Some Fiscal Calculus*

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PRELMINARY
COMMENTS WELCOME

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Abstract

The 2008 financial crisis and its policy response has urgently raised the old question of the impact of fiscal policy, in particular government spending and tax cuts, on the economy. This paper contributes to this debate, using a simple neoclassical growth model with endogenous labor, adding fiscal instruments to provide a positive rather than normative analysis of the impact of fiscal policy shocks. It is shown that the timing of the tax response to the ensuing deficits may be crucial and that the calculations of fiscal multipliers can be misleading.

Keywords:

JEL codes:

1 A short introduction

What is the impact of fiscal policy on the economy? How large are the "multipliers" of government spending and tax cuts? This old question has recently received considerable attention. This paper contributes to answering that question by thinking through fiscal multipliers in a baseline neoclassical growth model with endogenous labor supply and fiscal policy, allowing for government spending transfers, government debt and distortionary taxes on labor and capital income. The policy experiments are conducted holding transfers and capital income taxes fixed, i.e. changes in taxation require changes in the distortionary labor tax. The model is simple and fairly standard.

This is a positive, not a normative analysis. Whether these output or consumption responses are desirable or not needs to be evaluated by other means, e.g. by the political assessment of the consequences. I shall largely view the result through the lense of what it does to output, presuming that a more positive response is more benign, but no welfare conclusions are intended with these statements. The issue is taken up in section 5.

I shall argue that a key parameter in this exercise is the speed at which the government seeks to return debt to its original level. Furthermore, I shall argue, that short-run fiscal multipliers can be dramatically misleading. For example, assuming that the government permits only a very slow return of debt levels, the initially output-stimulating effect of of a permanent government spending increase, also visible in the short-run dynamics shown in figure 3 comes at a large cost in output reduction further down the road. Figure **??** shows the impulse response, drawn out until 2100, to exhibit the long-run response: output will eventually drop by nearly a percent,turning negative in about 2025. Furthermore, consumption is always negative and crowded out by government spending. By contrast, the impact of a persistent cut in labor taxes, financed from increases in these taxes further down the road, is considerably more benign in terms of the output dynamics, see figure 5.

The paper also examines a version of the fiscal stimulus plan as decided in January 2009. Figure 7 shows the scenario of the initial negative business cycle shock (modelled as a negative technology shock at the beginning of 2008) and the additional fiscal policy measures, notably the government spending increase modelled as in figure 6 as well as a persistent tax cut, at the beginning of 2009. The figure also shows the contribution of each component. While the fiscal policy succeeds in stimulating output at the beginning of 2009, there are persistent negative consequences for output due to the spending increase further down the road.

In sum, the paper concludes that in terms of stimulating output, persistent labor income tax cuts work considerably better than government spending increases. The latter may instead have lasting negative consequences for output. Assessing only the impact in the near-term and evaluating the fiscal multipliers only there can be highly misleading.

2 A long introduction

What is the impact of fiscal policy on the economy? How large are the "multipliers" of government spending and tax cuts? These old questions have once again received attention in light of the fiscal response to the 2008 financial crisis, notably with the American Recovery and Reinvestment Act of 2009.

In support of this "stimulus plan", the White House economists C. Romer and J. Bernstein (2009) have provided a document in January 2009, providing estimates of its impact. Detailed results are provided: for example, their table 5 estimates that 127000 of newly created jobs are expected to go to women in the financial activities industry, accounting for 59% of all the newly created jobs in that industry. As basis for these calculations, the authors point in particular to their appendix 1, which lists more generally the "output effects of a permanent stimulus of 1% of GDP (percent)". Assuming that this stimulus package and therefore these effects got off the ground in the first quarter of 2009, figure 1 plots the fiscal multipliers, as copied from their table.

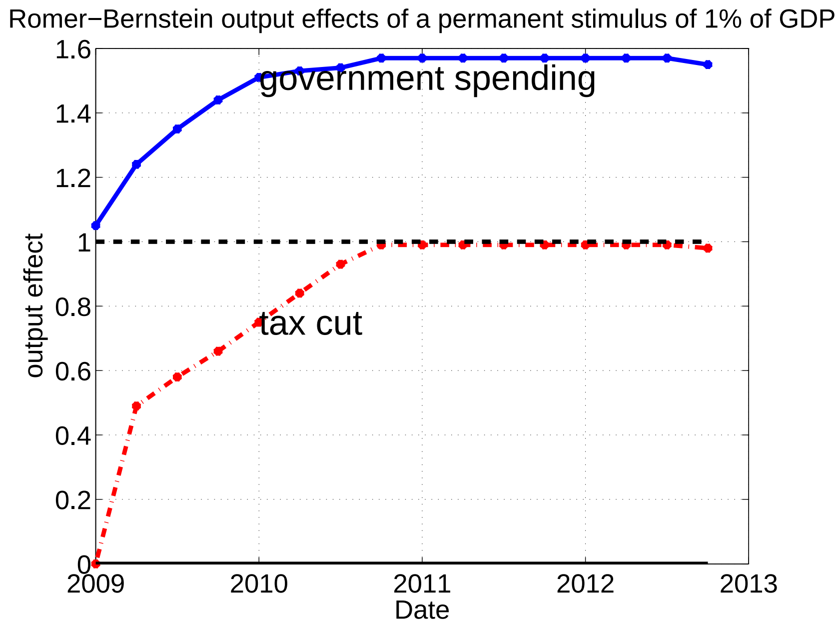


Figure 1: *The Romer-Bernstein (2009) fiscal multipliers: see their appendix 1.*

While these numbers may be broadly within the range that can be found in the literature, see the survey in Hemming-Kell-Mahfouz (2000), they are surprising in light of recent empirical research, employing structural vector autoregressions. While Mountford-Uhlig (2008) use sign restrictions and are probably most decisive in concluding that tax cuts rather than spending increases have a larger impact on GDP. Generally, this ordering is also found in e.g. Blanchard and Perotti (2002), Edelberg-et-al (1999) and Burnside-et-al (2003), and possibly Leeper et al (1996). With the exception of Gali (2007), the fiscal multipliers for government spending also typically seem to be considerably more modest than the Romer-Bernstein numbers in 1. It may well be that these vector autoregressive approaches suffer from fundamental "invertibility" problems in identifying fiscal policy shocks if they are truly news shocks about future fiscal policy, see Leeper et al (2009). Ramey (2007) has therefore recently sought to identify these news shocks directly by newspaper evidence, expanding on Ramey-Shapiro (1998): if anything, her findings encourage a "neoclassical" and consumption-depressing view of government spending expansions. It may also be interesting to compare Romer-Bernstein (2009) to previous publications by one of the authors, notably Romer-Romer (1994) and Romer-Romer (2007).

It is fair to conclude that the literature allows for disagreement with the Romer-Bernstein numbers shown in 1: it may not be appropriate to consider these numbers to reflect a broad consensus of economists. Therefore and in light of Leeper et al (2009), it is all the more important to understand how to derive such multipliers from the perspective of quantitative macroeconomic theory and to understand the basis for the calculations in Romer-Bernstein (2009).

The document lists the Federal Reserve's FRB/US model as well as a "leading private forecasting firm" as the key source for these numbers. For the latter, Mark Zandi and Moody's economy.com have been mentioned explicitly previously in the Romer-Bernstein text. There is little more information that has been provided, however, except to note that the "federal funds rate [has been assumed to] remain ... constant, rather than the usual case where the Federal Reserve raises the funds rate in response to fiscal expansion." In order to obtain more background and detail on the calculations that went into obtaining the numbers shown in 1, this author has written on March 5th 2009 to the White House, requesting further information on the grounds that the administration has promised to be particularly open, as well as to Mark Zandi and has also contacted the Federal Reserve Bank. Only the Federal Reserve Bank has provided some answers so far. I am particularly grateful to John Roberts and David Reifschneider there for sharing a document, describing all equations of the estimated FRB/US model, as well as an Excel sheet with the simulation output that may have been an input into the Romer-Bernstein document. These simulations cannot be shared, however, since the FRB/US model is meant to be used only for the in-house analysis of monetary policy issues, and not for evaluating the impact of fiscal policy as a general matter of principle. A document evaluating the stimulus plan can be found on Moody's economy.com, but it does not seem to provide further detail that would be useful for thinking about the claims in Romer-Bernstein (2009).

So rather than pursuing a "top-down" approach of understanding where the numbers in 1 come from, and how robust they may be to variations in the underlying assumptions, this paper pursues a "bottom-up" approach of thinking through fiscal multipliers in a baseline neoclassical growth model. The quantitative implications of this model should surely be taken with a grain of salt: it does not have the detail of e.g. the FRB/US model or even the detail of a recent slate of DSGE models. It does not feature sticky prices or wages, nor does it feature adjustment costs for capital or employment. It also does not feature an essential financial sector or a central bank, both of which surely played a crucial role in the 2008 financial crisis.

I believe, however, that useful insights can be obtained from this exercise, that may well carry over into a broader context, and can, at the very least, serve as warning signs and useful reminders: they all can be understood easily in the context provided here. For example, one result on fiscal multipliers for a permanent, anticipated increase of government spending versus a cut in taxes, both under the assumption of a very gradual adjustment of taxes to restore fiscal balance, can be seen in figure 2. The permanent increase of government spending is assumed to be decided in the first quarter of 2009, but only happen beginning with the first quarter of 2010[1]. The fiscal multipliers have been calculated as a net present value, i.e., the discounted sum of output changes until each horizon have been divided by the sum of discounted spending changes (or tax receipt changes) until the same horizon. Technically, therefore, one obtains a multiplier of infinity for the first four

[1]Pre-Announced tax changes have already been studied elsewhere, e.g. in chapter 5 of Trabandt (2006).

quarters for government spending: for the purpose of this plot, this has been cut at the maximal value of 4.

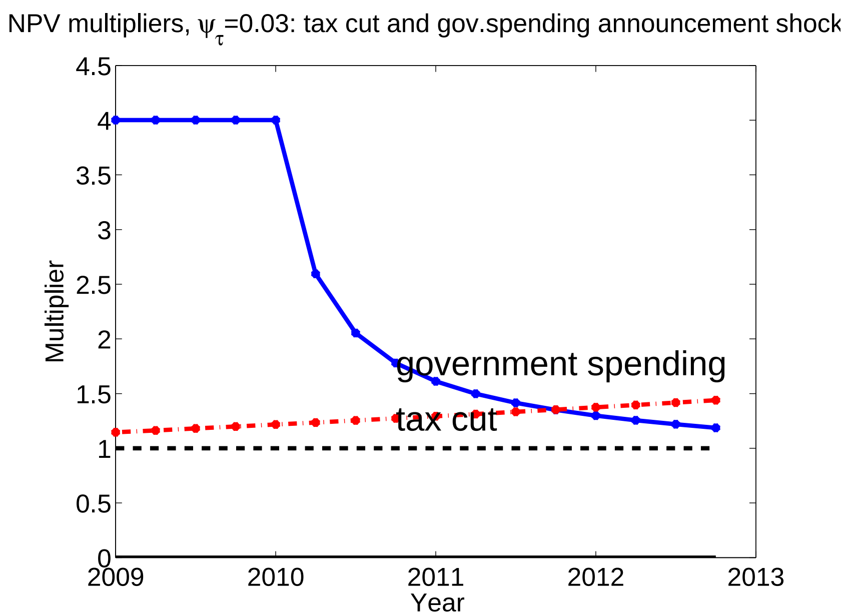


Figure 2: Net present value fiscal multipliers from a neoclassical growth model for an anticipated permanent increase in government spending as well as a persistent tax cut. For the plot, the multipliers have been cut at the maximal value of 4, rather than plotting ∞ due to a division of zero in the first four quarters. The model and the calculations are described in the main text.

While the figure indicates that tax cuts rather than spending increases eventually are more potent for increasing output – which is in line with the empirical evidence cited above, but in contrast to the ranking in Romer-Bernstein (2009) – the figure appears to agree with Romer-Bernstein (2009) that fiscal multipliers above unity can reasonably expected for the horizon considered by these authors.

I shall argue, however, that this figure is quite misleading. The initially output-stimulating effect of e.g. of a government spending increase, also visible in the short-run dynamics shown in figure 3 comes at a large cost in output reduction further down the road. Figure 4 shows the impulse response, drawn out until 2100, to exhibit the long-run response: output will eventually drop by nearly a percent,turning negative in about 2025. Furthermore, consumption is always negative and crowded out by government spending, in line with Ramey (2007). The same is not true for a tax cut: while eventually tax increases need to follow to finance the ensuing deficits, the impact on output is much milder, see the long-run responses in figure 5. In fact, the present value of the output increase is strictly positive, presumably because such a tax cut acts as a one-time tax increase on initial capital "in disguise".

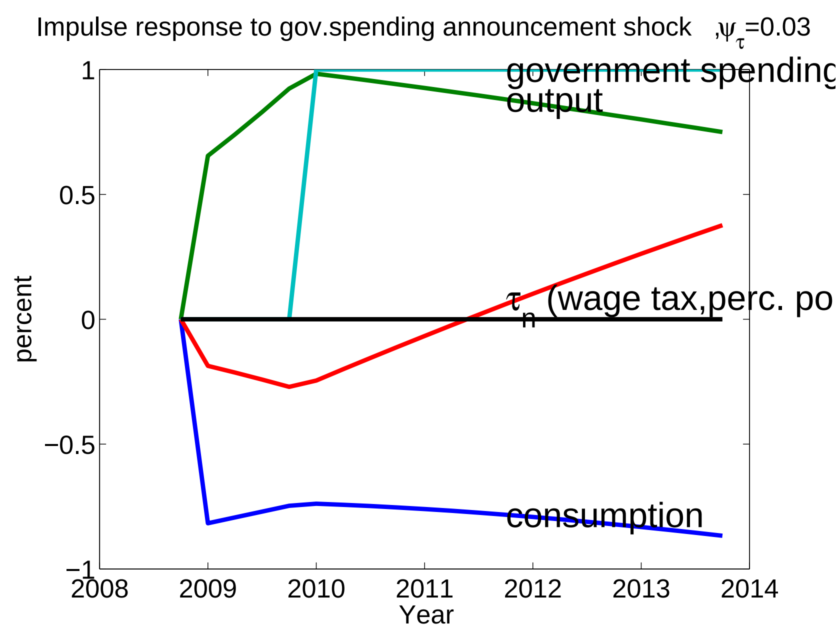


Figure 3: *Impulse response to a permanent increase in government spending, anticipated by one year and with a slow adjustment of tax rates.*

One may still be willing to consider these results to be politically desirable: after all, output is increased for a number of years, and the incidence of the drop of consumption may not fall on the electorate of the democratic

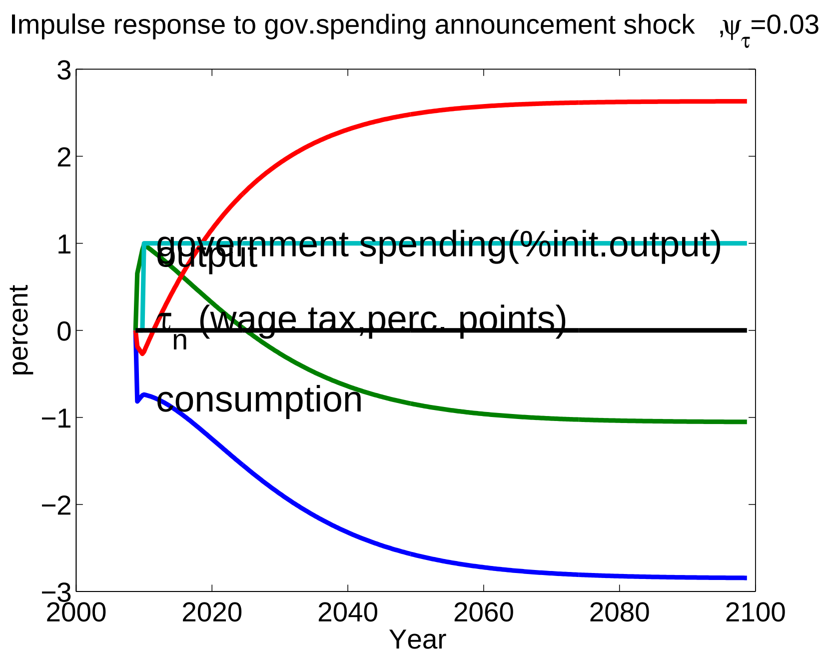


Figure 4: *Impulse response to a permanent increase in government spending, anticipated by one year and with a slow adjustment of tax rates.*

party. But surely, figure **??** tells a rather different story than figure 2.

Recently, Cogan et al (2009) have provided a related exercise, evaluating the stimulus plan using the Smets-Wouters (2007) model. That model is a New Keynesian model and is one of the currently leading DSGE models fitted to US data: it therefore allows for simulations involving e.g. sticky prices and the inclusion of an interest rate policy. That model and therefore Cogan et al (2009) assume lump-sum taxation (post price-setting) . As a result, Ricardian equivalence holds and the timing of taxation is irrelevant: the stimulus plan may as well be financed by immediately raising the taxes to pay for it. In contrast, I focus in this paper on the role that distortionary labor taxes have in raising the revenue needed to finance any stimulus. I view the exercise here as complementary to theirs. Redoing the calculations here in an extended version of the Smets-Wouters (2007) would surely be

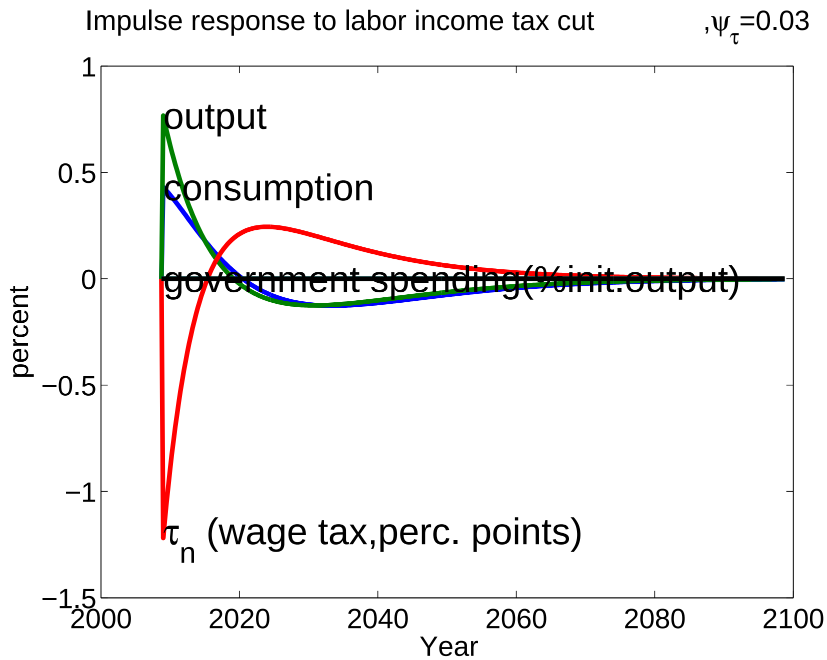


Figure 5: *Impulse response to a persistent reduction in the labor income tax rate.*

interesting and is planned for future research.

Table 1 shows the differences in the results for two exercises from the Cogan-et-al exercise, using two different scenarios for monetary policy, and the results in this paper, using different assumptions on the speed of returning to the original deb-to-GDP ratio, ordered from "very fast" to "very slow". It also compares these results to the Bernstein-Romer numbers. While the differences for the two monetary policy scenarios in Cogan-et-al are there, the dramatic differences arise from different assumptions regarding the fiscal deficit adjustment speeds, with distortionary taxation. The main focus of this paper is therefore on this issue. The interaction of these effects with monetary policy should nonetheless receive further attention, see also Davig-Leeper (2009).

For the paper at hand, though, I shall also consider a (fully anticipated)

	09Q1	09Q4	10Q4	11Q4	12Q4
Bernstein-Romer:	1.05	1.44	1.57	1.57	1.55
Cogan et al 1. Federal funds rate zero in 2009 and 2010:					
	1.03	0.89	0.61	0.44	0.40
Cogan et al 2. Federal funds rate zero in 2009:					
	0.96	0.67	0.48	0.41	0.40
Uhlig (2009):					
very fast	-0.26	-0.26	-0.27	-0.28	-0.28
fast	0.67	0.15	-0.11	-0.20	-0.24
slow	0.82	0.63	0.42	0.26	0.13
very slow	0.78	0.75	0.71	0.66	0.61

Table 1: *Impact on GDP of permanent increase in government spending by 1 percent of GDP.*

version of the spending increase close to the "data" shape calculated in Cogan et al (2009) from the law, see figure 6. The simulated version can be captured easily, using an AR(2) process, at the drawback of generating a slower decline after 2011, than calculated by Cogan et al (2009). Then again, it may not be unreasonable to assume that agents are actually more skeptical than these authors that government spending will indeed decline that much again after 2011, and rather believe and act, as if the simulated path will be true.

I use this simulated path for government spending as well as a labor income tax cut of 1 percentage point, starting in January 2009, as capturing the stimulus package as decided by Congress in January 2009 in response to the downturn beginning of 2008. I capture the downturn as a decline in labor productivity starting one year earlier: while the detailed reasons may indeed be the upheaval on financial markets, the aggregate effect may be rather similar. Under further assumptions listed in the model, one may therefore view the figure 7 as the scenario that best describes current events, from the perspective of the model of this paper, using $\psi_\tau = 0.1$ for the value of a crucial budget balancing parameter there.

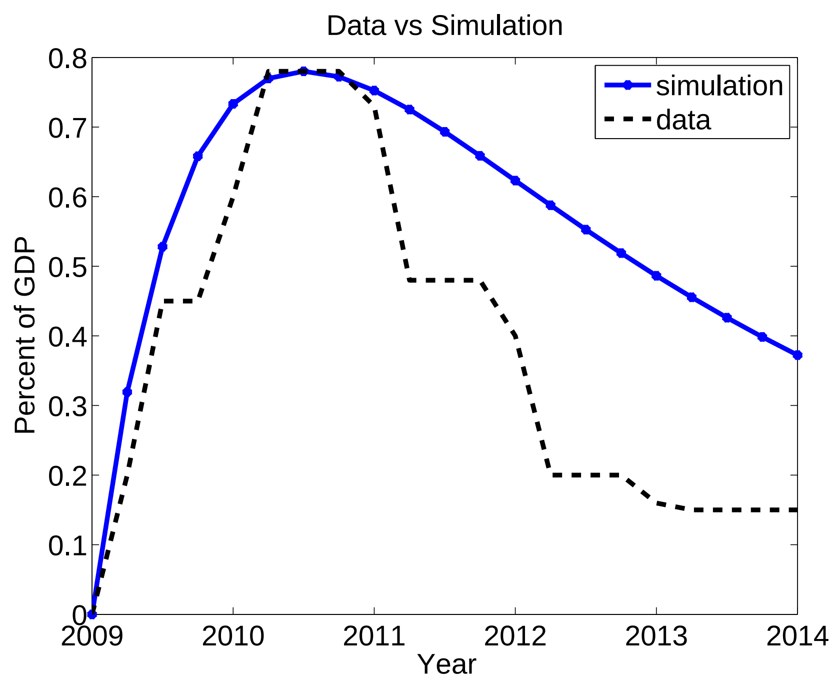


Figure 6: *Simulated stimulus plan.*

One can see, that the fiscal policy indeed leads to a boost in output at the beginning of 2009. However, this comes at the cost of triggering a further anemic development[2] of output later on. One can see this more clearly again by drawing out the impulse response to a longer horizon, see figure 8.

Figure 9 shows the dynamics of debt and taxes for the same time frame: due to a rather muted reaction to finance the increase in spending early on, debt and taxes have to rise considerably much later, even as spending has largely returned back to zero.

One may conclude that the government spending in particular is remarkably costly as an attempt to stimulate output at the beginning of 2009: while a short-lived effect is there, the long-run costs are substantial. According to

[2]It is best to read these graphs as deviations from some long-run growth trend. In that case, a gradual decline of output in the figures amounts to slow growth of output during the corresponding period in the data.

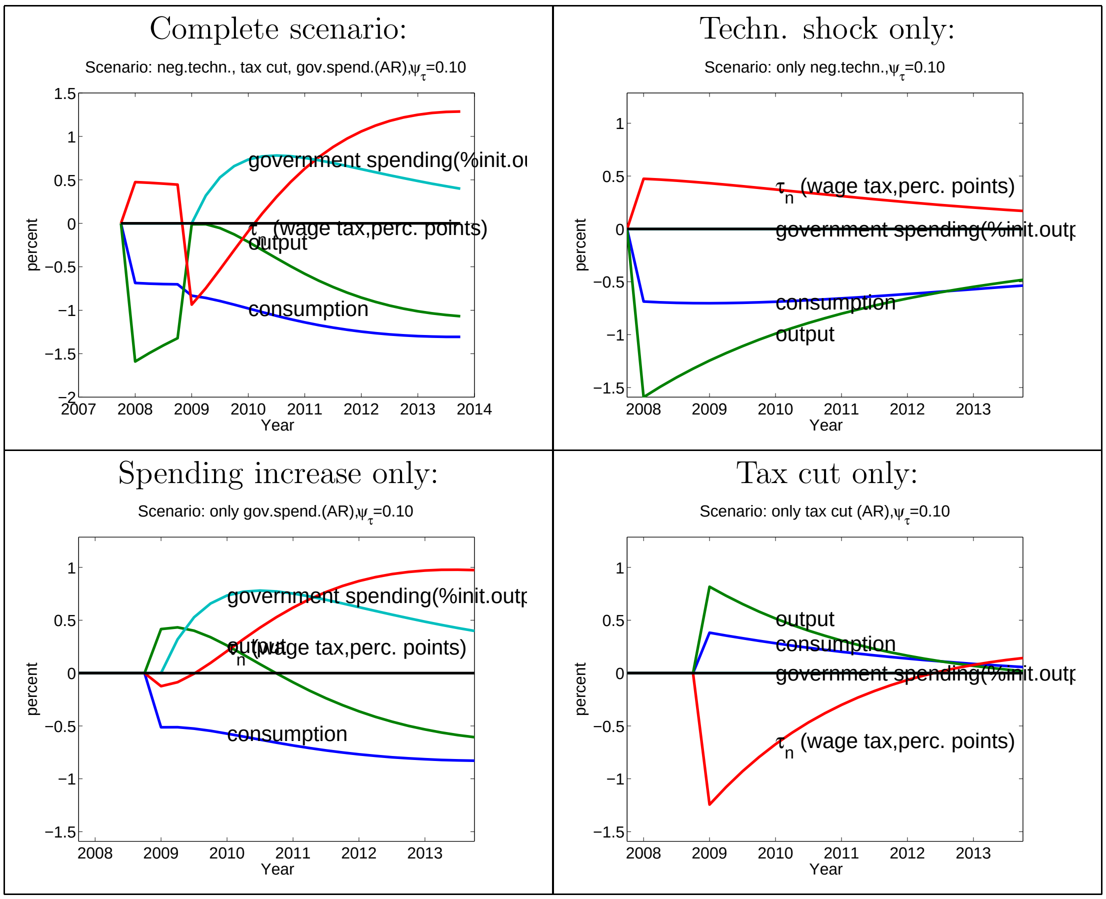


Figure 7: *Scenario of a negative productivity shock at the beginning of 2008, followed at the beginning of 2009 by a labor income tax cut and the scheduled increase in government spending. The complete scenario is in the upper left, whereas the upper right shows the result due to the technology shock only. The bottom row shows the result due to the government spending increase only and the tax cut only. The scenario in the upper left corner is the sum of the responses in the other three quadrants.*

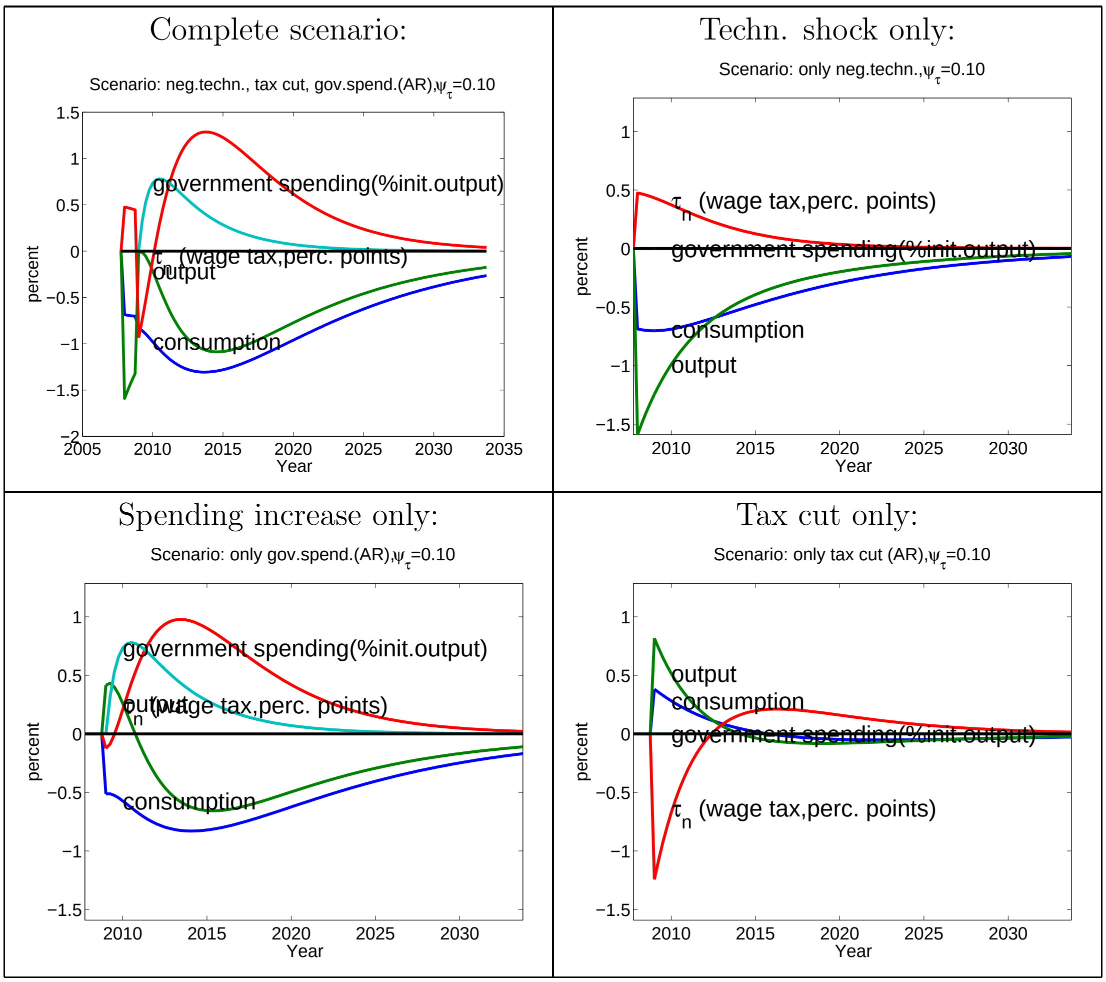


Figure 8: *Longer horizon, but the same scenario and details as in the previous figure.*

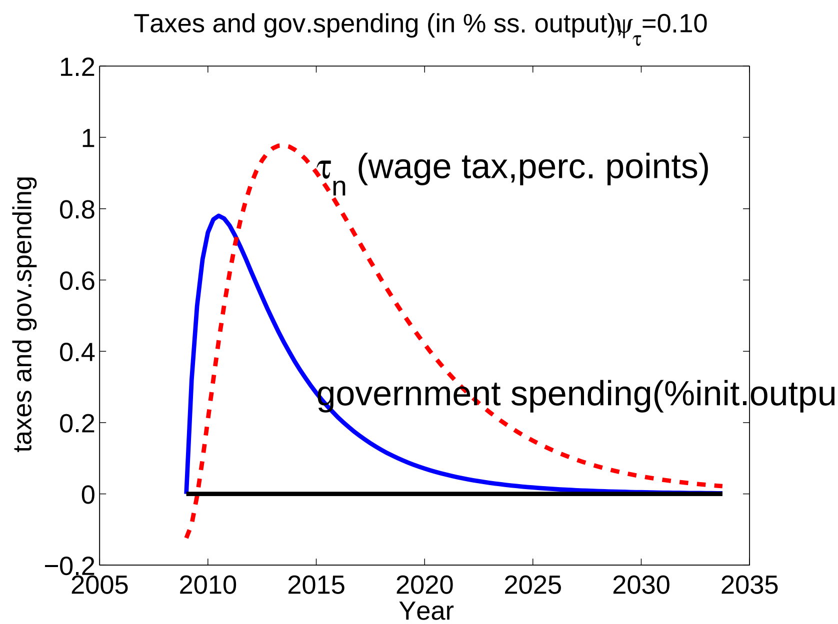


Figure 9: *Dynamics of taxes and debt, following the fiscal stimulus plan and assuming* $\psi_\tau = 0.1$.

these simulations, the economy would have returned back to steady state faster without any government intervention.

These calculations suggest that the recession may be prolonged precisely because of the massive fiscal intervention, not despite of it. This also echoes the lesson drawn by de Córdoba and Kehoe (2009), who draw lessons from the examination of a number of past great depressions to argue "that massive public interventions in the economy to maintain employment and investment during a financial crisis can, if they distort incentives enough, lead to a great depression." This paper re-confirms that lesson.

The paper is structured as follows. Section 3 states the model. Section 4 discusses the results. Section 6 concludes.

3 The model

Except perhaps for the details on fiscal policy (and for a specific, but largely innocuous choice for preferences), the model is standard. Time is discrete, $t = 0, 1, \ldots, \infty$. The representative household maximizes the discounted sum of life-time utility subject to a per-period budget constraint,

$$max_{c_t, n_t, k_t, x_t, b_t} \quad E_0 \sum_{t=0}^{\infty} \beta^t \left[u(c_t, n_t) + v(g_t) \right] \tag{1}$$

s.t.

$$\begin{aligned}
(1+\tau_t^c)c_t + x_t + q_t b_t &= (1-\tau_t^n)w_t n_t + (1-\tau_t^k)(d_t - \delta)k_{t-1} \\
&\quad + \delta k_{t-1} + b_{t-1} + s_t + \Pi_t \\
k_t &= (1-\delta)k_{t-1} + x_t
\end{aligned}$$

where c_t, n_t, k_t, x_t, b_t denote consumption, hours worked, capital, investment and government discount bonds. The household chooses consumption, labor, capital, investment and the purchase of government bonds, taking as given government spending g_t, transfers s_t, wages w_t, capital rental rates d_t, tax rates on labor income τ_t^n and capital income, τ_t^k as well as transfers s_t. Note that capital income taxes are levied on dividends net-of-depreciation as in Prescott (2002,2004).

For preferences, I assume that $u(c, n)$ is given by constant Frisch elasticity (CFE) preferences, described in greater detail in Trabandt-Uhlig (2008). I.e., I assume that

$$u(c, n) = \log(c) - \kappa n^{1+\frac{1}{\varphi}} \tag{2}$$

if $\eta = 1$ and by

$$u(c, n) = \frac{1}{1-\eta} \left(c^{1-\eta} \left(1 - \kappa(1-\eta) n^{1+\frac{1}{\varphi}} \right)^{\eta} - 1 \right) \tag{3}$$

if $\eta > 0, \eta \neq 1$, where $\kappa > 0$, up to affine transformations and where η is the inverse of the intertemporal elasticity of substitution in consumption.

The following proposition can be found in Trabandt-Uhlig (2008) and is shown there: it is useful for log-linearizing the dynamics of the model.

Proposition 1 *Suppose an agent has CFE preferences, where the preference parameter κ_t is possibly stochastic. The log-linearization of the first-order conditions around a balanced growth path at some date t is given by*

$$\begin{array}{lcl} \hat{\lambda}_t & = & \nu_{cc}\hat{c}_t + \nu_{cn}\hat{n}_t + \nu_{c\kappa}\hat{\kappa}_t \\ \hat{\lambda}_t + \hat{w}_t & = & \nu_{nc}\hat{c}_t + \nu_{nn}\hat{n}_t + \nu_{n\kappa}\hat{\kappa}_t \end{array} \tag{4}$$

where hat-variables denote log-deviations and where

$$\begin{aligned} \nu_{cc} &= -\eta \\ \nu_{cn} &= -\left(1+\frac{1}{\varphi}\right)(1-\eta)\left(\left(\eta\kappa\bar{n}^{1+\frac{1}{\varphi}}\right)^{-1}+1-\frac{1}{\eta}\right)^{-1} \\ \nu_{c\kappa} &= \frac{\varphi}{1+\varphi}\nu_{cn} \\ \nu_{nn} &= \frac{1}{\varphi}-\frac{1-\eta}{\eta}\nu_{cn} \\ \nu_{nc} &= 1-\eta \\ \nu_{n\kappa} &= 1-\frac{1-\eta}{\eta}\nu_{c\kappa} \end{aligned}$$

These preferences are consistent with long-run growth. For the purposes of this paper, one may wish to contemplate an extension with a heterogeneous population and in particular with respect to a nonlinear tax schedule, approximated locally by the relevant marginal tax rates. Assuming CFE preferences with the same preference parameters and using a log-linear approximation to the first-order condition as shown in the proposition above allows for a fairly straightforward solution to the aggregation problem: essentially, the aggregate dynamics is then given by the appropriate population averages of the individually relevant variables and choices. An extension to a small list of "types" of agents, who differ in their CFE parameters, is also fairly straightforward, per aggregating across the individual groups.

These preferences may leave much to desire. E.g. Jaimovich-Rebelo (2006) have recently emphasized the need to create preferences that imply that substitution effects and wealth effects cancel only after considerable time in response to rising wages, in order to allow productivity news shocks to drive the business cycle. More generally, a variety of other preferences have been suggested in the literature: surely, the results here are sensitive to that. Nonetheless, the choice here strikes me as reasonable due to its attractive features and its potential for easy aggregation.

The representative firm maximizes its profits subject to a Cobb-Douglas production technology,

$$max_{k_{t-1},n_t} \quad y_t - d_t k_{t-1} - w_t n_t \tag{5}$$

s.t.

$$y_t = \gamma_t k_{t-1}^{\theta} n_t^{1-\theta} \tag{6}$$

where γ_t denotes exogenous TFP. I assume that $\log \gamma_t$ follows a stationary AR(1) with autoregressive parameter ρ_γ.

Note that we do not allow for sticky wages and/or sticky prices and we do not introduce adjustment costs to capital. These features have been argued to be important in a slate of recent DSGE models. Leading "medium scale" New Keynesian models such as Smets-Wouters (2007) often incorporate them. There are also no search frictions on labor markets, an assumption popular in the macro-labor literature, see e.g. Krause-Lubik (2007a,2007b) and the investigation of the interaction with inflation in Krause-Lopez-Salido-Lubik (2008a,2008b). Surely, the results here are sensitive to the introduction of these frictions and their effect: investigating them in more detail should be a topic of future research.

Nonetheless, the simple model here already allows and generates a number of insights, which I find useful and which provide lessons to be investigated in richer frameworks as well.

The government faces the budget constraint,

$$f_t = q_t b_t + \tau_t^n w_t n_t \tag{7}$$

where F_t is given by

$$f_t = g_t + s_t + b_{t-1} - \tau_t^c c_t - \tau_t^k (d_t - \delta) k_{t-1}. \tag{8}$$

I need some rule to determine the evolution of taxes. I assume that $s_t \equiv \bar{s}$, $\tau_t^c \equiv \bar{\tau}_t^c, \tau_t^k \equiv \bar{\tau}^k$ and that g_t follows an exogenous stochastic process. Therefore the amount f_t needs to be financed with either labor income taxes or new debt. I assume that a fraction ψ_τ plus some random amount is financed with the former, and the rest with the latter. I.e., I assume that

$$\tau_t^n w_t n_t = \psi_\tau f_t + z_\tau \tag{9}$$

where z_τ is an exogenous AR(1) process with autoregressive parameter ρ_τ.

I consider three scenarios for a surprise change in exogenous government spending, all rising to 0.78% of steady state GDP at their peak[3]. First, I consider a surprise, permanent increase in g_t, i.e,

$$g_t \equiv \bar{g} + \chi_0 \epsilon_{g,0} \text{ for all } t \tag{10}$$

Second, I consider an announced permanent increase known at date 0,

$$g_t \equiv \bar{g} + \chi_4 \epsilon_{g,0} \text{ for all } t \geq t_0 = 4, \text{ else:} g_t \equiv \bar{g} \tag{11}$$

Finally, I seek a simple characterization of anticipated dynamics shown in figure 6. An AR(2) process is particularly convenient for that purpose. More precisely, let

$$\begin{aligned} z_{g,t} &= \alpha \left(\xi_1^t - \xi_2^t \right) && (12) \\ &= (\xi_1 + \xi_2) z_{g,t-1} - \xi_1 \xi_2 z_{g,t-2} && (13) \end{aligned}$$

with the initial conditions $z_{g,-1} = 0$ and $z_{g,0} = \alpha(\phi_1 - \phi_2)$ for two real, positive roots $1 > \phi_1 > \phi_2 > 0$. One way to find suitable values for $z_{g,0}$ and α is to impose a value for one root as well as a date and a level for the peak response: using numerical means, it is then straightforward to determine the other root as well as α. Consider now $z_{t,0}$ to be the surprise increase in government spending at date 0, with the further evolution given by

$$g_t = \bar{g} + z_{g,t} \tag{14}$$

[3]That value was chosen as it is the peak value in the graph given in Cogan et al (2009), see figure 6.

Variable	value	Description	Restriction
$\bar{\tau}^n$	28%	Labor tax	Data
$\bar{\tau}^k$	36%	Capital tax	Data
$\bar{\tau}^c$	5%	Consumption tax	Data
$\bar{b}/\bar{y}$	63%	Gov. debt to GDP	Data
$\bar{g}/\bar{y}$	15%	Gov.cons+inv. to GDP	Data
($\bar{s}/\bar{y}$	7.8%	Gov. transfer to GDP	Implied)
β	0.99	inv. of real interest	Data
θ	0.36	Capital share	conventional value
δ	0.015	Depr. rate of capital	conventional value
η	3/2	inverse of IES	benchmark
φ	1	Frisch elasticity	benchmark
κ	2.41	weight of labor	$\bar{n} = 1/3$
ρ_γ	0.9	AR for TFP	implied recess. half life for y: 12 qu.
ρ_τ	0.95	AR for τ_n	persistent shock
ψ_τ	$\in [1, 0.3, 0.1, 0.03]$	budget balance speed	a range of values
ξ_1	0.933	root 1 for g-AR(2)	half life 10 quarters
ξ_2	0.72	root 2 for g-AR(2)	peak date at 6 quarters
$z_{g,0}$	0.32%*$\bar{y}$	g-AR(2) shock	peak value = 0.78% of ss. GDP

Table 2: *Calibration. For the discussion of some values, see Trabandt-Uhlig (2008).*

To calibrate the model, I have used the values given in table 2. A crucial parameter is the Frisch elasticity of labor supply, and there has been considerable debate on that value. The number chosen here is in the middle range of the macro literature. For the reconciliation of the micro and the macro evidence, focussing on the Hicks elasticity, Chetty (2009) has recently pointed to small optimization frictions. The only somewhat unusual value there may be ρ_γ which I have set to 0.9 to incorporate a recession half life of 7 quarters rather than the more persistent dynamics which is usually imposed to model average behavior across expansions and recessions. For evaluating the quantitative magnitudes, one may wish to pick the initial size of the government spending increase so that all three scenarios result in the same net present value, using the steady state interest rate for discounting: this requires $\chi_0 = 0.146\% * \bar{y}$and $\chi_1 = 0.152\% * \bar{y}$. For the plots and the permanent increases in government spending, and for comparability with the literature, I have chosen the more conventional "1 % of GDP" however, i.e. $\chi_0 = \chi_1 = 1\% * \bar{y}$ and therefore a value nearly seven times as large. One may wish to keep that in mind when comparing the results to the impact of the stimulus plan shown in figure 6.

4 Results

Except for the fiscal policy pieces, this model is a fairly standard real business cycle model. The upper right hand panel of figure 7 shows a fairly conventional response to a TFP shock (assumed to be negative in that graph).

In this section, I shall therefore describe the responses to fiscal policy changes. Figure 12 shows the response to a permanent increase in government spending, either in the form of an immediate increase (left column) or in the form of an announced increase (right column), which then takes place four quarters later. Two scenarios for balancing the budget are considered. The top row shows the effect, when no debt financing is used, i.e. $\psi_\tau = 1$. The bottom row shows the result, if budget balance is re-established only very gradually, $\psi_\tau = 0.03$. The graphs have been shown for the same scaling of the axes.

Essentially, the impulse response of all variables is rather similar, once the spending increase happens, regardless of whether it has been pre-announced or not: output and consumption decreases, and taxes rise, either immediately or eventually. With the pre-announced spending increase, there is an initial phase, however, where taxes have not yet risen (and will actually endogenously even fall a little) and where the income effect leads agents to work harder. This leads to an initial boom in the economy, per anticipating the lower wealth of the increased government spending later.

It is this initial boom of anticipated increases in government spending later which explains the initially high fiscal multipliers for government spending in figure 2. One obtains a longer-lasting boom – with a correspondingly larger and longer subsequent phase of output reduction – the slower is the adjustment of taxes the ensuing deficits. For the stimulus spending plan shown in figure 6, figure 11 compares the reaction of tax rates, output and debt for the four values for $\psi_\tau \in \{1, 0.3, 0.1, 0.03\}$.

The output response seems particularly attractive perhaps for the slowest response rate, i.e. $\psi_\tau = 0.03$. As emphasized in the introduction, the long-run consequences are substantial however.

The same plot, just for the tax cut, shows that the deep dip in output is avoided, see figure **??**

5 Welfare

It is tempting and interesting to ask whether it is a good idea to pursue the policies studied in this paper. For example, the long decline in consumption in figure 8, in particular in response to an increase in government spending, could lead one easily to conclude that this is a remarkably bad policy indeed.

However, these results are driven by taking the "representative agent" perspective of this model perhaps too seriously. The model is meant to cap-

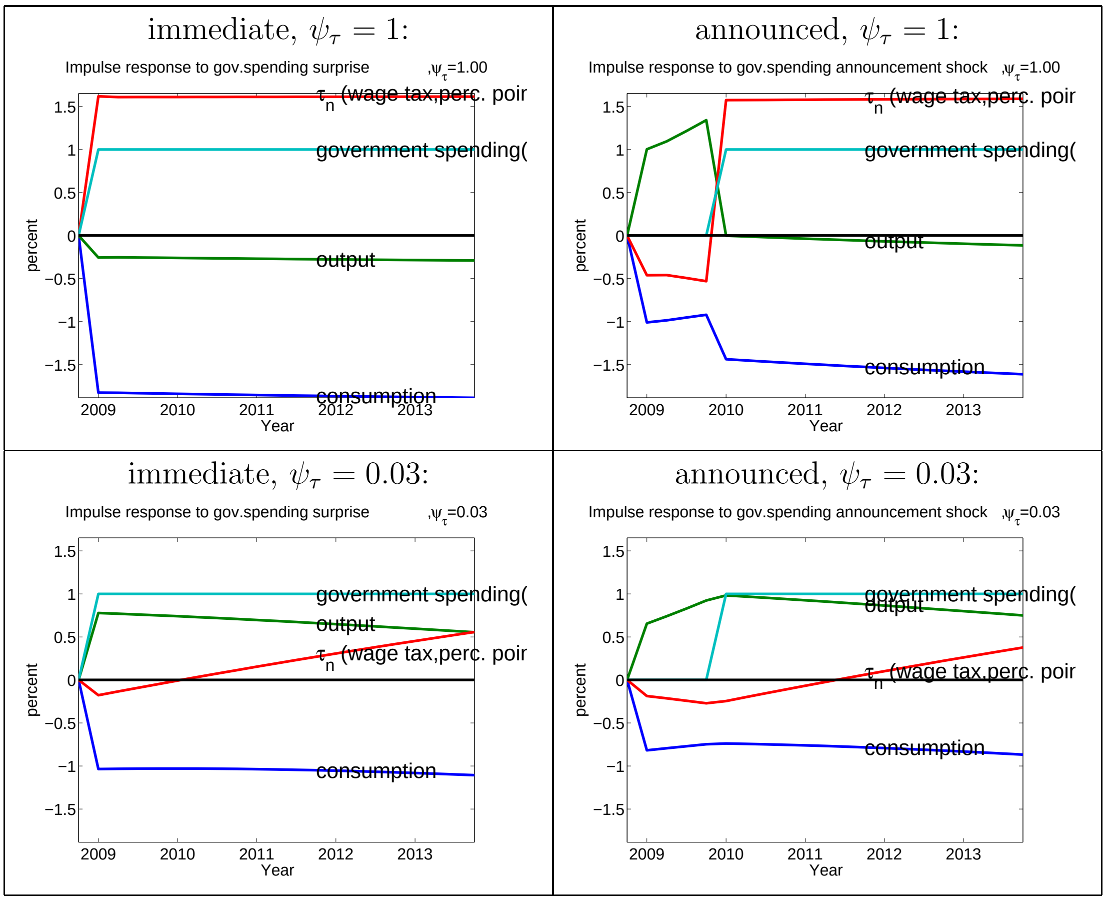
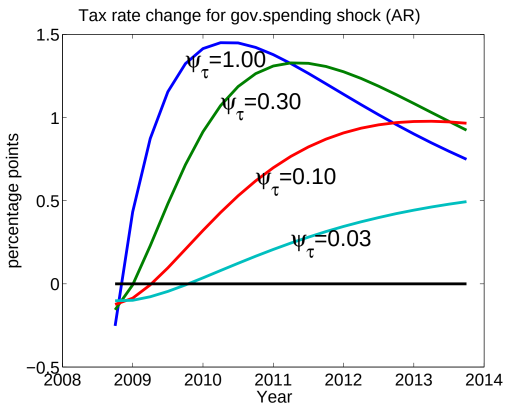
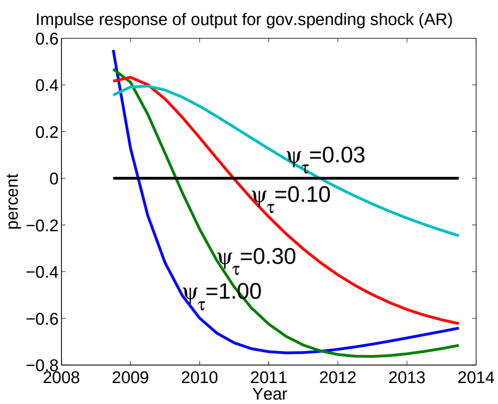


Figure 10: *Impact of a permanent rise in government consumption. Left column: immediate rise. Right column: announced, with rise four quarters in the future. Top row: no debt financing,* $\psi_\tau = 1$. *Bottom row: slow tax adjustment to re-establish budget balance,* $\psi_\tau = 0.03$.

Comparison of tax rate responses:



Comparison of output responses:



Comparison of debt responses:

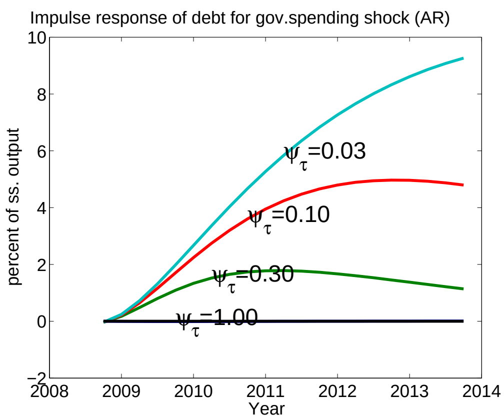


Figure 11: *Comparison of the tax rate dynamics, the output dynamics and the debt dynamics for the simulated stimulus-plan government spending increase, and four values for the tax rate and budget dynamics:* $\psi_\tau \in [1, 0.3, 0.1, 0.03]$.

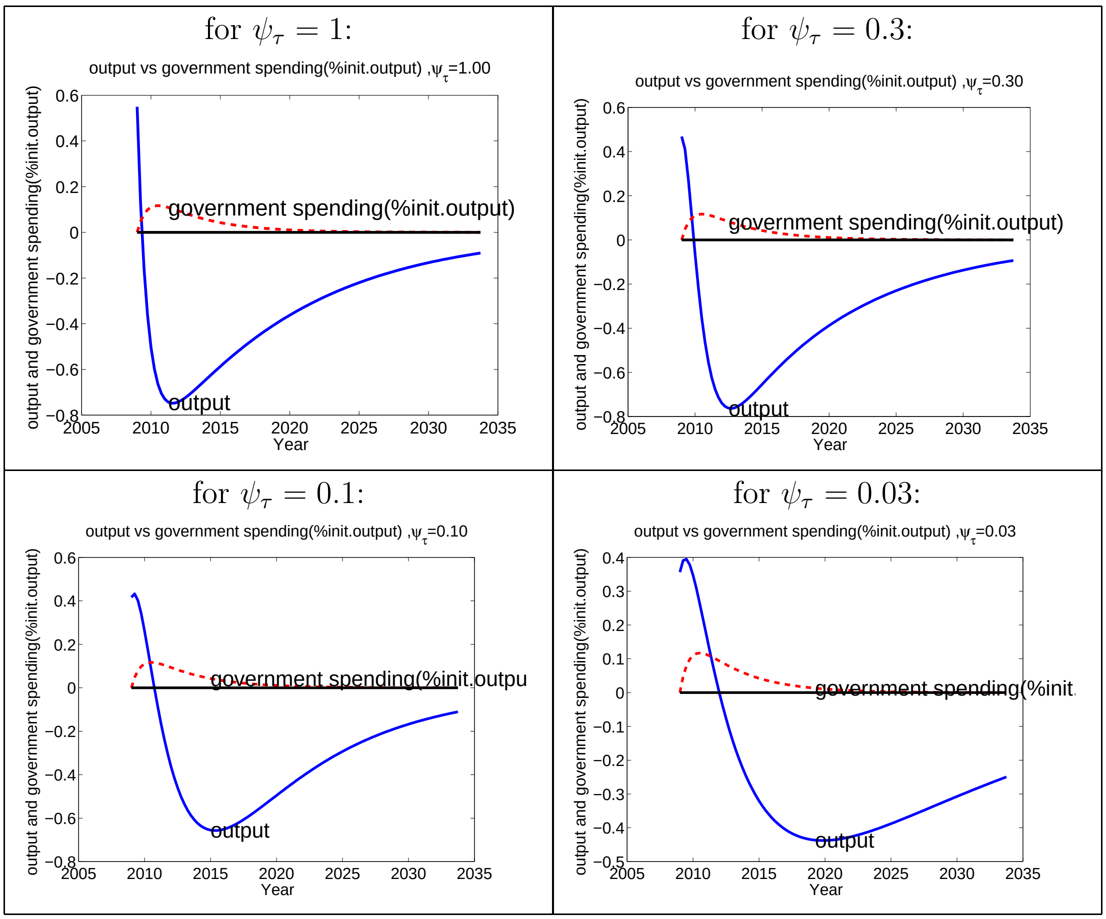


Figure 12: *Longer-run output dynamics, compared to the (constant) government stimulus plan, for different values of the tax response,* $\psi_\tau \in [1, 0.3, 0.1, 0.03]$.

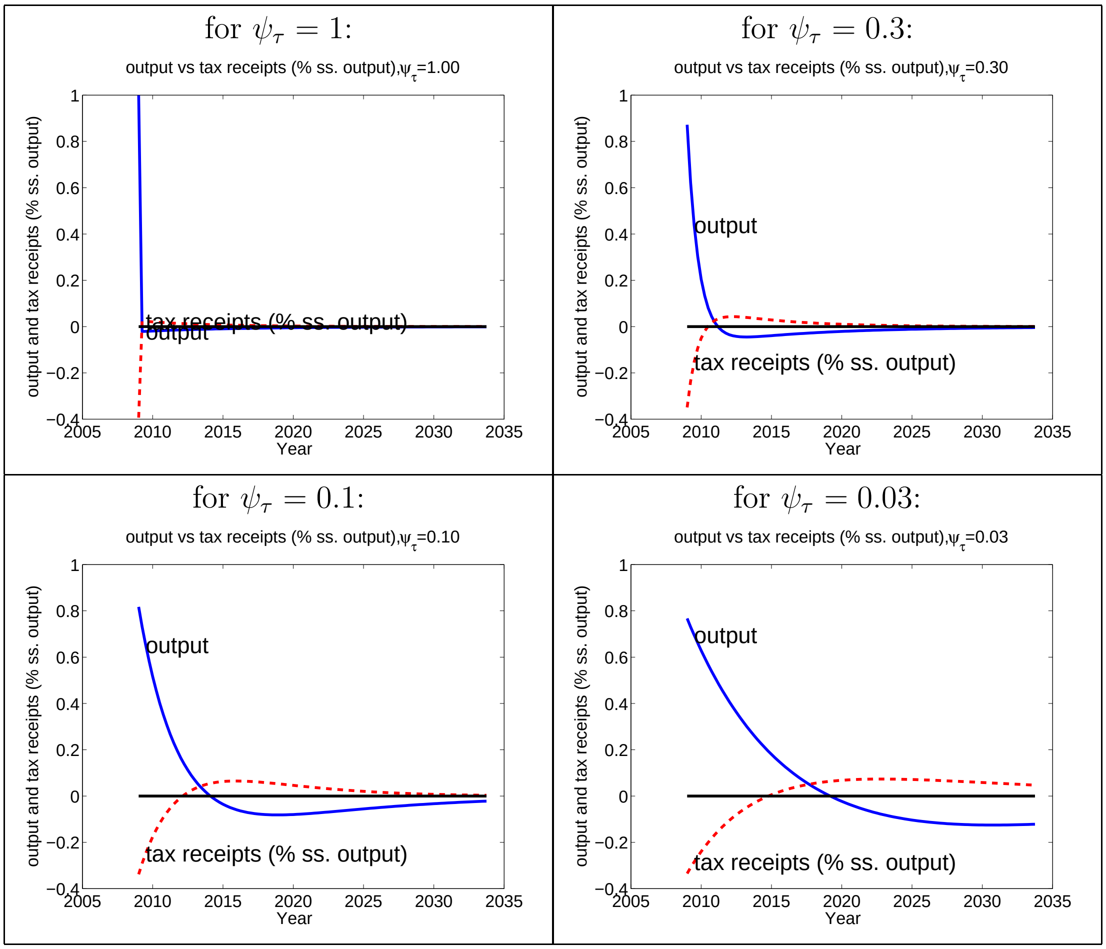


Figure 13: *Longer-run output dynamics in response to a tax cut, for different values of the tax response,* $\psi_\tau \in [1, 0.3, 0.1, 0.03]$.

ture aggregate dynamics in response to fiscal policy changes. It predicts that total private consumption does indeed decrease. The model may be viewed resulting from some sort of aggregating across a large and heterogeneous population, see the remarks above following the description of the CFE preferences. If so, it may well be that consumption actually increases for a fraction of the population – and declines even steeper for another. It then depends on the relative welfare weights on each part of the population as well as possibly a comparison of marginal utilities to come to a more serious assessment of the welfare effects.

From a political perspective, moreover, the weights may be chosen from the perspective of emphasizing the needs of, say, the electorate of the Democratic party more than the electorate of the Republican party, rather than choosing some kind of "blind" or even-handed weighting of utilities. Economics has little guidance to offer here: any set of welfare weights is acceptable in principle as input into the analysis, and welfare statements can typically only be made with respect to some chosen set of weights. Furthermore, much of the spending is undertaken on items that were high on agenda of the current president to begin with: the reduction of green house gases and educational improvements may improve welfare quite apart from the response of the economy.

It may therefore not be prudent to offer any judgement on these policies in this paper. Nonetheless, the analysis here may lead one to conclude that the long-term consequences of massive expansions in government spending come at substantial costs in terms of total output eventually and at considerably higher long-term output costs than those of tax cuts. If these are indeed the consequences, there may be many who would therefore prefer the tax-cut-only scenario to the increase in spending, say. An analysis as the one in this paper puts the options and its consequences of the table: the more clearly the consequences are understood, the more informed the political decision both by policy makers as well as the electorate can be.

6 Conclusions

In this paper, I have investigated a simple neoclassical growth model with endogenous labor and various fiscal instruments to calculate fiscal multipliers. I have emphasized in particular the need to raise government revenue through distortionary taxation. I have considered four different values for the aggressiveness of changing taxes to address the financing needs, parameterized by $\psi_\tau \in [1, 0.3, 0.1, 0.03]$: for ψ_τ, there is no debt financing of new deficits, whereas for $\psi_\tau = 0.03$, budget balance is re-established only very gradually.

I have demonstrated that fiscal multipliers can be quite misleading, if the drawn-out response of the economy at longer horizons is not taken into account. More specifically, while the initial output response to an announced government spending increase or to the simulated version of the stimulus plan may look quite attractive initially, and the more so, the more gradual is the reaction of taxes to the increased financing need, the ensuing eventually decline of output is that much larger.

I have also shown that output declines considerably less in response to a tax cut rather than a spending increase.

References

[1] **Cogan, John F., Tobias Cwik, John B. Taylor and Volker Wieland (2009)**, "New Keynesian versus Old Keynesian Government Spending Multipliers," draft, Goethe University Frankfurt.

[2] **Burnside, Craig, Martin Eichenbaum and Jonas D.M. Fisher (2003):** "Fiscal Shocks And Their Consequences," *National Bureau of Economic Research*, Working Paper 9772).

[3] **Chetty, Raj (2009)** "Bounds on Elasticities with Optimization Frictions: An Application to Taxation and Labor Supply," draft, Department of Economics, Berkeley.

[4] **Davig, Troy and Eric M. Leeper (2009)**, "Expectations and Fiscal Stimulus," draft, Department of Economics, Indiana University.

[5] **de Córdoba, Gonzalo Fernández and Timothy J. Kehoe (2009)**, "The Current Financial Crisis: What Should We Learn from the Great Depressions of the Twentieth Century?", Federal Reserve Bank of Minneapolis, Research Department Staff Report 421.

[6] **Edelberg, Wendy, Martin Eichenbaum and Jonas D.M. Fisher (1999):** "Understanding the Effects of a Shock to Government Purchases," *Review of Economic Dynamics*, 2:166:206.

[7] **Galí, Jordi, López-Salido, J. David, and Javier Vallés (2007):** "Understanding the Effects of Government Spending on Consumption" *Journal of the European Economic Association*, 5(1):227-270

[8] **Hemming, Richard, Michael Kell and Selma Mahfouz (2000):** "The Effectiveness of Fiscal Policy in Stimulating Economic Activity - A Review of the Literature", *Mimeo*, International Monetary Fund.

[9] **Jaimovich, Nir and Rebelo, Sergio:** "Can News about the Future Drive the Business Cycle?", NBER working paper 12537, American Economic Review, forthcoming.

[10] **Krause, Michael U. and Thomas A. Lubik (2007a)**, "On-the-job search and the cyclical dynamics of the labor market," Deutsche Bundesbank Discussion Paper Series 1 (2007:15).

[11] **Krause, Michael U. and Thomas A. Lubik (2007b)**, "The (ir)relevance of real wage rigidity in the New Keynesian model with search frictions," Journal of Monetary Economics, Elsevier, vol. 54(3), pages 706-727, April.

[12] **Krause, Michael U., David Lopez-Salido and Thomas A. Lubik(2008a)**, "Do search frictions matter for inflation dynamics?," European Economic Review, Elsevier, vol. 52(8), pages 1464-1479,

[13] **Krause, Michael U., David Lopez-Salido and Thomas A. Lubik (2008b)**, "Inflation dynamics with search frictions: a structural econometric analysis", Journal of Monetary Economics, vol. 55(5), 892-916.

[14] **Leeper, Eric, Sims, Christopher and Tao Zha (1996):** "What Does Monetary Policy Do ?" *Brookings Papers on Economic Activity*, 2, pp. 1-63.

[15] **Leeper, Eric, Todd B. Walker and Shu-Chun Susan Yang (2009):** "Fiscal Foresight and Information Flows," draft, Indiana University, Department of Economics.

[16] **Mountford, Andrew and Harald Uhlig (2008)**, "What are the Effects of Fiscal Policy Shocks?", NBER Working Paper 14551, Journal of Applied Econometrics, forthcoming.

[17] **Prescott, Edward C. (2002)**, "Prosperity And Depression," American Economic Review, vol. 92, p. 1-15.

[18] **Prescott, Edward C. (2004)**, "Why Do Americans Work So Much More Than Europeans?", Quarterly Review, Federal Reserve Bank Of Minneapolis.

[19] **Ramey, V. and M. Shapiro (1998):** "Costly Capital Reallocation and the Effects of Government Spending" *Carnegie Rochester Conference on Public Policy*.

[20] **Ramey, Valerie A. (2007)**, "Identifying Government Spending Shocks: Its All in the Timing," draft, University of California, San Diego.

[21] **Romer David, H. and Christina Romer (1994):** "What Ends Recessions ?" *NBER Macroeconomics Annual*, 9:13-57.

[22] **Romer David, H. and Christina Romer (2007):** "The Macroeconomic Effects of Tax Changes: Estimates Based On a New Measure of Fiscal Shocks" *NBER Working Pape*, No. 13264.

[23] **Romer, Christina and Bernstein, Jared (2009)**, "The Job Impact of the American Recovery and Reinvestment Plan," memo, The White House.

[24] **Smets, Frank and Raf Wouters (2007)**, "Shocks and Frictions in U.S. Business Cycles: A Bayesian DSGE Approach," American Economic REview 97 (3), 586-606.

[25] **Trabandt, Mathias (2006)**, *Essays in Macroeconomics*, Dissertation, Humboldt Universität zu Berlin.

[26] **Trabandt, Mathias and Harald Uhlig (2009)**, "How far are we from the slippery slope? The Laffer Curve Revisited,", draft, University of Chicago.