, in 2005, California voters considered a proposal to require the state's spending limit to be based on the average of revenue growth over the preceding three years (Waisanen, 2014).

Even more expenditure stabilizing than the *moving average* rule is a rule that sets government real per capita program spending (plus interest payments on the debt accumulated when the rule is implemented) equal to the average of real per capita revenue over an historical period; for example, the 10 years prior to the implementation of the rule. This *average revenue* rule provides the most extreme form of smoothing, since it sets real per capita program expenditure equal to a constant. Since expenditure is constant in real per capita terms, government program spending increases only with inflation and population growth. The CATO Institute advocates this type of fiscal rule (New, 2001), and a similar type of constraint on expenditures has been instituted in six U.S. states.[8]

### 2.3 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); that is, a budget balanced over the business cycle.[9] Following Geier (2011), the *Swiss* rule is specified as:[10]

$$G_t = \frac{Y_t^T}{Y_t^F} R_t^F - \tfrac{r}{1+r} D_{t-1}, \tag{6}$$

where $R_t^F$ is a forecast of revenue in period *t*, $Y_t^T$ is trend output (GDP) in period *t*, obtained using a

[8] Waisanen (2014) describes rules that aim to limit growth in government expenditure to inflation plus population growth in the U.S. states of Alaska, Colorado, Nevada, Ohio, Utah and Washington.

[9] The Swiss rule was approved by 85 percent of voters, is anchored in the Swiss constitution, and cannot be changed without a referendum.

[10] The rule employed in equation (6) is a simplified version of the rule used by Switzerland, since the latter offers an escape clause for extraordinary situations. If the escape clause is triggered, a record of deviations from the rule is kept in a notional compensation account and the balance in this account must be subsequently eliminated (Geier, 2011).

Hodrick-Prescott (HP) filter, and $Y_t^F$ is a forecast of output in period *t*, where the calculation of all three of these variables uses data from period *t*-1 and before. The incorporation of the ratio of trend to forecast output in this rule causes expenditure to be counter-cyclical. As well as being employed by the Swiss federal government, variations on the *Swiss* rule have been adopted by Germany (Kastrop et al., 2009) and Austria (Steger, 2010).

2.4 The *trend revenue* rule

The *trend revenue* rule is similar to the *Swiss* rule in that it is designed to produce a structurally balanced budget. With this rule, total spending is set equal to trend revenue, so in cyclical downturns government spending does not fall with revenue and, during cyclical booms, expenditure does not rise with revenue. Thus, government spending is acyclical rather than counter cyclical as with the *Swiss* rule. The *trend revenue* rule is simpler than the *Swiss* rule, as it does not require a forecast of future output or an estimate of trend output. Under this rule, government program spending is given by:

$$G_t = R_t^T - \tfrac{r}{1+r} D_{t-1}, \tag{7}$$

where $R_t^T$ is the trend level of government revenue in period *t*, calculated in the simulations using an HP filter and data from period *t-1* and before.

2.5 The *profligate government* scenario

A "profligate" government has a tendency to increase spending irrespective of the path of revenue, a policy that is untenable in the long run. As argued by Passarelli and Tabellini (forthcoming), a government may procrastinate on unpleasant policy choices, such as controlling spending, until excessive debt accumulation makes the current rate of spending increase infeasible. Velasco (2000) builds a dynamic political interest group model in which governments borrow until a debt ceiling is reached. We model this type of behaviour as a situation in which government spending increases until resources are constrained, with the constraint arising when debt hits a critical level and creditors insist on expenditure cuts to continue lending. Specifically, we assume in the *profligate government* scenario that the government increases spending by 2 percent per year when the debt-to-GDP ratio is below 90 percent, but cuts spending by 3 percent per year when the debt-to-

GDP ratio reaches or exceeds the 90 percent level.[11] Hence, government program spending follows:

$$G_t = 1.02G_{t-1} \quad \text{if } \frac{D_{t-1}}{Y_{t-1}} \leq .9, \tag{8}$$

$$G_t = .97G_{t-1} \quad \text{if } \frac{D_{t-1}}{Y_{t-1}} > .9. \tag{9}$$

While no government would be expected to choose this spending pattern as a rule, this case provides a useful counterpoint and base of comparison for the rules considered. The results for this case also provide evidence on whether our methodology can distinguish an obviously sub-optimal expenditure pattern. In addition, this rule is one possible representation of a rule that targets the debt-to-GDP ratio.

## 3. Methodology

This section describes the methodology we use to compare the welfare levels of the different fiscal rules.

### 3.1 Calculation of the welfare benefits of the fiscal rules

As the future is uncertain, welfare is represented by an expected intertemporal utility function, with utility in each period given by a function of private consumption and government program spending. We calculate the welfare of each fiscal rule relative to the welfare of the baseline using standard methods for measuring welfare when income is variable (Lucas, 2003; Barro, 2009; Kumhof and Laxton 2013). Specifically, the welfare gain of a fiscal rule relative to the baseline is measured as the percentage reduction in government program expenditure under the fiscal rule that would equate welfare under the rule to welfare under the baseline. 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, forever, 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 $\tau$ that makes expected utility under the baseline equal to expected utility under the fiscal rule, so $\tau$, measured as a percent of government expenditure, is the solution to:

[11] The 90 percent debt level was chosen because Reinhart and Rogoff (2010) find that economic growth slows significantly when government debt exceeds 90 percent of GDP.

$$\sum_{j=1}^{N} P_j \left( \sum_{t=0}^{\infty} \frac{U\left(G_{tj}^{BL}, Y_{tj}^{BL} - R_{tj}^{BL}\right)}{(1+\rho)^t} \right) = \sum_{j=1}^{N} P_j \left( \sum_{t=0}^{\infty} \frac{U\left(\left(1-\frac{\tau}{100}\right)G_{tj}^{FR}, Y_{tj}^{FR} - R_{tj}^{FR}\right)}{(1+\rho)^t} \right), \tag{10}$$

where each $j$ is one of $N$ possible future states of the world; $Y_{tj}$ -$R_{tj}$ is private consumption (after-tax income) in state $j$ and period $t$; the superscript $BL$ denotes the baseline path; $FR$ denotes the fiscal rule path; $P_j$ is the probability of state $j$; and $\rho$ is the discount rate. This calculation yields one value of $\tau$ for each fiscal rule. If the fiscal rule yields lower welfare than the baseline, $\tau$ will be negative, while a fiscal rule that generates higher welfare than the baseline will be associated with a positive value for $\tau$. The larger the value of $\tau$ the greater the relative welfare gain from the fiscal rule. If the baseline discretionary policy follows a welfare maximizing expenditure path, a fiscal rule that constrains government behaviour would reduce welfare and generate a negative value for $\tau$. If $\tau$ is positive, so the introduction of the fiscal rule increases welfare, the government behaviour represented by the baseline cannot be welfare maximizing, which would be the case if the baseline incorporates an expenditure or deficit bias.

Utility in each period is assumed to have the standard constant relative risk aversion (CRRA) form:[12]

$$U(G_t, Y_t - R_t) = \frac{\left[G_t^{\beta}(Y_t - R_t)^{1-\beta}\right]^{1-\gamma}}{1-\gamma}, \tag{11}$$

where $\beta$ is the share of government-provided goods in total consumption. The homotheticity of the CRRA utility function makes the calculation of $\tau$ tractable. In the simulations, $\beta$ is set equal to .28, the average share of $G$ in the data; and the coefficient of relative risk aversion, $\gamma$, is assumed to be 2, a value commonly used in other studies.[13] The discount rate, $\rho$, is set to .02 and is assumed equal to the real interest rate, $r$. The robustness of the results to variations in these parameter choices is discussed in Section 5.

### 3.2 Modeling the paths of output, government revenue and expenditure

From equation (10), the calculation of the welfare measure, $\tau$, requires estimates of the $N$ future paths of real per capita output ($Y$), government revenue ($R$), and government program

[12] This form of utility function 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), Lucas (2003), Pallage and Robe (2003), Barlevy (2004), Durdu et al. (2009), Maliszewski (2009), Barro (2009), Bems and Carvalho Filho (2011), Borensztein et al. (2013) and Céspedes and Velasco (2014). With this form of the utility function, there are no economies of scale associated with government spending and no public good aspects to spending.
[13] See, for example, Ghosh and Ostry (1997), Durdu et al. (2009), and Borensztein et al. (2013).

expenditure (*G*) under each fiscal rule as well as under the baseline policy. When evaluating each rule, we must take into account that the change in the path of government spending dictated by the rule may cause a change in the paths of output and government revenue. These changes may cause a further change to government expenditure which can lead to a further impact on output and revenue. To take account of these interaction effects, we begin by assuming that, under the baseline, the relationship between output, government revenue and government spending can be represented by a three variable structural VAR in the logarithms of real per capita output, *y*, government revenue, *rev*, and government program expenditure, *g*. Estimation of this VAR allows the interaction effects between these three variables to be determined by data.

To identify the structural VAR, we impose restrictions on the parameters of the model using the standard lower-triangular Cholesky decomposition.[14] We follow related literature in assuming government spending, *g*, does not contemporaneously respond to changes in the other two variables, *y* and *rev*, although these variables can be immediately altered by changes in government spending (Blanchard and Perotti, 2002; Beetsma et al., 2008; Corsetti and Müller, 2006). This structure is based on the view that government spending plans are usually determined before the new fiscal year begins. Further, we assume output, *y*, affects government revenue, *rev*, contemporaneously, so tax revenue responds immediately to changes in income, but *y* is not affected contemporaneously by *rev*.

The VAR we estimate takes the form:

$$\boldsymbol{z}_t = \boldsymbol{\Theta} \boldsymbol{z}_{t-1} + \boldsymbol{\Gamma} \boldsymbol{w}_t + \boldsymbol{u}_t \,, \tag{12}$$

where $\boldsymbol{z}$ is a vector consisting of *g*, *y*, and *rev*; $\boldsymbol{w}$ is a vector of exogenous and predetermined variables, such as fixed effects; and $\boldsymbol{\Theta}$ and $\boldsymbol{\Gamma}$ are matrices of coefficients. The structural VAR corresponding to equation (12) is:

[14] While other methods of identification have been employed when estimating VAR models (see the survey by Hebous, 2011), the Cholesky decomposition is the approach used in several other recent studies that employ panel data (for example, Beetsma et al. (2008), Beetsma and Giuliodori (2011) and Jawadi et al. (2016)). One specific critique of this methodology, raised by, for example, Ramey (2011b) and Leeper et al. (2008 and 2012), is that it does not take into account anticipated changes in government spending and taxes, which can result in invalid inferences. To deal with the possibility of anticipation effects, studies for the U.S. have used professional forecasts or other information to determine when the American public began to anticipate a change in policy. As we utilize data for a panel of countries, it is problematic to obtain consistent forecasts or institutional data for our panel that are similar to the types of data used in the U.S. studies. Further, Hebous (2011), Beetsma et al. (2008) and Beetsma and Giuliodori (2011) maintain that anticipation effects are less of an issue when annual data are employed, the frequency of the data used in this study, than is the case for quarterly data. While Cavallari and Romano (2017) find fiscal policy anticipation effects using data for Germany, France and Italy, Beetsma and Giuliodori (2011) find no evidence of this type of effect using data for European countries. Finally, Perotti (2012) finds almost no statistically significant evidence of anticipation effects of U.S. tax rate changes, and Ramey (2011a) finds that the range of multiplier values for a deficit financed government spending shock are similar across the different methods of identification whether or not account is taken of anticipated policy changes.

$$\boldsymbol{A}\boldsymbol{z}_t = \boldsymbol{B}\boldsymbol{z}_{t-1} + \boldsymbol{C}\boldsymbol{w}_t + \boldsymbol{e}_t, \tag{13}$$

where $\boldsymbol{A}$, $\boldsymbol{B}$ and $\boldsymbol{C}$ are matrices of parameters, $\boldsymbol{A}$ is a lower triangular matrix, $\boldsymbol{\Theta}=\boldsymbol{A}^{-1}\boldsymbol{B}$, $\boldsymbol{\Gamma}=\boldsymbol{A}^{-1}\boldsymbol{C}$, and $\boldsymbol{e}$ is the vector of structural errors. The residuals ($\hat{\boldsymbol{u}}_t$) from the estimates of the VAR given by equation (12) can be used to derive the estimated structural errors, $\hat{\boldsymbol{e}}_t$, assuming the identification scheme given above and noting that $\hat{\boldsymbol{A}}^{-1}\hat{\boldsymbol{e}}_t = \hat{\boldsymbol{u}}_t$, where $\hat{\boldsymbol{A}}$ is the estimate of matrix $\boldsymbol{A}$.

The $N$ future paths for $G$, $Y$ and $R$ required to calculate the welfare measure, $\tau$, are simulated for the baseline policy and under each fiscal rule as follows. First, we assume that the number of possible future paths, $N$, is equal to 20,000.[15] Second, we draw 20,000 series of length 200 from each of three normal distributions with standard deviations equal to the standard deviations of the three series of structural errors — one each for output, revenue and expenditure — estimated using the three-variable VAR.[16] Using these three sets of randomly generated shocks and the parameters of the estimated VAR, we simulate 20,000 series for government expenditure, output and government revenue of length 200, using the following representation of the VAR:

$$\tilde{\boldsymbol{z}}_t = \hat{\Theta}\tilde{\boldsymbol{z}}_{t-1} + \hat{\boldsymbol{\Gamma}}\boldsymbol{w}_t + \hat{\boldsymbol{A}}^{-1}\tilde{\boldsymbol{e}}_t. \tag{14}$$

The elements of $\tilde{\boldsymbol{e}}_t$ are the randomly drawn structural shocks ($\tilde{e}_g, \tilde{e}_y, \tilde{e}_r$) associated with each of the three variables ($g$, $y$, $rev$); the elements of the vector $\tilde{\boldsymbol{z}}_t$ are the simulated values of $g$, $y$ and $rev$; and $\hat{\boldsymbol{\Theta}}$, $\hat{\boldsymbol{\Gamma}}$, and $\hat{\boldsymbol{A}}$ are matrices of the estimated parameters of the VAR.

As an example, with one lag and one exogenous variable, $W$, in the vector $\boldsymbol{w}$, equation (14) takes the form:

$$\begin{pmatrix} \tilde{g}_t \\ \tilde{y}_t \\ r\tilde{e}v_t \end{pmatrix} = \begin{pmatrix} \hat{\theta}_{gg}\tilde{g}_{t-1} + \hat{\theta}_{gy}\tilde{y}_{t-1} + \hat{\theta}_{gr}r\tilde{e}v_{t-1} \\ \hat{\theta}_{yg}\tilde{g}_{t-1} + \hat{\theta}_{yy}\tilde{y}_{t-1} + \hat{\theta}_{yr}r\tilde{e}v_{t-1} \\ \hat{\theta}_{rg}\tilde{g}_{t-1} + \hat{\theta}_{ry}\tilde{y}_{t-1} + \hat{\theta}_{rr}r\tilde{e}v_{t-1} \end{pmatrix} + \begin{pmatrix} \hat{\gamma}_g W_t \\ \hat{\gamma}_y W_t \\ \hat{\gamma}_r W_t \end{pmatrix} + \begin{pmatrix} \tilde{e}_{gt} \\ \hat{\alpha}_{yg}\tilde{e}_{gt} + \tilde{e}_{yt} \\ \hat{\alpha}_{rg}\tilde{e}_{gt} + \hat{\alpha}_{ry}\tilde{e}_{yt} + \tilde{e}_{rt} \end{pmatrix}, \tag{14'}$$

where $\tilde{g}$, $\tilde{y}$ and $r\tilde{e}v$ represent the simulated values of $g$, $y$ and $rev$, respectively, and the $\hat{\theta}$, $\hat{\gamma}$, and $\hat{\alpha}$ parameters represent the elements of $\hat{\boldsymbol{\Theta}}$, $\hat{\boldsymbol{\Gamma}}$, and $\hat{\boldsymbol{A}}^{-1}$. The specification employed in the actual estimation and simulation is more general than equation (14') in that we use two lags in the VAR and $\boldsymbol{w}$ includes more than one variable, as described in Section 3.3 below.

[15] We chose 20,000 replications because, by 20,000 replications, the calculated values for $\tau$ changed by less than 1/100 of a percentage point with further replications.
[16] The standard deviations of the estimated structural errors of $g$, $y$, and $rev$ are .052, .011, and .042, respectively.

The simulated values for *g*, *y* and *rev* from equation (14) represent the baseline *discretionary* path to which each fiscal rule is compared. Under the fiscal rules, the simulated values for *g*, *y* and *rev* are calculated as in equation (14) except that the equation for *g* in the VAR is replaced by the equation for *g* specified by the fiscal rule. As an example, for the *forecast balanced budget* rule, the simulation would use:

$$\begin{pmatrix} \tilde{g}_t \\ \tilde{y}_t \\ r\tilde{e}v_t \end{pmatrix} = \begin{pmatrix} \ln(\tilde{R}_t^F - \frac{r}{1+r}\tilde{D}_{t-1}) \\ \hat{\theta}_{yg}\tilde{g}_{t-1} + \hat{\theta}_{yy}\tilde{y}_{t-1} + \hat{\theta}_{yr} r\tilde{e}v_{t-1} \\ \hat{\theta}_{rg}\tilde{g}_{t-1} + \hat{\theta}_{ry}\tilde{y}_{t-1} + \hat{\theta}_{rr} r\tilde{e}v_{t-1} \end{pmatrix} + \begin{pmatrix} 0 \\ \hat{\gamma}_y W_t \\ \hat{\gamma}_r W_t \end{pmatrix} + \begin{pmatrix} 0 \\ \tilde{e}_{yt} \\ \hat{\alpha}_{ry}\tilde{e}_{yt} + \tilde{e}_{rt} \end{pmatrix}, \tag{15}$$

where $\tilde{R}_t^F$ and $\tilde{D}_{t-1}$ are the simulated values of $R_t^F$ and $D_{t-1}$, respectively, and, since $\tilde{g}$ is determined strictly by the fiscal rule, the government spending shock, $\tilde{e}_g$ does not appear in any of the three equations.[17]

Using equation (14), simulated paths of length 200 are calculated for *g*, *y*, and *rev* under the baseline *discretionary* case and converted from logs to levels. Expenditure, output, and revenue under each fiscal rule are simulated beginning with observation 101. We begin the welfare comparison at observation 101 (which corresponds to time 0 in equation (10)) to minimize the effect of the starting values on the simulation. The first 100 simulated values for the baseline *discretionary* path also provide the historical series required to employ the HP filter and generate the initial forecasts (used in the *Swiss*, *trend revenue*, and *forecast balanced budget* rules) and the initial lags (used by the *moving average* and *average revenue* rules).

Although the intertemporal welfare function given in equation (10) has an infinite horizon, to make the calculation of the welfare gains tractable, output and government revenue and expenditure are assumed to be stochastic for only 200 periods. From period 201 onward, government revenue and output are nonstochastic and set equal to $\overline{R}$ and $\overline{Y}$, respectively, where $\overline{R}$ and $\overline{Y}$ are given by the average values for *R* and *Y* over all the 20,000 simulations of the baseline VAR for observations 101 through 200. Government program spending from period 201 onwards is set equal to $\overline{R}$ minus payments on the government debt accumulated as of period 200.[18] Hence, after period 200, private consumption ($\overline{Y}$ - $\overline{R}$) is the same for both the baseline VAR and all the fiscal rules, but government spending differs as a result of differences in the level of debt accumulated as of period 200 and

[17] We assume that the parameters of the equations for output and government revenue in the VAR do not depend on the fiscal rule.
[18] The debt is repaid over an infinite horizon. The magnitude of the annual debt payments is specific to each of the 20,000 replications and each rule and depends on the quantity of debt accumulated at the end of period 200.

differences in the corresponding debt payments. Given these spending differences, welfare will also differ after period 200 across the 20,000 replications for each fiscal rule.

3.3 Data and implementation

We estimate the VAR using a panel of annual data for sixteen European countries: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the UK.[19] As data availability varies across countries, the panel is unbalanced. The earliest year for which we have data for any country is 1970, while the latest year is 2011. There are 391 observations in total. All government expenditure and revenue data are for the central government. For more detail on the data and sources, see the Data Appendix.

The estimated VAR is used to construct our baseline discretionary policy case. Some of the countries in our sample were subject to fiscal constraints for at least part of the sample period, although these constraints vary to the extent that they were enforced. Hence, the data used to estimate the baseline may include expenditure and revenue observations that have been influenced somewhat by rules.[20] To minimize the influence of rules on the baseline when estimating the VAR, we exclude observations for countries with a constitutionally-based fiscal rule, since these tend to be enforced most strictly and are likely to have the most constraining effect on expenditure.[21] The Fiscal Compact that committed 25 European counties to introduce more effective fiscal rules will not affect our results as it was signed in 2012 and ratified in 2014, while the most recent data we use to estimate the VAR is for 2011. To the extent that the baseline incorporates the influence of rules, the welfare change from adopting a strict fiscal rule, as studied here, would be expected to be smaller.

We use a panel of countries to increase the precision of the estimates. To incorporate the possibility of cross-country heterogeneity and common year effects, we include country fixed effects and time period (year) fixed effects as in Beetsma et al. (2008), so the method of estimation uses a least squares dummy variable estimator. We also follow Beetsma et al. (2008) by including two lags of each variable in the VAR to eliminate serial correlation in the residuals.

In addition to the country and time-period fixed effects, we include the lag of the government

[19] We excluded former Eastern-bloc countries, as these experienced significant structural and economic change during the sample period, as well as very small European countries (Iceland and Luxembourg).

[20] Heinemann, *et al.* (2016), using a 30 study meta-regression-analysis (although not for European countries only), find that supranational restrictions increase the effectiveness of rules, which is consistent with government behaviour having been constrained to some extent by the Stability and Growth Pact.

[21] Inman (1996) finds that constitutionally-based rules in U.S. states are more effective. The excluded observations are for Switzerland from 2003 onwards and Germany in 2011. Heinemann, *et al.* (2016) find that rules have a significant constraining effect for Switzerland. If we also exclude countries from the sample that have made political, but not constitutional, commitments to fiscal rules, such as Sweden since 2000 and Austria since 2009, the welfare ranking of the fiscal rules does not change.

debt-to-GDP ratio in the vector ***w*** of the VAR (equation (12)). The estimates of the VAR imply that, when the debt-to-GDP ratio rises, governments respond by reducing *g* and raising *rev*.[22] As well, increases in the government debt-to-GDP ratio have a negative effect on output, which is consistent with other studies (Reinhart and Rogoff, 2010; Checherita and Rother, 2010; Cecchetti et al., 2011; International Monetary Fund, 2012). The debt-to-GDP ratio is not included as a fourth equation in the VAR because this would cause the model to be over-determined, given that the evolution of government debt is determined by government spending and revenue, as described by equation (1).[23]

The impulse response functions for a one standard deviation shock are shown in Figure 1.[24] As a check of the robustness of these estimates, we excluded selected countries from the sample and re-estimated the VAR. We found this change had little impact on the impulse responses.

3.4 Forecast and trend calculation

As noted in Section 2, implementation of the *Swiss*, *trend revenue*, and *forecast balanced budget* rules requires trend values and/or forecasts of output and revenue: $Y_t^T$, $R_t^T$, $Y_t^F$ and $R_t^F$. Forecasts for output ($Y_t^F$) and revenue ($R_t^F$) are derived for each period *t* by estimating a univariate second order autoregressive process using the 40 observations up to and including period *t*-1.[25] The trends are calculated each period using a Hodrick-Prescott (HP) filter. To address the HP filter endpoint problem, and the non-observability of current period data, we dynamically forecast ahead for five periods — periods *t* to *t*+4. The HP filter methodology is then applied using 45 observations, the 40 observations up to period *t*-1 and the five forecasts from *t* to *t*+4. The value given by the HP

[22] This is consistent with the finding of Maltritz and Wuste (2015), using data for European countries, that more outstanding debt leads to smaller deficits.

[23] For the simulations described by equation (14), we employ the debt accumulation equation, equation (1), to determine the evolution of the debt-to-GDP ratio (included in the vector ***w***). The constant term used in the simulation of the VAR is the average of the estimated constant terms across all 391 observations of the sample, where the constant term for each observation incorporates the corresponding estimated year effect and country fixed effect from the VAR. The starting values for the two lags of *g*, *rev*, and *y* used in the simulations are the averages over the sample. The starting value for the lagged debt-to-GDP ratio, 54.2, is also the average over the sample. Although the same debt-to-GDP ratio is used as a starting value in all 20,000 simulations, by period 101 (when the comparison between the fiscal rules and the baseline begins) each simulation has experienced different paths for the three shocks and, as a result, has accumulated different amounts of debt.

[24] Although the estimated output responses to changes in the policy variables are small, other authors that employ European data have found government expenditure multipliers that are of similar size, larger or smaller than our estimates (see Hebous, 2011; Hebous and Zimmermann, 2013; Beetsma et al., 2008; Beetsma and Giuliodori, 2011; Burriel et al., 2010; Hondroyiannis and Papaoikonomou, 2015).

[25] An alternative is to use the information criteria to choose the form of the forecasting equation in each of the 20,000 simulations and for each of the 100 annual forecasts (for the rules that incorporate forecasts). Use of this alternative could have resulted in different forecast equation specifications through time, across the 20,000 simulations, and for each of the fiscal rules. As our focus is on a comparison of the fiscal rules, rather than the forecast method, we chose to keep the forecast method simple and uniform across the different fiscal rule specifications. This makes the forecast method clear and ensures that welfare differences across the fiscal rules do not depend on differences in the forecast methodology adopted for each rule.

filter for period *t* is taken as the trend value for that period.[26]

With the *current period balanced budget* rule, spending is determined under the assumption that current period revenue is known. In contrast, with the *moving average*, *Swiss*, *trend revenue, average revenue* and *forecast* and *one-lag balanced budget* rules, the level of spending is set at the beginning of the period based on lagged revenue or revenue and output forecasts for period *t*. As a result, other than the *current period balanced budget* rule, the informational requirements for implementation of the fiscal rules are only that revenue and output from the previous period be observed.

## 4. Comparison of the Fiscal Rules

This section discusses the welfare gains, as captured by $\tau$, of the different fiscal rules relative to the baseline *discretionary* policy. To help illuminate the factors underlying the welfare effects, we also compare government spending and private consumption volatility under each of the rules, where these are measured as the mean over the 20,000 simulations of the standard deviations calculated for the 100 years following the implementation of a rule. Finally, we assess how well the different rules avoid excessive debt accumulation. As an indicator of whether a fiscal rule is likely to generate high debt, we calculate the percentage of the 20,000 simulations for which the debt-to-GDP ratio exceeds 150 percent in at least one year. The findings are reported in Tables 1 and 2.

The first key result is that a fiscal rule can increase welfare relative to the baseline *discretionary* policy even though the rule constrains a government's spending path. Of the eleven cases for which results are provided in Tables 1 and 2, only two yield lower levels of welfare than the baseline – the *average revenue rule* and the *profligate government* scenario. Since some of the fiscal rules increase welfare relative to the baseline, the historical expenditure paths used to estimate the baseline may have been influenced by factors such as spending or deficit bias.

Another key finding is that balanced budget rules differ greatly in terms of their welfare effects. The *one-lag balanced budget* rule, which avoids debt accumulation beyond one period, yields a very small positive value for $\tau$, and so generates a level of welfare that is almost identical to that of the *discretionary* policy. The rapid elimination of debt, as required by the *one-lag balanced budget* rule, leads to greater variation in the provision of government services (volatility of .111 versus .107 under *discretion*), and this greater volatility entails a welfare cost.

[26] See Mise et al. (2005) on the endpoint problem and International Monetary Fund (2010, Appendix IVa) on methods to deal with it. Changing the magnitude of the weight in the HP filter from 6.25 was not found to be important to the results. We applied the forecasts and filters to the logarithms of the variables and then took exponentials, but found that the results did not change if the HP filter was applied to the levels of the variables.

The *current period balanced budget* policy of spending all revenue as it is received is more stabilizing than the *one-lag balanced budget* rule since it does not lead to the accumulation of debt which must then be quickly eliminated. The *current period balanced budget* rule is also more stabilizing of government spending than is *discretionary* policy (Table 1, column 2, rows A.1 and C), and private consumption is also slightly more stable (Table 1, column 3). These outcomes help explain why the *current period balanced budget* rule yields higher welfare – a $\tau$ of .32, equivalent to approximately one third of one percent of government program spending each year – than the *discretionary* policy (Table 1, row A.1, column 1).

The third type of balanced budget rule considered, the *forecast balanced budget* rule, sets total spending equal to a simple univariate forecast of current period revenue. This type of balanced budget rule is more stabilizing and has a higher value of $\tau$ than the *discretionary* policy as well as the other two balanced budget rules. Welfare is higher because a forecast of revenue is smoother than actual revenue, so movements in government spending are less variable than under a rule that sets spending equal to revenue in every period or with a one period lag (Table 1, column 2). The value of $\tau$ achieved with the *forecast balanced budget* rule (.60) is among the highest of all the rules considered.

Rules that aim to maintain a structurally balanced budget, the *trend revenue* and *Swiss* rules, are the best performing rules and the welfare gains associated with these rules are in the range of estimates from studies of the benefits of business cycle stabilization (Barro, 2009; Kumhof and Laxton, 2013; Pallage and Robe, 2003).[27] The goal of these two rules is to balance the budget over the business cycle, so in downturns spending does not fall and in recoveries the government saves. As shown in Table 2, the variability of government program spending is lower by about a third with these rules relative to *discretionary* policy. As a consequence of this more stable government spending, along with slightly more stable private consumption, welfare is higher. The *Swiss* rule is designed to be counter-cyclical, while the *trend revenue* rule is a-cyclical, so the *trend revenue* rule leads to slightly lower government expenditure volatility, which may account for its slightly higher welfare gain (.63 compared to .60 with the *Swiss* rule).

Of the eleven rules considered in Tables 1 and 2, the best-performing rule is the *trend revenue* rule, but welfare is only slightly lower with the *Swiss* and *forecast balanced budget* rules. A factor that differentiates the *forecast balanced budget* rule from these other two rules is that it requires only

[27] Using a stylized model of a small open economy, Kumhof and Laxton (2013) find that a fiscal rule can lead to welfare gains as large as .131 percent of consumption (which is similar in magnitude to .5 percent of government program spending). Their calibration exercise also reveals that the gains from adopting an optimal fiscal policy rule are four to five times larger than the gains from choosing an optimal monetary policy rule.

a one period ahead forecast of revenue, while the *trend revenue* rule requires an estimate of trend revenue, and the *Swiss* rule requires an estimate of trend output and forecasts of revenue and output. The greater simplicity of the *forecast balanced budget* rule is an advantage since distinguishing the trend and cycle can be controversial.

We find that some rules lead to considerable debt accumulation and lower welfare. This is clearly evident with the *average revenue* rule. Under this rule, government real per capita program expenditure is set equal to the average of real per capita revenue, net of interest payments, over the 10 years prior to the implementation of the rule.[28] This rule implies that real per capita program spending is held constant, so program spending increases at the same rate as the sum of population growth and inflation. While this rule eliminates government expenditure volatility, private consumption volatility is one third higher than under the baseline *discretionary* policy – .084 compared to .061. More importantly, this rule often results in excessive debt accumulation. As shown in column (4) of Table 2, with the *average revenue* rule, in 29.2 percent of the 20,000 simulations, the government debt-to-GDP ratio exceeds 150 percent in at least one year. This rule produces high debt in many cases because it does not incorporate feedback from debt to spending.[29] Greater consumption volatility and debt accumulation leads the *average revenue* rule to yield lower welfare than the *discretionary* policy.

The welfare benefit of a *moving average* rule increases with a longer moving average process, so the 10-year moving average has the highest welfare of the four *moving average* rules considered in Table 1 (Part B). The 10-year *moving average* rule also yields greater smoothing of government expenditure than all the other rules except the *average revenue* rule. The standard deviation of the logarithm of government program spending is .061 with the 10-year *moving average* rule, which is only slightly more than half the magnitude of the volatility associated with the *discretionary* policy. On the other hand, the risk of excessive debt accumulation is somewhat elevated with the 10-year *moving average* rule. The percentage of the 20,000 simulations for which the debt-to-GDP ratio exceeds 150 percent in at least one year is 0.7, which is higher than the percentage for the *trend*

[28] Results and the ranking of this rule are similar if spending is based on an average of revenue over the previous 20 years, rather than the previous 10 years.
[29] The percentage of the 20,000 simulations for which the debt/GDP ratio exceeds 150 percent in at least one year is lower, but still a substantial 20.5 percent, for a variation of the simple *average revenue* rule in which total expenditure, rather than program expenditure, is held constant. In this case, total government expenditure (program expenditure plus current period interest payments) is set equal to an average of past revenue, so current period program expenditure varies with interest payment changes. The interest payments create feedback from higher debt to lower program expenditure which causes somewhat less new debt to be accumulated. In this case, the standard deviation of the log of government expenditure is small, at .016, but not zero, as in the truly constant program expenditure case. Also, $\tau$ is higher, at .17, since private consumption volatility is lower (.072 compared to .084), but the ranking of the *average revenue* rule, relative to all the other rules except the *one-lag balanced budget* rule, does not change.

*revenue*, *Swiss* and *forecast balanced budget* rules (Table 2, column 4).[30] While the value of $\tau$ for the 10-year *moving average* rule is relatively high (.45), it is not quite as high as with these other rules.

In contrast to the other cases considered, the *profligate government* scenario yields high debt accumulation, volatile expenditures, and a large negative impact on welfare. The value of $\tau$ in this case is -2.70, implying that the representative agent would sacrifice 2.7 percent of government program spending every year to avoid the *profligate government* spending path.[31] Further, despite the requirement that the government cut spending by 3 percent per year when the debt-to-GDP ratio reaches or exceeds 90 percent of GDP, for 17 percent of the simulations this expenditure cut is not adequate to stop the government debt-to-GDP ratio from exceeding 150 percent in at least one year (Table 2, column 4). The results for this scenario make clear that, while some of the rules given in Table 2 improve on *discretionary* policy, there exist expenditure paths, which approximate the spending strategies of some governments, which generate significant welfare losses.

## 5. Robustness of the Results to Changes in the Simulation Parameters

For the four best performing rules – the *trend revenue* rule, the *Swiss* rule, the *forecast balanced budget* rule and the 10-year *moving average* rule, we check for robustness by re-calculating the results using a coefficient of relative risk aversion of 4 (as in Barro (2009)) rather than 2, and values of 1 percent and 3 percent for both the discount rate and interest rate, rather than 2 percent. The results for these alternative choices of the simulation parameters are reported in Table 3.

For all the permutations of the parameters considered in Table 3, the four fiscal rules increase welfare relative to the baseline of *discretionary* spending. Thus, the conclusion that a fiscal rule can raise welfare relative to the baseline is robust to variations in the simulation parameters. Further, as would be expected, for a higher value of the risk aversion parameter, the welfare benefit of a rule is larger. For example, an increase in the coefficient of relative risk aversion from 2 to 4 causes the welfare benefit of the *trend revenue* rule to rise from .63 to .93 percent of annual program spending.

The results reported in Table 3 also show that varying the simulation parameters does not alter the ranking of the rules. Of the four rules, the *trend revenue* rule yields the highest welfare in all six cases. The *Swiss* and *forecast balanced budget* rules remain the next highest ranked rules, followed by the 10-year *moving average* rule. As well, Parts B and C of Table 3 show that, while the standard

[30] If interest payments on government debt are not incorporated in the 10-year *moving average* rule, so there is no feedback from debt to spending, the percentage of the simulations for which the debt-to-GDP ratio exceeds 150 percent in at least one year rises from .7 to 8.3 percent. Thus, the feedback from debt that follows from the inclusion of interest payments in equation (5) has a large impact on debt accumulation.

[31] If the debt threshold is increased from 90 to 120 percent, which facilitates greater expenditure volatility, the value of $\tau$ falls to -10.6.

deviation of government expenditure is lowest with the *moving average* rule, the standard deviation of private consumption is higher under this rule than with the other rules, which is consistent with the results in Table 2.

## 6. Discussion and Conclusions

Prolonged deficits and the accumulation of high levels of debt in many jurisdictions have led to increased interest in fiscal rules. This study aims to improve our understanding of the benefits of different types of fiscal rules and to determine whether some rule designs reduce volatility and increase welfare by more than others. Using data for European countries and Monte Carlo methods, we evaluate the welfare and stabilization performance of a variety of fiscal rules.

With many of the rules we analyze, although not all, it is possible to increase both welfare and government expenditure stability. The best rules increase welfare by more than half of one percent of government program spending each year forever and reduce government expenditure volatility by about one third relative to the baseline *discretionary* policy. While most of the rules also reduce the volatility of private consumption by between 5 and 10 percent, the principal benefit of a rule is to reduce government expenditure volatility.

The benefits of stabilization are understated to the extent that the welfare function includes only the consumption benefits of stabilization and does not include savings in terms of reduced government costs (Crain, 2003), the reduced costs of re-allocating resources (such as hiring and firing costs), or the reduction in the negative effects of government expenditure volatility on uncertainty and private sector investment and growth (Barlevy, 2004; Fernández-Villaverde et al., 2015; Born and Pfeifer, 2014). On the other hand, to the extent that some shocks to government program expenditures are not easily controlled by government, so a rule cannot be followed strictly, the results may overstate the benefit of a fiscal rule.

A somewhat surprising finding is that the different forms of balanced budget rules differ considerably in terms of their impact on welfare. The *current period balanced budget* rule, which sets government expenditure equal to actual revenue, yields higher welfare and lower volatility of government program spending and private consumption than the baseline *discretionary* policy. This implies that discretionary government spending, as represented by the simulated VAR, leads to less stable government expenditure than if the budget had been balanced in every period. Such a result is unexpected, given that discretionary policy is usually undertaken to decrease, rather than increase, economic volatility.

While the *current period balanced budget* rule provides a useful comparison, it is not implementable in practice since it requires knowledge of current period revenue. A second type of balanced budget rule relaxes this informational requirement, balances the budget with a one period lag, and retires new debt within a year. This *one-lag balanced budget* rule yields more volatile government spending than the *current period balanced budget* rule and generates a level of welfare that is almost identical to that of the *discretionary* policy. The rapid elimination of debt can lead to significant volatility in the provision of government services, which entails a welfare cost. The third type of balanced budget rule we consider, the *forecast balanced budget* rule, leads to smoother government expenditure and higher welfare than the two other balanced budget rules, and higher welfare than all the other rules except those that target a zero structural deficit.

Although rules with more stable government spending generally yield a better welfare outcome, we find that a rule that imposes completely stable government spending (equal to average real per capita revenue over the 10 years prior to the implementation of the rule) generates greater private consumption volatility and lower welfare than the *discretionary* policy. This result suggests that some responsiveness of government expenditure to revenue movements is preferred from a welfare perspective. Further, a rule that sets real per capita spending equal to a constant is associated with a high probability of excessive debt accumulation, along with the associated greater risk of a debt crisis and abandonment of the rule. Thus, a rule that links government expenditure growth to inflation and population growth, while popular in some U.S. states, is found to be a relatively poorly-performing rule.

Another expenditure path that can lead to a significant welfare loss is the *profligate government* expenditure path, where policymakers procrastinate on making unpleasant policy choices, such as controlling spending, until further expenditure increases become infeasible due to excessive debt accumulation (Passarelli and Tabellini, forthcoming). Such a strategy leads to increased government and private spending volatility, high debt accumulation, and a large welfare loss. The results from this scenario also indicate that a debt-to-GDP ratio target can yield a poor welfare outcome.

Rules that target a zero structural deficit — the *trend revenue* and *Swiss* rules — perform best. The highest welfare is achieved with the *trend revenue* rule, which may be the result of the greater stability in government expenditure that results with this a-cyclical rule. While the rules that target a zero structural deficit yield the highest welfare, the *forecast balanced budget* rule, where current spending is based on a simple univariate forecast of current revenue, increases welfare by as much as the *Swiss* rule and by almost as much as the *trend revenue* rule.

While yielding a similar level of welfare as rules that target a zero structural deficit, the *forecast balanced budget* rule does not require trend revenue or trend output estimates. This may be an advantage from a political perspective since, as noted by Wyplosz (2012, 10), "Cyclical correction is more art than science and is not easily comprehended by the public at large, which opens the doors to manipulations and, quite possibly, to an eventual repeal." Another attractive feature of the *forecast balanced budget* rule is that it is relatively straightforward and easy to understand. A rule that is understood by the public 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. In their review of fiscal rules, Schaechter et al. (2012) note that a less complex rule could facilitate monitoring by the public, which may be an important component of a successful and enduring rule.

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***Data Appendix***

Real GDP (millions). Source: OECD stat - Gross Domestic product (expenditure approach). National currency, constant prices, OECD base year.

Central government total revenues (millions of national currency). Source: Eurostat Total general government revenue Central government. Millions of national currency (including 'euro fixed' series for euro area countries).

Central government total expenditure (millions of national currency). Source: Eurostat Total general government expenditure Central government. Millions of national currency (including 'euro fixed' series for euro area countries).

Central government debt interest payments (millions of national currency). Source: Eurostat. Interest, payable Central government, millions of national currency (including 'euro fixed' series for euro area countries).

Government expenditure price index. OECD base year 2005=100. Source: OECD stat - deflator Final consumption expenditure of general government.

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Population. Source: Eurostat. Population on 1 January total all ages and both sexes.

Units of national currency per Euro in 2005. Source: Eurostat - annual average for 2005.

Note: For countries that do not use the euro, national currency units are converted to euros using the rate in the Eurostat base year, 2005.

Sample estimation periods are as follows (391 observations). Two earlier years of data are available for each country and employed as lags.

| | |
|---|---|
| Austria | 1990-2011 |
| Belgium | 1972-2011 |
| Denmark | 1992-2011 |
| Finland | 1977-2011 |
| France | 1980-2011 |
| Germany | 1993-2010 |
| Greece | 1997-2011 |
| Ireland | 1992-2011 |
| Italy | 1982-2011 |
| Netherlands | 1972-2011 |
| Norway | 1992-2011 |
| Portugal | 1979-2011 |
| Spain | 1997-2011 |
| Sweden | 1995-2011 |
| Switzerland | 1992-2002 |
| UK | 1989-2011 |

**Table 1: *Balanced Budget* Rules, *Moving Average* Rule, and Baseline *Discretionary* Policy**

| | Welfare Gain (Value of $\tau$)* (1) | Standard deviation† of the log of government program spending (2) | Standard deviation† of the log of private consumption (3) | Percentage of the 20,000 simulations where the debt/GDP ratio exceeds 150% in at least one year (4) |
|---|---|---|---|---|
| A. Balanced budget rules | | | | |
| 1. *Current period balanced budget* | .32 | .087 | .056 | .1 |
| 2. *Forecast balanced budget* | .60 | .072 | .056 | .2 |
| 3. *One-lag balanced budget* | .01 | .111 | .056 | .1 |
| B. *Moving average* rule | | | | |
| *Moving average length:* | | | | |
| 2-years | .36 | .080 | .056 | .1 |
| 5-years | .41 | .071 | .056 | .2 |
| 7-years | .43 | .067 | .057 | .4 |
| 10-years | .45 | .061 | .058 | .7 |
| C. Baseline *discretionary* policy (the VAR) | - | .107 | .061 | .3 |

* $\tau$ is defined as the welfare gain of the indicated fiscal rule, measured as the percentage reduction in government program expenditure under the fiscal rule that would equate welfare under the rule to welfare under the baseline (*discretionary*) path given by the simulated VAR. That is, $\tau$ is the proportion of government expenditure the representative individual would be willing to give up in every period, forever, to be guaranteed the government expenditure path associated with the fiscal rule rather than the baseline path.
† The standard deviation is calculated for each of the 20,000 simulations over the 100 periods for which government spending, revenues and output are variable. This table reports the average of the standard deviations for the 20,000 simulations.

**Table 2: Comparison of Selected Expenditure Rules**

| | Welfare Gain (Value of $\tau$)* (1) | Standard deviation† of the log of government program spending (2) | Standard deviation† of the log of private consumption (3) | Percentage of the 20,000 simulations where the debt/GDP ratio exceeds 150% in at least one year (4) |
|---|---|---|---|---|
| 1. *Trend revenue* rule | .63 | .070 | .056 | .2 |
| 2. *Swiss* rule | .60 | .071 | .057 | .3 |
| 3. *Forecast balanced budget* rule | .60 | .072 | .056 | .2 |
| 4. 10-year *moving average* rule | .45 | .061 | .058 | .7 |
| 5. *Average revenue* rule | -.26 | 0 | .084 | 29.2 |
| 6. *Profligate government* scenario | -2.70 | .153 | .072 | 17.0 |
| 7. Baseline d*iscretionary* policy (the VAR) | — | .107 | .061 | .3 |

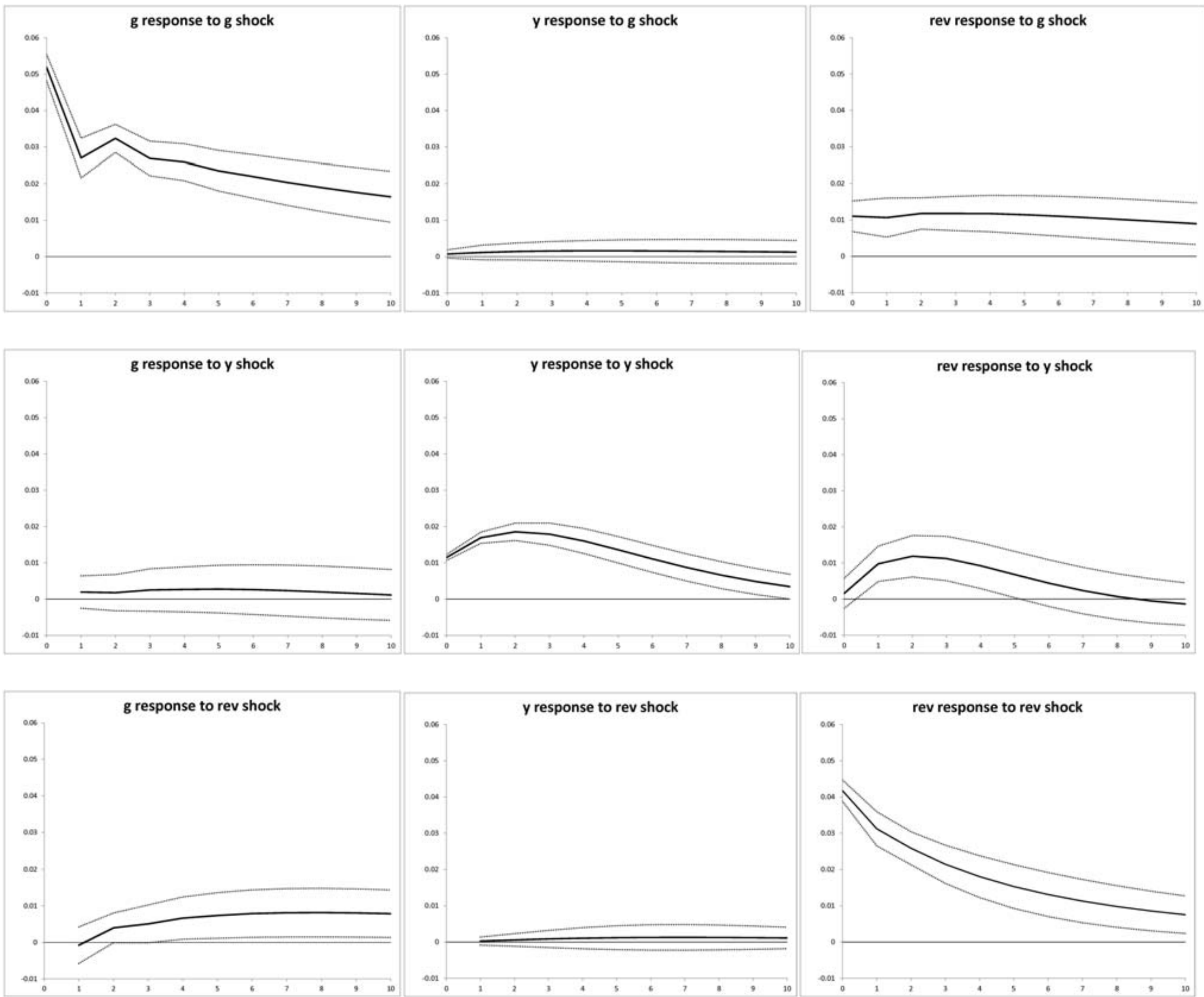
See notes to Table 1.

**Table 3: Comparison of the Welfare Gain (*τ*) and Volatility Measures for Different Model Parameters**

| | γ=2 r=.02 ρ=.02 (1) | γ=2 r=.03 ρ=.03 (2) | γ=2 r=.01 ρ=.01 (3) | γ=4 r=.02 ρ=.02 (4) | γ=4 r=.03 ρ=.03 (5) | γ=4 r=.01 ρ=.01 (6) |
|---|---|---|---|---|---|---|
| A. Welfare Gain (Value of *τ*) | | | | | | |
| 1. *Trend revenue* rule | **.63** | **.71** | **.47** | **.93** | **1.07** | **.67** |
| 2. *Swiss* rule | .60 | .67 | .44 | .91 | 1.04 | .65 |
| 3. *Forecast balanced budget* rule | .60 | .67 | .44 | .90 | 1.04 | .64 |
| 4. M*oving average* rule, 10-year | .45 | .53 | .31 | .67 | .80 | .45 |
| B. Average standard deviation of log(*G)* | | | | | | |
| 1. *Trend revenue* rule | .070 | .075 | .066 | .070 | .075 | .066 |
| 2. *Swiss* rule | .071 | .076 | .067 | .071 | .076 | .067 |
| 3. *Forecast balanced budget* rule | .072 | .076 | .068 | .072 | .076 | .068 |
| 4. *Moving average* rule, 10-year | **.061** | **.067** | **.055** | **.061** | **.067** | **.055** |
| C. Average standard deviation of log(*Y-R)* | | | | | | |
| 1. *Trend revenue* rule | **.056** | **.057** | **.056** | **.056** | **.057** | **.056** |
| 2. *Swiss* rule | .057 | **.057** | .057 | .057 | **.057** | .057 |
| 3. *Forecast balanced budget* rule | **.056** | **.057** | **.056** | **.056** | **.057** | **.056** |
| 4. *Moving average* rule, 10-year | .058 | .058 | .057 | .058 | .058 | .057 |

See notes to Table 1.
Entries in bold type indicate the best fiscal rule for the indicated parameter values.

# Figure 1: Responses to a One Standard Deviation Structural Shock




Note: Confidence bands are the 5th and 95th percentiles.

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