Discussion Paper Series

RIEB

Kobe University

DP2011-26

An Optimal Government Spending Reversal Rule in a Small Open Economy

Shigeto KITANO

Kenya TAKAKU

Revised October 17, 2012

Research Institute for Economics and Business Administration

Kobe University

2-1 Rokkodai, Nada, Kobe 657-8501 JAPAN

An Optimal Government Spending Reversal Rule in a Small Open Economy*

Shigeto Kitano† Kenya Takaku‡

Abstract

This paper presents a reexamination of debt stabilization policy in a small open economy borrowing from abroad. Spending reversals are incorporated as a policy option available to policy-makers for stabilizing public debt. Results show that a spending reversal rule can be welfare-improving and that there exists an optimal degree of spending reversal. An optimal spending reversal rule can lower both the tax rate volatility and interest rate volatility compared with the case without the reversal rule. Results also suggest that, as friction in foreign borrowing becomes greater (because of a higher country-specific interest rate premium), the welfare benefit of the reversal rule will be increasingly important.

Keywords: sovereign debt, debt stabilization, welfare, spending reversals, Spain, small open economy
JEL Classification: F41

*Earlier versions of the paper were presented at the 8th MME SI in Kobe at Kobe University, the JEA annual meeting at Tsukuba University, and the 6th Conference of Macroeconomics for Young Professionals in Osaka. The authors thank the participants for helpful comments. The authors are especially grateful to two anonymous referees, Takashi Kamihigashi, Takayuki Tsuruga, Nao Sudo, Teruyoshi Kobayashi, Shingo Iokibe, and Eiji Okano for valuable comments. Any remaining errors are ours. This work was supported by Grants-in-Aid for Scientific Research.

†RIEB, Kobe University, 2-1, Rokkodai, Nada, Kobe, 657-8501 Japan, E-mail: kitano@rieb.kobe-u.ac.jp.

‡Graduate School of Economics, Nagoya University, Furo-cho, Chikusa, Nagoya, 464-8601, Japan, E-mail: k_takaku0408@yahoo.co.jp.

1 Introduction

The recent sovereign debt crises in the Euro zone emerging countries (Greece, Italy, Ireland, Portugal, Spain), and expansionary fiscal policies and the resulting rapid surge of public debt in developed countries attributable to the global financial crisis of 2007–2009 have stimulated the discussion of an exit strategy from expansionary fiscal policy and an appropriate mode of stabilizing public debt.

Many studies have examined debt stabilization policies from the perspective of welfare (e.g., Schmitt-Grohé and Uribe (2007) and Kollmann (2008)). Reflecting the recent sovereign debt crises in the Euro zone, Bi (2011) analyzes optimal debt stabilization policies in a small open economy with borrowing from abroad. Bi (2011) specifically examines optimal tax policy as a policy tool for stabilizing public debt, and thereby demonstrates that because the sovereign interest rate depends on the level of public foreign debt, the government faces a tradeoff between smoothing of the tax rate and stabilizing the sovereign interest rate. An aggressive tax adjustment can stabilize foreign debt and lower the volatility of the sovereign interest rate through the country premium, although it increases the volatility of the tax rate itself.[1]

Corsetti, Meier and Müller (2012) report that most existing analytical studies assume that higher current deficits engender future tax increases, but that government spending does not respond to the level of public debt. They subsequently discuss the effects of an increase in government spending

[1]As argued by Bi (2011), the tax rate affects households' decisions related to consumption and the labor supply directly, whereas the sovereign interest rate affects the interest payment on the government debt and future tax rates. Consequently, the government faces a tradeoff between smoothing the tax rate and the sovereign interest rate.

followed by spending reversals.[2] They find that, with spending reversals, a fiscal expansion can have a crowding-in effect of consumption through a decline of the long-term interest rate because of an expected future fall in the short-term interest rate. Their results suggest that it would be important to consider not just tax increases but also spending reversals as policy tools for offsetting fiscal measures when conducting policy evaluation.

We reconsider debt stabilization policy while examining spending reversals as a policy option that is available to policymakers for stabilizing public debt. Following Bi (2011), we use a real business cycle model of a small open economy in which the government and households can borrow from abroad.[3] Using the perturbation methods presented by Schmitt-Grohé and Uribe (2004), we measure welfare levels under different degrees of spending reversals. Our analysis, based on a calibration to the Spanish economy, shows that a spending reversal rule can be welfare-improving. A spending reversal rule can improve economic welfare compared with the case without a reversal rule because it might reduce the volatility of tax rates and that of interest rates through limitation of the deviation of foreign debt. The positive effect of spending reversals on the economy's welfare through reduction of the volatility of interest rates becomes larger, as the debt elasticity of the country-specific risk premium becomes higher.

The remainder of the paper is organized in three sections. In section 2,

[2] If the government allows fiscal spending to respond systematically to the level of public debt, then we observe a decline of government spending below the trend after a current episode of deficit spending. 'Spending reversal' is the designation given to the dynamics.

[3] Although Bi (2011) assumes that households borrow from abroad at a constant rate (but face an adjustment cost for their bond holdings), we assume that households face a country-specific interest rate premium, as does the government. Therefore, the risk premium depends on the debt level of households as well as the public debt level.

we present a real business cycle model of a small open economy in which the government and households can borrow from abroad. Section 3 explains the method of conducting policy evaluation, and presents an examination of how different degrees of spending reversals affect the economy's welfare level. Section 4 presents sensitivity analysis. Conclusions are presented in Section 5.

2 Model

2.1 Households

The model examined in this paper resembles the model used by Schmitt-Grohé and Uribe (2003). Consider a small open economy with many homogeneous households, each of which maximizes the following utility function.

$$E_0 \sum_{t=0}^{\infty} \beta^t U(c_t, h_t) \tag{1}$$

Therein, E_t denotes the mathematical expectations operator that is conditional on information available at time t, $\beta \in (0,1)$ is the discount factor, c_t signifies consumption in period t, h_t represents labor effort, and U denotes a period utility function that is assumed to be strictly increasing in its first argument, strictly decreasing in its second argument, and strictly concave.

The households' flow budget constraint is

$$b_t = (1+r_{t-1})b_{t-1} - (1-\tau_t)[w_t h_t + (r_t^k - \delta)k_t] + c_t + i_t - \delta k_t + \Phi(k_{t+1} - k_t), \tag{2}$$

where b_t is the foreign debt position of the household, k_t stands for capital, i_t signifies investment, τ_t is the rate of income tax, w_t is the real wage, r_t^k is the rental rate of capital, and δ represents the depreciation rate of physical capital. $\Phi(\cdot)$ is the capital adjustment cost, which is assumed to be convex and which satisfies $\Phi(0) = \Phi'(0) = 0$. The interest rate at which households can borrow from abroad, r_t, is given as

$$r_t = r + p(s_t), \tag{3}$$

where r is the world interest rate, and $p(\cdot)$ is a country-specific interest rate premium that is increasing in the aggregate level of foreign debt s_t. The aggregate level of foreign debt s_t is the sum of the foreign debt positions of households and the government as

$$s_t \equiv b_t + d_t, \tag{4}$$

where d_t stands for the foreign debt position of the government. The process of capital accumulation is given as

$$k_{t+1} = (1 - \delta)k_t + i_t. \tag{5}$$

The household takes as given the processes $\{r_t, w_t, r_t^k\}_{t=0}^{\infty}$ as well as b_{-1} and k_0, and chooses $\{c_t, h_t, i_t, k_{t+1}, b_t\}_{t=0}^{\infty}$ to maximize the utility function (1) subject to Eqs. (2), (5) and a no-Ponzi-game condition.

$$\lim_{j \to \infty} E_t \frac{b_{t+j}}{\prod_{z=1}^{j}(1 + r_z)} \leq 0. \tag{6}$$

The optimality conditions associated with the households' maximization problem are given as

$$U_c(c_t, h_t) = \lambda_t, \tag{7}$$

$$U_h(c_t, h_t) = -\lambda_t(1-\tau_t)w_t, \tag{8}$$

$$\lambda_t = \beta(1+r_t)E_t\lambda_{t+1}, \tag{9}$$

and

$$\lambda_t[1+\Phi'(k_{t+1}-k_t)] = \beta E_t\lambda_{t+1}[(1-\tau_{t+1})(r^k_{t+1}-\delta)+1+\Phi'(k_{t+2}-k_{t+1})], \tag{10}$$

where λ_t is the Lagrange multiplier on Eq. (2).[4]

2.2 Firms

The production function is given as

$$y_t = A_t F(k_t, h_t), \tag{11}$$

where A_t is a stochastic productivity shock, and the function F is assumed to be increasing in both arguments and concave. The productivity is exogenously evolving according to the following process.

$$\ln A_t = \rho_A \ln A_{t-1} + \varepsilon_{A,t}, \quad \varepsilon_{A,t} \sim i.i.d.\mathcal{N}(0, \sigma_A^2). \tag{12}$$

[4]Because a country-specific interest rate premium presumably depends on the level of the households' debt as well as the public debt level in our model, the interest rate affects households' decisions on consumption and the labor supply directly as well as the tax rate.

The firm's profit is given as

$$\pi_t = A_t F(k_t, h_t) - r_t^k k_t - w_t h_t. \tag{13}$$

The optimality conditions associated with the firm's maximization problem are given as

$$r_t^k = A_t F_k(k_t, h_t), \tag{14}$$

and

$$w_t = A_t F_h(k_t, h_t). \tag{15}$$

2.3 Government

The government collects income tax and borrows from abroad to finance government spending. The government's budget constraint is given as

$$d_t = (1 + r_{t-1})d_{t-1} + g_t - \tau_t[w_t h_t + (r_t^k - \delta)k_t], \tag{16}$$

where g_t denotes government consumption spending. The government spending and the tax policy are, respectively, assumed to accord with the following rules:

$$\hat{g}_t = \rho_{gg}\hat{g}_{t-1} + \rho_{gd}\hat{d}_{y,t-1} + \varepsilon_{g,t}, \quad \varepsilon_{g,t} \sim i.i.d.\mathcal{N}(0, \sigma_g^2), \tag{17}$$

and

$$\tau_t = \tau + \theta\hat{d}_{y,t-1}. \tag{18}$$

Therein, $\hat{g}_t$ denotes the percentage deviation of the government spending from its steady state level g. Additionally, $d_{y,t}$ is the ratio of public debt to output (i.e., $d_{y,t} \equiv d_t/y_t$), and $\hat{d}_{y,t}$ denotes the percentage deviation from its steady state level d_y. Parameters $\rho_{gd}(\leq 0)$ and $\theta(\geq 0)$ respectively represent the sensitivities of the government spending and the tax rate to the level of public debt. This paper specifically examines ρ_{gd} because the parameter directly governs the amplitude of the government spending reversals. As ρ_{gd} becomes smaller, government spending becomes more sensitive to the public debt and consequently displays a stronger reversal.

2.4 Equilibrium

By combining Eqs. (2) and (16) and using (4), we obtain the economy's current account ca_t as

$$ca_t \equiv -s_t + s_{t-1} = tb_t - r_{t-1}s_{t-1}, \tag{19}$$

where tb_t is the economy's trade balance:

$$tb_t \equiv y_t - c_t - i_t - g_t - \Phi(k_{t+1} - k_t). \tag{20}$$

2.5 Functional forms

Following Schmitt-Grohé and Uribe (2003), and Neumeyer and Perri (2005) (among others), we adopt the following standard forms for the utility function, production function, capital adjustment cost, and risk premium:

$$U(c,h) = \frac{[c - \eta h^{\omega}]^{1-\gamma} - 1}{1-\gamma}, \tag{21}$$

$$F(k,h) = k^{\alpha} h^{1-\alpha}, \tag{22}$$

$$\Phi(x) = \frac{\phi}{2} x^2, \quad \phi > 0, \tag{23}$$

and

$$p(s) = \psi(e^{s-\bar{s}} - 1), \tag{24}$$

where $\bar{s}$ is the steady state level of the economy's aggregate foreign debt position.

2.6 Calibration

The model is calibrated to the Spanish economy using annual data obtained during 1960–2010. Data are from the *International Financial Statistics* database, unless otherwise stated. We calibrate parameters using long-run data relations as well as parameter values that are standard in the related literature. The calibrated parameters and the steady state values used for calibration are presented in Table 1. We set the parameter of the share of capital in output α equal to 0.38, which is consistent with the average value of the Spanish economy's wage share during the period 1960–2010 (0.62).[5] The (annual) depreciation rate δ is set to 0.10, which is frequently used in the related business cycle studies. We set η to 1.36 so that the steady state level of hours worked h is 0.201, which is the average value of per-capita hours of

[5]Data on the wage share are from the AMECO database of European Commission.

work of total time in the data (20.1%).[6] As in most studies, we set the coefficient of relative risk aversion γ to 2. The curvature of labor ω is set to 1.6, which implies a labor supply elasticity given by $\frac{1}{\omega-1}$ is about 1.7. This value of ω is similar to the value of 1.455 used by Mendoza (1991), the value of 1.6 used by Neumeyer and Perri (2005) and García-Cicco et al. (2010), and the value of 1.7 used by Correia et al. (1995). The (annual) discount factor (β) is set to 0.96, which is a standard value used in the relevant literature. We obtain that $\rho_{gg} = 0.431$ and $\sigma_g = 0.0242$ by estimating a first-order autoregressive stochastic process for the government consumption data.[7] The steady-state value of the government spending to output ratio $\frac{g}{y}$ is set equal to its data average (0.155). The steady-state value of government debt to output ratio $\frac{d}{y}$ is also set equal to its data average (0.385).[8] In a consistent way with $\frac{g}{y}$ and $\frac{d}{y}$, we calibrate the steady-state value of the income tax rate τ equal to 0.228 from (16). The elasticity of the tax rate to the debt level θ is estimated by OLS using data on total tax revenue to GDP ratio and government debt to GDP ratio.[9] The steady-state value of trade balance to output ratio $\frac{tb}{y}$ is set equal to its data average as well (−0.022). The steady state level of the economy's aggregate foreign debt position ($\bar{s}$) is then calibrated from Eq. (19) to ensure that $\frac{tb}{y}$ equals its data average. We set ρ_A and σ_A to 0.405 and 0.0092, respectively, by estimating a first-order autoregressive

[6]Data related to hours worked are from the *OECD Employment and Labour Market Statistics*. Because of data limitations, the average value is that for 1977–2010.

[7]IFS data of government consumption are transformed to real and per-capita terms. We take logs and apply the Hodrick–Prescott filter with a smoothing parameter of 100.

[8]Data source for the government debt to output ratio is the AMECO database of European Commission (data are for 1970–2010).

[9]Data sources for the total tax revenue to GDP ratio and the government debt to GDP ratio are the *OECD Revenue statistics* and the AMECO database of European Commission, respectively (data are for 1970–2010).

stochastic process for total factor productivity (TFP).[10] The capital adjustment cost parameter ϕ and the debt elasticity of the country-specific risk premium ψ govern volatilities of investment and the trade balance to output ratio. We set ϕ and ψ to match the standard deviation of investment and especially that of the trade balance to output ratio with their data as close as possible ($\phi = 0.354$ and $\psi = 0.010$). Table 2 provides the standard deviation of the cyclical component of each series.[11] A noticeable feature of the Spanish economy's business cycle is that consumption is more volatile than output.[12] Although it predicts slightly higher volatility of output and lower volatility of consumption than data, the model can replicate basic features of the Spanish economy's business cycle, showing especially that consumption is more volatile than output.

[10]TFP data are from the AMECO database of European Commission.

[11]IFS data of output, consumption and investment are transformed to real and per-capita terms. We take logs and apply the Hodrick–Prescott filter with a smoothing parameter of 100.

[12]Although the Spanish economy is a developed small open economy, this is a typical characteristic of business cycles in emerging markets. In contrast with developed small open countries, emerging-market economies tend to exhibit consumption volatility that exceeds output volatility. See, for example, Aguiar and Gopinath (2007) for details.

Table 1: Calibration.

Parameter or Steady-state value	Value	
α	0.38	Share of capital in output
δ	0.1	Depreciation rate
η	1.36	Labor coefficient
h	0.201	Steady-state value of hours worked
γ	2	Risk aversion
ω	1.6	Curvature parameter in labor
β	0.96	Discount factor
ρ_{gg}	0.431	Persistence: government spending shock
σ_g	0.0242	Standard deviation: government spending shock
g/y	0.155	Steady-state value of the government spending to output ratio
d/y	0.385	Steady-state value of the government debt to output ratio
τ	0.228	Steady-state value of the income tax rate
θ	0.405	Debt elasticity of tax rate
tb/y	-0.022	Steady-state value of trade balance to output ratio
$\bar{s}$	-0.183	Steady-state value of the aggregate foreign debt
ρ_A	0.405	Persistence: productivity shock
σ_A	0.0092	Standard deviation: productivity shock
ϕ	0.354	Capital adjustment cost parameter
ψ	0.010	Debt elasticity of the country-specific risk premium

Table 2: Second Moments.

	$std(y_t)$	$std(c_t)$	$std(i_t)$	$std(g_t)$	$std(\frac{tb_t}{y_t})$
data	3.28	4.68	9.35	2.42	1.93
model	3.59	4.01	9.52	2.69	1.93

Note) Standard deviations are reported in percentage points.

3 Welfare

3.1 Welfare benefit measure

We use the perturbation methods presented by Schmitt-Grohé and Uribe (2004) that compute second-order accurate solutions to measure the levels of life time utility. By comparing the measured welfare levels under different degrees of spending reversals with the welfare level under no spending reversals, we conduct policy evaluations of spending reversals.

We define the lifetime utility in the case of no spending reversals (i.e. $\rho_{gd} = 0$) as

$$V_0^b \equiv E_0 \sum_{t=0}^{\infty} \beta^t U(c_t^b, h_t^b).$$

We next define the life time utility with different degrees of spending reversals as alternative policy regimes:

$$V_0^a \equiv E_0 \sum_{t=0}^{\infty} \beta^t U(c_t^a, h_t^a).$$

We then define λ^c as the welfare benefit of adopting policy regime a rather than policy regime b. Formally, λ^c is defined as

$$V_0^a = E_0 \sum_{t=0}^{\infty} \beta^t U((1+\lambda^c)c_t^b, h_t^b).$$

In other words, λ^c is the fraction of regime b's consumption process that compensates a household to be as well off under regime b as under regime

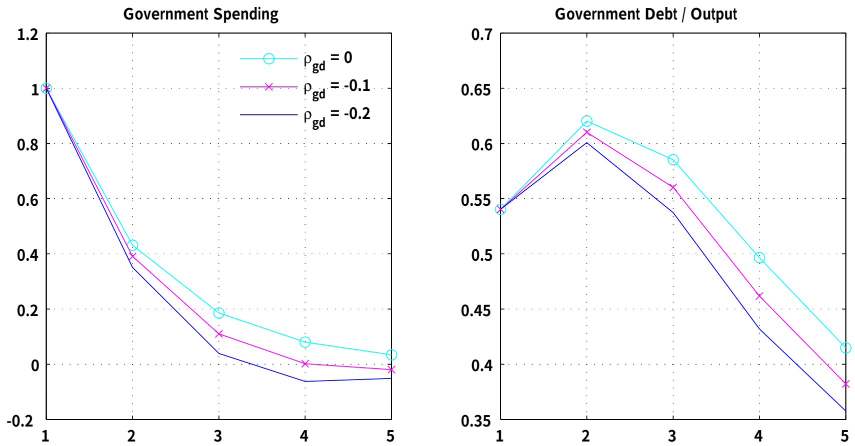


Figure 1: Impulse responses to government spending shocks.

a.[13]

3.2 Effect of spending reversals on economic welfare

Before we analyze the effect of spending reversals on economic welfare, we examine the effects of spending reversals on the government debt to output ratio. Figure 1 presents the effects of the government spending shock to the government spending and the government debt to output ratio for different values of ρ_{gd} ($\rho_{gd} = 0$, -0.1, and -0.2). The smaller the value of ρ_{gd}, the further the government spending falls below zero (after the shock) and the more limited is the expansion of the government debt to output ratio.[14]

We next examine the effect of spending reversals on the economy's welfare.

[13]Specifically, we obtain λ^c as follows. We first measure the percentage change in consumption in the deterministic steady state that would give households the same expected utility in the stochastic economy in each case. Then we calculate the welfare benefits of adopting different values of ρ_{gd} in place of the benchmark case of $\rho_{gd} = 0$.

[14]However, as we will argue in the next section, if the degree of spending reversal is too strict, the overshooting effect of spending reversal may make the fluctuation of government debt more volatile.

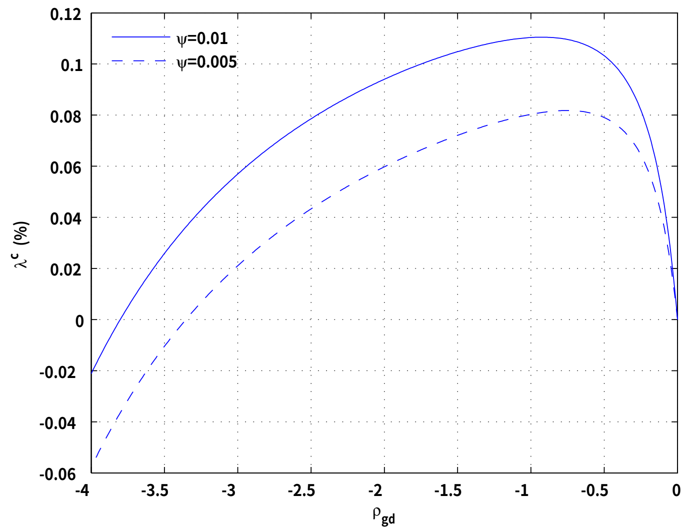
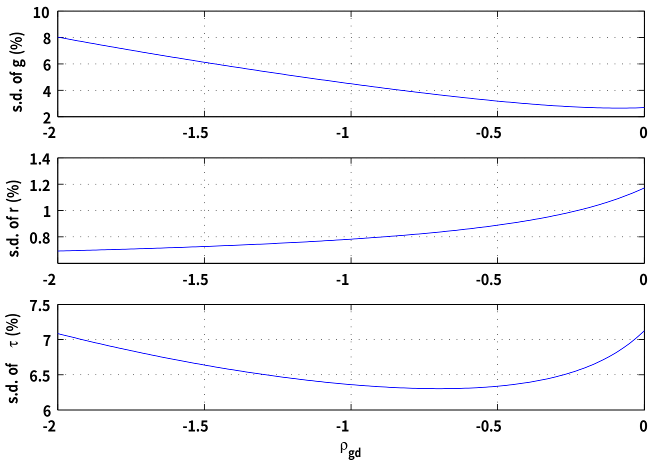


Figure 2: Welfare benefit.

The solid curve in Figure 2 presents the welfare benefit of spending reversals ($\lambda^c(\%)$) corresponding to the various values of ρ_{gd}. In Figure 2, the economy's welfare curve displays a hump shape. It is apparent that some range of ρ_{gd} $(-3.80 < \rho_{gd} < 0)$ improves welfare levels. To explain the rationale for our analysis results, we present the standard deviations of government spending, interest rate, and the tax rate corresponding to different values of ρ_{gd} in Figure 3. Figure 3 shows that, starting from $\rho_{gd} = 0$, the smaller ρ_{gd} increases the volatility of government spending and reduces the volatility of the interest rate toward its optimal point (-0.93), which achieves the maximum welfare benefit. The smaller ρ_{gd} reduces the volatility of the tax rate almost until ρ_{gd} reaches the optimal point, but increases the volatility of the tax rate after ρ_{gd} passes it. It is noteworthy that, compared with the no-reversal case (i.e., the case with $\rho_{gd} = 0$), an optimal spending reversal rule can reduce both the volatility of the interest rate and that of the tax

Figure 3: Standard deviations of government spending, interest rate, and tax rate.



Note) Standard deviations are reported in percentage points.

rate. However, because a stricter degree of spending reversal increases the volatility of government spending monotonically, a much stricter degree of spending reversal will ultimately destabilize government debt and generate extra volatility of the tax rate; then it degrades the economy's welfare level.[15]

To clarify our analysis results, we compare the economy's welfare benefit curve in this case with that in the case in which the country-specific interest rate premium parameter ψ is set to a lower value. The dotted curve in Figure 2 presents the welfare benefit of spending reversals corresponding to the various values of ρ_{gd} in the case in which ψ is set to a half of the calibrated value (i.e., 0.01/2).[16] Comparison between the two cases (i.e., the

[15] It is not shown in Figure 3, but the standard deviation of the interest rate also starts to increase for a very low value of ρ_{gd}.

[16] Literature of the small-open-economy RBC model tends to fix this parameter at a very small number only to induce stationarity (e.g., Aguiar and Gopinath (2007)). García-Cicco et al. (2010) argue that the parameter ψ acts as a reduced form of financial friction, and

solid and dotted curves) suggests that as the friction in foreign borrowing becomes greater (because of a higher country-specific interest rate premium parameter), the positive effect of spending reversals on the economy's welfare (through reduced volatility of interest rates) will become increasingly important.

4 Sensitivity Analysis

In this section, we describe our verification of the robustness of our results. We follow the same procedures as those used in the previous sections, but here we assume that the government expenditure is a pure lump sum transfer to the private sector (households), so that government spending does not affect the economy's resource constraint. In this case, the households' flow budget constraint (2) is changed to

$$b_t = (1+r_{t-1})b_{t-1} - (1-\tau_t)[w_t h_t + (r_t^k - \delta)k_t] + c_t + i_t - \delta k_t + \Phi(k_{t+1} - k_t) - g_t, \tag{25}$$

where g_t is the government's lump-sum transfer to the households. The economy's current account (19) is then (combined with Eq. (16) and) changed to

$$ca_t(\equiv -s_t + s_{t-1}) = y_t - c_t - i_t - \Phi(k_{t+1} - k_t) - r_{t-1}s_{t-1}, \tag{26}$$

which implies that government spending does not affect the economy's resource constraint. Figure 4 shows welfare benefit levels corresponding to various values of ρ_{gd} in the case in which government spending is used as the

show that its value is much higher for emerging markets using Bayesian estimation.

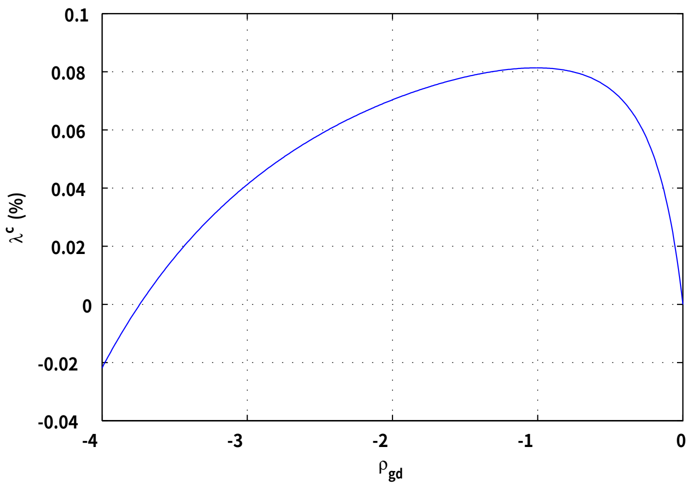


Figure 4: Welfare benefit: transfer case.

lump-sum transfer to households. The welfare benefits are slightly lower than those in Figure 2. Because g_t is missing in the current account (26) in the transfer case, the stabilizing effect of spending reversals through the channels of s_t and interest rates is weaker than that in the main text case (whereas that through the channels of d_t and tax rates is almost as effective as in the main text case). However, we still obtain a similar figure and confirm that our main result remains unchanged.

5 Conclusion

Regarding spending reversals as a policy option available to policymakers for stabilizing public debt, we have reexamined debt stabilization policy in a small open economy with borrowing from abroad. Using the perturbation methods developed by Schmitt-Grohé and Uribe (2004), we measured lifetime utility levels under different degrees of spending reversals. By comparing them with the welfare level under no spending reversals, we conducted policy evaluations of spending reversals.

Our analysis results show that a spending reversal rule can be welfare-improving. The intuition underlying our analysis results is straightforward. Spending reversals increase the volatility of the government spending. However, spending reversals can curtail the government debt deviation and consequently reduce the volatility of the tax rate and that of the interest rate toward the optimal point. The imposition of the optimal spending reversal rule therefore improves welfare compared with the no reversal rule case. If the degree of spending reversals is too strict, however, it ultimately destabilizes government debt and generates extra volatility of the tax rate. It then degrades the economy's welfare level. Therefore, a hump-shaped relation exists between spending reversals and welfare levels.

Results described in this paper also suggest that the welfare benefit of the optimal spending reversal rule will be greater to the degree that the country-specific risk premium parameter is higher (i.e., the friction in foreign borrowing is greater). This is true because, for a higher country-specific risk premium parameter, the beneficial effect of spending reversals is also higher through reduction of interest rate volatility.

As described in this paper, to consider spending reversals as a policy option available to policymakers, we have examined an optimal fiscal rule in a parallel way to the optimal tax policy rules that have been examined previously in the literature. However, more general arguments related to fiscal policies that are not limited to fiscal rules might be important. We leave this as a subject for our future work.

References

[1] Aguiar, M., and G. Gopinath, (2007), "Emerging Market Business Cycles: The Cycle Is the Trend," *Journal of Political Economy* 115, pp.69-102.

[2] Bi, H., (2011), "Optimal Debt Targeting Rules for Small Open Economies," Manuscript, Bank of Canada.

[3] Correia, I., J. Neves, and S. Rebelo, (1995), "Business Cycles in a Small Open Economy," *European Economic Review* 39, pp.1089-1113.

[4] Corsetti, G., A. Meier, and G. Müller, (2012), "Fiscal Stimulus with Spending Reversals," *Review of Economics and Statistics*, forthcoming.

[5] García-Cicco, J., R. Pancrazi, and M. Uribe, (2010), "Real Business Cycles in Emerging Countries?" *American Economic Review* 100, pp.2510-2531.

[6] Kollmann, R., (2008), "Welfare-Maximizing Operational Monetary and Tax Policy Rules," *Macroeconomic Dynamics* 12, pp.112-125.

[7] Mendoza, E., (1991), "Real Business Cycles in a Small Open Economy," *American Economic Review* 81, pp.797-818.

[8] Neumeyer, P., and F. Perri, (2005), "Business Cycles in Emerging Markets: The Role of Interest Rates," *Journal of Monetary Economics* 52, pp.345-380.

[9] Schmitt-Grohé, S., and M. Uribe, (2003), "Closing Small Open Economy Models," *Journal of International Economics* 61, pp.163-185.

[10] Schmitt-Grohé, S., and M. Uribe, (2004), "Solving Dynamic General Equilibrium Models Using a Second-Order Approximation to the Policy Function," *Journal of Economic Dynamics and Control* 28, pp.755-775.

[11] Schmitt-Grohé, S., and M. Uribe, (2007), "Optimal Simple and Implementable Monetary and Fiscal Rules," *Journal of Monetary Economics* 54, pp.1702-1725.

Appendix A Equilibrium conditions (Not for publication)

$$k_{t+1} = (1-\delta)k_t + i_t$$

$$[c_t - \eta h_t^{\omega}]^{-\gamma} = \lambda_t$$

$$h_t^{\omega-1} = \frac{(1-\tau_t)w_t}{\omega\eta}$$

$$\lambda_t = \beta(1+r_t)E_t\lambda_{t+1}$$

$$\lambda_t[1+\phi(k_{t+1}-k_t)] = \beta E_t\lambda_{t+1}[(1-\tau_{t+1})(r_{t+1}^k - \delta) + 1 + \phi(k_{t+2}-k_{t+1})]$$

$$y_t = A_t k_t^{\alpha} h_t^{1-\alpha}$$

$$r_t^k = A_t \alpha k_t^{\alpha-1} h_t^{1-\alpha}$$

$$w_t = A_t(1-\alpha)k_t^{\alpha} h_t^{-\alpha}$$

$$d_t = (1+r_{t-1})d_{t-1} + g_t - \tau_t(w_t h_t + r_t^k k_t) + \delta\tau_t k_t$$

$$\hat{g}_t = \rho_{gg}\hat{g}_{t-1} + \rho_{gd}\hat{d}_{y,t-1} + \varepsilon_{g,t}$$

$$\tau_t = \tau + \theta\hat{d}_{y,t-1}$$

$$d_{y,t} = \frac{d_t}{y_t}$$

$$r_t = r + \psi(e^{s_t - \bar{s}} - 1)$$

$$tb_t = y_t - c_t - i_t - g_t - \frac{\phi(k_{t+1}-k_t)^2}{2}$$

$$s_t = (1 + r_{t-1})s_{t-1} - tb_t$$

$$ca_t = tb_t - r_{t-1}s_{t-1}$$

$$tb_{y,t} = \frac{tb_t}{y_t}$$

$$ca_{y,t} = \frac{ca_t}{y_t}$$

$$s_t = b_t + d_t$$

$$s_{y,t} = \frac{s_t}{y_t}$$

$$b_{y,t} = \frac{b_t}{y_t}$$

Appendix B Steady state (Not for publication)

$$r^k = \frac{\beta^{-1} - \delta\tau - 1 + \delta}{1 - \tau}$$

$$w = (1 - \alpha)\left(\frac{r^k}{\alpha}\right)^{-\frac{\alpha}{1-\alpha}}$$

$$h = \left(\frac{(1 - \tau)w}{\omega\eta}\right)^{\frac{1}{\omega-1}}$$

$$k = h\left(\frac{\alpha}{r^k}\right)^{\frac{1}{1-\alpha}}$$

$$y = k^\alpha h^{1-\alpha}$$

$$i = \delta k$$

$$\frac{g}{y} = 0.155$$

$$r = \frac{1-\beta}{\beta}$$

$$d = \frac{-g + \tau(wh + r^k k) - \delta\tau k}{r}$$

$$\frac{tb}{y} = -0.022$$

$$\bar{s} = \frac{tb}{r}$$

$$b = \bar{s} - d$$

$$ca = tb - r\bar{s}$$

$$c = y - i - g - tb$$

$$\lambda = (c - \eta h^{\omega})^{-\gamma}$$

$$d_y = \frac{d}{y}$$

$$tb_y = \frac{tb}{y}$$

$$ca_y = \frac{ca}{y}$$

$$s_y = \frac{\bar{s}}{y}$$

$$b_y = \frac{b}{y}$$