The Value of Constraints on Discretionary Government Policy

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Abstract

Recent events have renewed the debate on the desirability of imposing institutional constraints on government policy. This paper investigates how policy constraints discipline the behavior of discretionary governments in dynamic stochastic monetary economies and evaluates the welfare properties of such restrictions. Across a variety of possible shocks, the best policy is to impose a minimum surplus at all times, of about half a percent of output. Most welfare gains derived from imposing policy constraints arise from the imposed discipline on government behavior during normal times. It is not optimal to ever suspend constraints on fiscal policy, whereas monetary policy constraints should only be imposed during normal times.

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1 Introduction

The 2007-08 financial crisis and the recession that followed drew a large-scale policy response across governments in the developed world. This response and the individual countries' experiences have renewed the debate on the desirability of imposing institutional constraints on government policy.

In the United States, during the Great Recession, debt and the fiscal deficit soared to levels not seen since the end of World War II. The Federal Reserve intervened heavily in financial markets with successive rounds of "quantitative easing". The behavior of government during this episode revitalized proposals for balanced-budget amendments to the Constitution and for closer monitoring of the Federal Reserve by Congress.

Significant, seemingly discretionary, government response to adverse events is not a new phenomenon. Historical examples abound: the American Civil War, the two World Wars and the Great Depression. Demand for government intervention or an increase in policy discretion is at its highest during these type of episodes. Sometimes the effects are permanent, as in the expansion of government in the aftermath of the Great Depression and World War II.

Within the European Union, several countries experienced banking, fiscal and sovereign debt crises. Member countries of the monetary union (the "Eurozone") argued ex-post about the benefits of delegating monetary policy to a supranational entity that did not internalize regional concerns and pondered the desirability of abandoning the monetary union. Although membership was granted conditional on meeting explicit convergence criteria, the reality was that many countries did not meet them (Greece being a notable example). As of late 2014, even countries such as France are not satisfying European Union deficit targets. Outside the Eurozone, the U.K. let inflation grow above its target band as a response to the recession and increased unemployment.

Even though the institutional and policy contexts are marked by important differences, both the U.S. and the Eurozone as a whole responded to the recent recession by increasing debt and deficits significantly. The U.S. government arguably acted within a more permissive environment. This prompted calls for limiting its ability to act with unchecked discretion. In contrast, European Union (and Eurozone) countries were bound by a set of seemingly restrictive rules. These restrictions were aimed at imposing discipline in government policy during normal times and constrain discretion during adverse events. The political response was to argue for the desirability of lifting or relaxing these restrictions.

The objective of this paper is to understand the role played by discretion in the policy response to adverse shocks and to evaluate the effects of placing restrictions on such conduct. Consider an economy that gets hit by severe adverse shocks with some regularity. These shocks could be a reduction in aggregate demand, a war, a fall in productivity, a collapse in private asset returns or a surge in the demand for liquidity. Several pertinent questions arise. First, how would a discretionary government behave in such an environment? Second, would placing constraints on the policy response improve welfare? If so, which constraints are more effective? Should we target inflation or nominal interest rates, limit the size of deficits or the level of debt? And what are the optimal levels of such constraints? Third, would it be desirable to suspend rules during adverse times or is it better to impose constraints in all states of the world? Fourth, how do these results depend on the likelihood, duration and magnitude of shocks?

To provide answers to the questions posed above, I extend the model of fiscal and monetary policy of Martin (2011, 2013*b*). The environment is a monetary economy based on Lagos and Wright (2005), with the addition of a government that uses distortionary taxes, money and nominal bonds to finance the provision of a valued public good.[1] The government may not be fully benevolent and lacks the ability to commit to policy choices beyond the current period.

Government policy is determined by the interaction of three main forces: distortion-smoothing, a time-consistency problem and political frictions. The incentive to smooth distortions intertemporally follows the classic arguments in Barro (1979) and Lucas and Stokey (1983). Time-consistency problems arise from the interaction between debt and monetary policy, as analyzed in Martin (2009, 2011, 2013*b*): how much debt the government inherits affects its monetary policy since inflation reduces the real value of nominal liabilities; in turn, the anticipated response of future monetary policy affects the current demand for money and bonds, and thereby how the government today internalizes policy trade-offs. The political friction creates an upward bias in public expenditure.

The overall lesson is that the best policy is to set a minimum primary surplus (about half a percent of output) at all times. Fiscal policy constraint should not ever be suspended, whereas monetary policy constraints should only be imposed during normal times.

Related work on fiscal policy constraints includes Bohn and Inman (1996), Bassetto and Sargent (2006), Chari and Kehoe (2007), Azzimonti et al. (2010), Barseghyan and Battaglini (2012), Halac and Yared (2012) and Harchondo et al. (2012).

2 Model

2.1 Environment

The environment extends Martin (2011, 2013*b*), which study a variant of Lagos and Wright (2005). There is a continuum of infinitely-lived agents, which discount the future by factor $\beta \in (0, 1)$. Let s denote the exogenous aggregate state of the economy, which is revealed to all agents at the beginning of each period. Let $E[s'|s]$ be the expected value of s' given s. The set of all possible realizations for the stochastic state is S. Each period, two competitive markets open in sequence: a *day* and a *night* market. All goods produced in this economy are perishable and cannot be stored from one subperiod to the next. There is a unit measure of physical assets in fixed supply ("Lucas trees") that bear $\delta(s) \geq 0$ units of the night good every period. Claims to these assets are exchanged in the night market.

At the beginning of each period, agents receive an idiosyncratic shock that determines their role in the day market. With probability $\eta \in (0, 1)$ an agent wants to consume but cannot produce the day-good x, while with probability $1 - \eta$ an agent can produce but does not want consume. A *consumer* derives utility $u(x)$, where u is twice continuously differentiable, satisfies Inada conditions and $u_{xx} < 0 < u_x$. A *producer* incurs in utility cost $\phi > 0$ per unit produced.

At night, all agents can produce and consume the night-good, c. The production technology is assumed to be linear in labor, such that n hours worked produce $\zeta(s)n$ units of output, where $\zeta(s) > 0$ for all $s \in S$. Assuming perfect competition in factor markets, the wage rate is equal to productivity $\zeta(s)$. Utility at night is given by $\gamma(s)U(c) - \alpha n$, where U is twice continuously differentiable, $U_{cc} < 0 < U_c$, $\gamma(s) > 0$ for all $s \in S$, and $\alpha > 0$. Note that preferences for the night good may depend directly on the exogenous aggregate state of the economy.

There is a government that supplies a valued public good g at night. Agents derive utility from the public good according to $v(g)$, where v is twice continuously differentiable, satisfies Inada conditions and $v_{gg} < 0 < v_g$. To finance its expenditure, the government may use

[1] The analysis here would carry over to economies with a cash-in-advance constraint or money-in-the-utility function.

proportional labor taxes τ, print fiat money at rate μ and issue one-period nominal bonds, which are redeemable in fiat money. The public good is transformed one-to-one from the night-good. Government policy choices for the period are announced at the beginning of each day, before agents' idiosyncratic shocks are realized. The government only actively participates in the night market, i.e., taxes are levied on hours worked at night and open-market operations are conducted in the night market.

All nominal variables—except for bond prices—are normalized by the aggregate money stock. Thus, today's aggregate money supply is equal to 1 and tomorrow's is $1 + \mu$. The government budget constraint is

$$p_c(\tau\zeta(s)n - g) + (1 + \mu)(1 + qB') - (1 + B) = 0, \tag{1}$$

where B is the current aggregate bond-money ratio, p_c is the—normalized—market price of the night-good c, and q is the price of a bond that earns one unit of fiat money in the following night market. "Primes" denote variables evaluated in the following period. Thus, B' is tomorrow's aggregate bond-money ratio. Prices and policy variables depend on the aggregate state (B, s); this dependence is omitted from the notation to simplify exposition.

2.2 Problem of the agent

Let $V(m, b, a, B, s)$ be the value of entering the day market with (normalized) money balances m, bond balances b and asset claims a, when the aggregate state of the economy is (B, s). Upon entering the night market, the composition of an agent's nominal portfolio (money and bonds) is irrelevant, since bonds are redeemed in fiat money at par. Thus, let $W(z, a, B, s)$ be the value of entering the night market with total (normalized) nominal balances z and claims a.

In the day market, consumers and producers exchange money for goods at (normalized) price p_x. Let x be the quantity consumed and κ the quantity produced. In addition to cash, consumers can pledge up to a fraction $\theta_b(s) \in [0, 1)$ of their bond holdings to finance their day market expenditures. Thus, government bonds in the day are not perfect substitutes of fiat money and consumers face a liquidity constraint as popularized by Kiyotaki and Moore (2002). The problem of a consumer is

$$V^c(m, b, a, B, s) = \max_x \; u(x) + W(m + b - p_x x, a, B, s)$$

subject to $p_x x \leq m + \theta_b(s)b$. The problem of a producer is

$$V^p(m, b, a, B, s) = \max_\kappa \; -\phi\kappa + W(m + b + p_x\kappa, a, B, s).$$

Let $V(m, b, a, B, s) \equiv \eta V^c(m, b, a, B, s) + (1 - \eta)V^p(m, b, a, B, s)$.

In the night market, consumption goods are exchanged at price p_c and asset claims at price p_a. The problem of an agent at night arriving with net nominal balances z is

$$W(z, a, B, s) = \max_{c,n,m',b',a'} \; \gamma(s)U(c) - \alpha n + v(g) + \beta E[V(m', b', a', B', s')|s]$$

subject to: $p_c c + (1 + \mu)(m' + qb') + p_a a' = p_c(1 - \tau)\zeta(s)n + (p_a + p_c\delta(s))a + z$.

2.3 Monetary equilibrium

The resource constraints in the day and night are, respectively: $\eta x = (1 - \eta)\kappa$ and $c + g = \zeta(s)n + \delta(s)$, where here, with a little abuse of notation, n is aggregate night labor. Given the preference assumption, individual consumption at night is the same for all agents, whereas individual labor depends on whether an agent was a consumer or a producer in the day. Due to the linear disutility of night labor, agents at the beginning of the period are indifferent over lotteries of night labor. The preference specification also implies that all agents makes the same portfolio choice. Market clearing at night implies $m' = 1$, $b' = B'$ and $a' = 1$.

After some work (omitted here), we get the following conditions characterizing a monetary equilibrium:

$$p_x = \frac{(1+\theta_b(s)B)}{x} \tag{2}$$

$$p_c = \frac{\gamma(s)U_c(1+\theta_b(s)B)}{\phi x} \tag{3}$$

$$p_a = \frac{\beta(1+\theta_b(s)B)}{\phi x} E\left[\frac{p_a'\phi x'}{1+\theta_b(s')B'} + \gamma(s')\delta(s')U_c'\Big|s\right] \tag{4}$$

$$1+\mu = \frac{\beta(1+\theta_b(s)B)}{\phi x} E\left[\frac{x'(\eta u_x' + (1-\eta)\phi)}{(1+\theta_b(s')B')}\Big|s\right] \tag{5}$$

$$\tau = 1 - \frac{\alpha}{\zeta(s)\gamma(s)U_c} \tag{6}$$

$$q = \frac{E[\frac{x'(\eta\theta_b(s')u_x' + (1-\eta\theta_b(s'))\phi)}{1+\theta_b(s')B'}|s]}{E[\frac{x'(\eta u_x' + (1-\eta)\phi)}{1+\theta_b(s')B'}|s]}, \tag{7}$$

Using these conditions, we can write the government budget constraint (1) in a monetary equilibrium as

$$\left(\gamma(s)U_c - \frac{\alpha}{\zeta(s)}\right)(c-\delta(s)) - \frac{\alpha g}{\zeta(s)} - \frac{\phi x(1+B)}{1+\theta_b(s)B} + \beta E\left[\frac{\phi x'(1+B')}{1+\theta_b(s')B'}\Big|s\right] + \beta\eta E[x'(u_x' - \phi)|s] = 0 \tag{8}$$

for all $s \in S$. Condition (8) is also known as an implementability constraint.

2.4 Problem of the government

The literature on optimal policy with distortionary instruments typically adopts what is known as the *primal approach*, which consists of using the first-order conditions of the agent's problem to substitute prices and policy instruments for allocations in the government budget constraint. Following this approach, the problem of a government with limited commitment can be written in terms of choosing debt and allocations. Note that from (5), for an expected future day-good allocation (which in equilibrium is a function of debt choice, B' and the exogenous state s'), a higher μ clearly implies a lower x. In other words, given current debt policy and future monetary policy, the allocation of the day-good is a function of *current* monetary policy. Thus, we can interchangeably refer to variations in the day-good allocation and variations in current monetary policy. Similarly, from (6) a higher tax rate is equivalent to lower night consumption.

Assume the government can commit to policy announcements for the current period, but not for policy to be implemented in future periods. In this case, the current government cannot directly control x', which as mentioned above, appear in its budget constraint. Instead, these allocations will depend on the policy implemented by the following government, which in turn, depends on the level of debt it inherits and the state of the economy. Let $x' = \mathcal{X}(B', s')$ be the policy that the current government anticipates will be implemented by future governments.

Let $\mathcal{U}(x, c, g, s) \equiv \eta(u(x) - \phi x) + \gamma(s)U(c) - \alpha(c + g - \delta(s))/\zeta(s) + v(g)$ be the ex-ante period utility of an agent. Following Martin (2013*a*) assume the government is not necessarily benevolent. Let $\mathcal{R}(g, \omega(s))$ be the government's political rent, which is increasing in public expenditure, g and decreasing in the level of government benevolence, $\omega \in (0,1]$. This rent is a purely utility benefit, with no direct resource cost.

Taking as given future government policy $\{\mathcal{B}, \mathcal{X}, \mathcal{C}, \mathcal{G}\}$ the problem of the current government is

$$\max_{B',x,c,g} \mathcal{U}(x,c,g,s) + \mathcal{R}(g,\omega(s)) \ + \beta E[\mathcal{V}(B',s')|s]$$

subject to (8) and given

$$\mathcal{V}(B',s') \equiv \mathcal{U}(\mathcal{X}(B',s'), \mathcal{C}(B',s'), \mathcal{G}(B',s'), s') + \mathcal{R}(\mathcal{G}(B',s'), \omega(s')) + \beta E[\mathcal{V}(\mathcal{B}(B',s'),s')|s].$$

With Lagrange multiplier $\lambda(s)$ associated with the government budget constraint, for all $s \in S$, the first-order conditions of the government's problem imply:

$$E\left[\frac{\phi x'(1-\theta_b(s'))(\lambda(s)-\lambda(s'))}{(1+\theta_b(s')B')^2}\Big| s\right]$$
$$+\lambda(s)E\left[\mathcal{X}'_B(s')\left\{\eta(u'_x + u'_{xx}x' - \phi) + \frac{\phi(1+B')}{1+\theta_b(s')B'}\right\}\Big| s\right] = 0 \tag{9}$$

$$\eta(u_x - \phi) - \frac{\lambda(s)(1+B)}{1+\theta_b(s)B} = 0 \tag{10}$$

$$\gamma(s)U_c - \frac{\alpha}{\zeta(s)} + \lambda(s)\left\{\gamma(s)U_c - \frac{\alpha}{\zeta(s)} + \gamma(s)U_{cc}(c-\delta(s))\right\} = 0 \tag{11}$$

$$-\frac{\alpha}{\zeta(s)} + v_g + \mathcal{R}_g(s) - \lambda(s)\frac{\alpha}{\zeta(s)} = 0 \tag{12}$$

for all $s \in S$. See Martin (2011) for an extended analysis of these conditions. A Markov-perfect monetary equilibrium (MPME) is a set of functions $\{\mathcal{B}, \mathcal{X}, \mathcal{C}, \mathcal{G}\}$ that solve (9)–(12) for all (B, s).

As shown in Martin (2011, 2013*a*) the non-stochastic version of this economy features the property that the steady state of the Markov-perfect equilibrium is constrained-efficient. Thus, endowing the government with commitment at the steady state would not affect the allocation. The result is summarized in the following proposition.

Proposition 1 *Assume $S = \{s^*\}$ and initial debt equal to $B^* \equiv \mathcal{B}(B^*, s^*)$. Then, a government with commitment and a government without commitment will both implement the allocation $\{x^*, c^*, g^*\}$ and choose debt level B^* in every period.*

Proof. See Martin (2013*a*). ■

In the absence of aggregate fluctuations, private agents cannot be made better-off, at the steady state, by endowing the government with more commitment power. The only inefficiency in this economy stems from the political friction (i.e., the misalignment in preferences between agents and government). With aggregate fluctuations, government policy will exhibit inefficiencies due to both a time-consistency problem and the political friction. This is where institutional constraints may play a role.

3 Constrained Discretionary Response to Shocks

3.1 Accounting

In order to place constraints on government policy we first need to define some relevant macroeconomic variables.

Let us start with nominal GDP, defined as $Y_t = p_{x,t}\eta x_t + p_{c,t}(c_t + g_t)$, which using (2) and (3) implies

$$Y_t = \frac{(1+\theta_{b,t}B_t)[\eta\phi x_t + \gamma_t U_{c,t}(c_t+g_t)]}{\phi x_t}. \tag{13}$$

Note that nominal GDP, as all other nominal variables, is normalized by the aggregate money stock.

For any given day-good and night-good expenditure shares, ς_x and ς_c, respectively, the price level can be defined as: $P_t = \varsigma_x p_{x,t} + \varsigma_c p_{c,t}$. Using (2) and (3) we obtain

$$P_t = \frac{(1+\theta_{b,t}B_t)(\varsigma_x\phi + \varsigma_c\gamma_t U_{c,t})}{\phi x_t}. \tag{14}$$

Thus, we can define inflation as $1+\pi_t \equiv P_t(1+\mu_{t-1})/P_{t-1}$ and expected inflation as $1+\pi^e_{t+1} \equiv E_t[P_{t+1}(1+\mu_t)/P_t]$. Using (5) and (14) we get

$$1+\pi^e_{t+1} = \beta E_t\left[\frac{(1+\theta_{b,t+1}B_{t+1})(\varsigma_x\phi + \varsigma_c\gamma_{t+1}U_{c,t+1})}{\phi x_{t+1}(\varsigma_x\phi + \varsigma_c\gamma_t U_{c,t})}\right] E_t\left[\frac{x_{t+1}(\eta u_{x,t+1} + (1-\eta)\phi)}{(1+\theta_{b,t+1}B_{t+1})}\right]. \tag{15}$$

The nominal interest rate is defined as $i_t \equiv 1/q_t - 1$, using (7).

The primary deficit over GDP is defined as $d_t \equiv p_{c,t}(g_t - \tau_t\zeta_t n_t)/Y_t$. Using (3), (6) and (13) we obtain

$$d_t = -\frac{(\gamma_t U_{c,t} - \alpha/\zeta_t)(c_t - \delta_t) - (\alpha/\zeta_t)g_t}{\eta\phi x_t + \gamma_t U_{c,t}(c_t+g_t)}. \tag{16}$$

The total fiscal deficit includes the primary deficit plus interest payments on the debt. Let $D_t \equiv d_t + \frac{(1+\mu_t)(1-q_t)B_{t+1}}{Y_t}$.

4 Policy constraints

Constraints on government actions can be loosely categorized as constraints on monetary policy and constraints on fiscal policy. The first type being targets for nominal rates and the second type being limits on fiscal variables.

I will consider two constraints on monetary policy. An inflation target restricts a government to implement policy so that expected inflation is within a given interval, that is, $\pi^e_{t+1} \in [\underline{\pi}, \bar{\pi}]$. Similarly, an interest rate target restricts policy to be consistent with the nominal interest rate fluctuating within a given interval, that is, $i_t \in [\underline{i}, \bar{i}]$. For the purpose of the exercises in this paper, I will focus on strict targets: $\underline{\pi} = \bar{\pi}$ and $\underline{i} = \bar{i}$

Constraints on fiscal variables take the form of inequality constraints. I consider limits on the primary deficit, the total deficit and debt. That is, constraints of the form: $d_t \le \bar{d}$, $D_t \le \bar{D}$ and $B_{t+1} \le \bar{B}$. Note that even though B is the bond-money ratio, the constraint should be interpreted as a limit on the nominal stock of debt, similar to the debt ceiling imposed by the US Congress.

Constraints can be imposed on all exogenous states of the world or on select ones. For example, it may be infeasible to restrict government behavior during a severe crisis. Alternatively, this may be time when government behavior *should* be restricted. I will consider all these possible cases in the analysis below.

5 Numerical Analysis

5.1 Calibration

Consider the following functional forms: $u(x) = \frac{x^{1-\sigma}-1}{1-\sigma}$; $U(c) = \frac{c^{1-\rho}-1}{1-\rho}$; $v(g) = \ln g$; and $\mathcal{R}(g,\omega) = (\omega^{-1} - 1)g$. The parameter $\omega \in (0,1]$ determines the degree of benevolence of the government, where $\omega = 1$ means the government is fully benevolent. Set η to one-half, i.e., an equal measure of consumers and producers in the day market. The exogenous state of the economy is given by the values of parameters $\{\gamma, \omega, \zeta, \theta_b, \delta\}$.

The economy is calibrated to the post-war, pre-Great Recession U.S., 1955-2008. Government in the model corresponds to the federal government and period length is set to a fiscal year. The variables targeted in the calibration are: debt over GDP, inflation, nominal interest rate, real return on private assets, outlays (not including interest payments) over GDP and revenues over GDP. All variables are taken from the Congressional Budget Office. Government debt is defined as debt held by the public, excluding holdings by the Federal Reserve system. Inflation is calibrated to the implicit 2% annual target adopted by the Federal Reserve. Tables 1 and 2 present the benchmark parameterization and target statistics, respectively.

Table 1: Benchmark Calibration

α	β	σ	ρ	ϕ	ω	θ_b	δ
5.7865	0.9614	2.8163	6.4313	7.8464	0.4310	0.3300	0.0377

Normalized parameters: $\gamma = \zeta = 1$, $\eta = 0.5$.

Table 2: Non-stochastic steady state statistics

Variable	Statistic	Calibrated	Benevolent
Debt over GDP	$\frac{B(1+\mu)}{Y}$	0.320	0.330
Inflation rate	π	0.020	0.010
Nominal interest rate	i	0.040	0.033
Real return on assets	$\frac{p_c\delta}{p_a}$	0.040	0.040
Revenue over GDP	$\frac{p_c\tau n}{Y}$	0.180	0.149
Expenditure over GDP	$\frac{p_c g}{Y}$	0.180	0.140

Note: "benevolent" refers to an economy with $\omega = 1$.

5.2 Optimal constraints in non-stochastic economy

Table 3 presents the optimal values of each policy constraint for the case of a non-stochastic economy. The values are compared to the steady state statistics. Recall that the steady state is constraint efficient, so all the welfare gains come from mitigating the political friction.

The optimal values are evaluated at the steady state of the non-stochastic economy, in terms of equivalent compensation, measured in units of night-good consumption. The gains for all the types of policy constraints go from a maximum of 0.7% for the case of a primary deficit ceiling to a minimum of 0.3% for the case of a debt ceiling.

Table 3: Optimal constraints in non-stochastic economy

Constraint	Steady State	Optimal Value	Welfare Gain
Inflation	0.020	0.008	0.6%
Interest rate	0.040	0.032	0.6%
Primary deficit	0.000	−0.005	0.7%
Deficit	0.012	0.002	0.5%
Debt over GDP	0.320	0.278	0.3%

5.3 Stochastic economy

I will consider economies with only one type of shock. That is, there is an economy where only productivity fluctuates, another where only government benevolence fluctuates, etc. Each economy has three exogenous states, $S = \{s_1, s_2, s_3\}$. Let ϖ_{ij} be the probability of going from state s_i today to state s_j tomorrow. I will interpret s_2 as "normal" times, similar to where the economy lies in the non-stochastic version of the economy. The state s_1 corresponds to "bad" times and s_3 ("good") is included for symmetry. The transition matrix is characterized by two values ϖ and ϖ^* such that $\varpi_{1,1} = \varpi_{33} = \varpi$, $\varpi_{1,2} = \varpi_{3,1} = 1 - \varpi$, $\varpi_{13} = \varpi_{3,1} = 0$, $\varpi_{22} = \varpi^*$ and $\varpi_{2,1} = \varpi_{2,3} = (1-\varpi^*)/2$. In other words, ϖ^* is the probability of remaining in the normal state of the world,with an equal chance of transitioning to a crisis (s_3) or boom (s_3). During bad (good) times there is a chance $1 - \varpi$ of transitioning back to normal times and there is no chance of transitioning to good (bad) state.

For the numerical simulations, I will assume $\varpi^* = 0.98$ and $\varpi = 0.90$. That is, normal times last on average 50 years and bad times have an expected duration of 10 years. For each economy, the corresponding parameter in states s_1 and s_3 is a multiple of the parameter in state s_2, which is equal to the calibrated parameter from Table 1. The parameterization is shown on Table 4.

Table 4: Stochastic economy parameterization

Economy	s_1	s_2	s_3
Demand shock	$\gamma(1-\varrho_\gamma)$	γ	$\gamma(1+\varrho_\gamma)$
Expenditure shock	$\omega(1-\varrho_\omega)$	ω	$\omega(1+\varrho_\omega)$
Productivity shock	$\zeta(1-\varrho_\zeta)$	ζ	$\zeta(1+\varrho_\zeta)$

Note: $\varrho_\gamma = 0.650$; $\varrho_\omega = 0.300$; $\varrho_\zeta = 0.166$.

Economies without policy constraints are solved globally using a projection method with the following algorithm:

(i) Let $\Gamma = [\underline{B}, \bar{B}]$ be the debt state space. Define a grid of $N_\Gamma = 10$ points over Γ and set $N_S = 3$. Create the indexed functions $\mathcal{B}^i(B)$, $\mathcal{X}^i(B)$, $\mathcal{C}^i(B)$, and $\mathcal{G}^i(B)$, for $i = \{1, \dots, N_S\}$, and set an initial guess.

(ii) Construct the following system of equations: for every point in the debt and exogenous state grids, evaluate equations (8)—(12). Since (9) contains $\mathcal{X}^j(\mathcal{B}^i(B))$ (and its derivative) and $\mathcal{G}^j(\mathcal{B}^i(B))$, use cubic splines to interpolate between debt grid points and calculate the derivatives of policy functions.

(iii) Use a non-linear equations solver to solve the system in (ii). There are $N_\Gamma \times N_S \times 4 = 120$ equations. The unknowns are the values of the policy function at the grid points. In each step of the solver, the associated cubic splines need to be updated so that the interpolated evaluations of future choices are consistent with each new guess.

For economies that include constraints to policy in all or some states, I use value function iteration: simply solve the maximization problem of the government at every grid point. Update the policy and value functions and iterate until convergence is achieved.

Welfare is evaluated as the equivalent compensation, in terms of night consumption, at the initial state (B^*, s_2), relative to the full discretionary outcome.

For each type of shock and each type of constraint, I will evaluate the welfare properties of three scenarios: (i) constraints apply to all states of the world; (ii) constraints are suspended in the bad state s_1, and so only imposed in states s_2 and s_3; and (iii) constraints are only imposed during normal times, i.e., state s_2. For each case, the optimal constraints are calculated.

Once the equilibrium for a stochastic economy is computed, the economy is simulated to provide a visual representation of the (possibly constrained) policy response to an adverse shock. Initial debt in period $t = -10$ is equal to steady state debt in the non-stochastic economy, B^*. The economy is in the normal state: $s = s_2$. In period $t = 1$, an adverse shock hits, i.e., $s = s_1$, and the economy stays in this state for 10 periods. In period $t = 11$, the economy returns to the normal state, $s = s_2$, and stays there from then on.

6 Full discretion vs constrained policy

6.1 Demand shocks

Table 5 summarizes the welfare effects of imposing constraints on policy in an economy facing demand shocks.

Table 5: Demand shocks—Welfare gains over full discretion

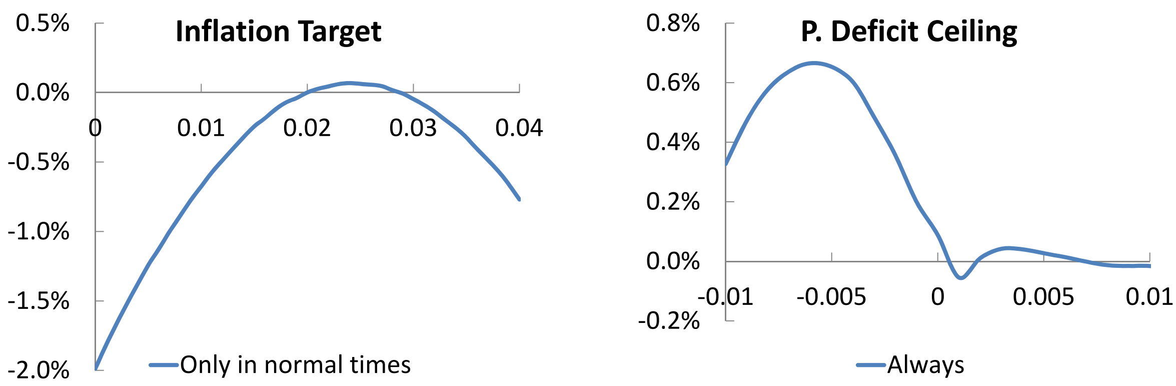
Constraint	Value	Always	In normal or good times	Only in normal times
Inflation	0.024	0.0%	0.1%	0.1%
Interest rate	0.038	−0.1%	0.0%	0.1%
P. Deficit	−0.006	0.7%	0.6%	0.5%
Deficit	0.002	0.4%	0.4%	0.4%
Debt	0.283	0.3%	0.2%	0.2%

Note: debt ceiling is imposed on its nominal value, but is expressed here as end-of period debt as a fraction of GDP, in the steady state of the non-stochastic economy.

There are several important observations. First, a primary surplus ceiling improves welfare the most. The optimal value is to have a small primary surplus of about half a percent of output. Second, for all types of constraints, most of the welfare gains come from imposing constraints in normal times. Third, monetary policy targets have small effects and are best imposed only in normal times. In contrast, fiscal constraints should not be suspended.

A pertinent question arises: is it costly to set the wrong value for a constraint? Figure 1 shows two illustrative cases. As we can see on the left panel, an inflation target that is

Figure 1: Demand shock: Welfare gains as a function of constraints



implemented only in normal times provides a small benefit for a very small range (between 2% and 3%). However, picking a target that is too low or two high can lead to large welfare losses. For example, setting the inflation target at its optimal non-stochastic value (see Table 3) implies a welfare loss of about 1% of consumption. In contrast, a primary deficit ceiling provides benefits for a larger range: small primary surpluses are always beneficial, so getting the exact value for the constraint right is not critical.

Figure 2 compares the policy response to an adverse demand shock under full discretion vs the optimal inflation and interest rate targets. Monetary policy constraints are only imposed during normal times, as suggested by the welfare results in Table 5. During bad times, both constrained regimes increase debt less than under full discretion. Even though constraints are suspended during bad times, the policy response is more muted than under full discretion because the government is anticipating that constraints will be imposed again after the economy returns to normal. The resulting effect is less reliance on deficits during adverse times. The abrupt correction of monetary policy during the transition back to normal times also explains the low welfare gains.

Figure 3 compares the policy response to a negative demand shock under full discretion vs the optimal primary deficit and debt ceilings. Fiscal policy constraints are always in place, as suggested by the welfare results in Table 5. Both fiscal constraint regimes display a significantly more muted response to the adverse shock. The better welfare performance of the optimal primary deficit constraint comes from the lower inflation distortion it allows. In effect, by implementing a primary surplus, inflation can be lower, both in normal and adverse times.

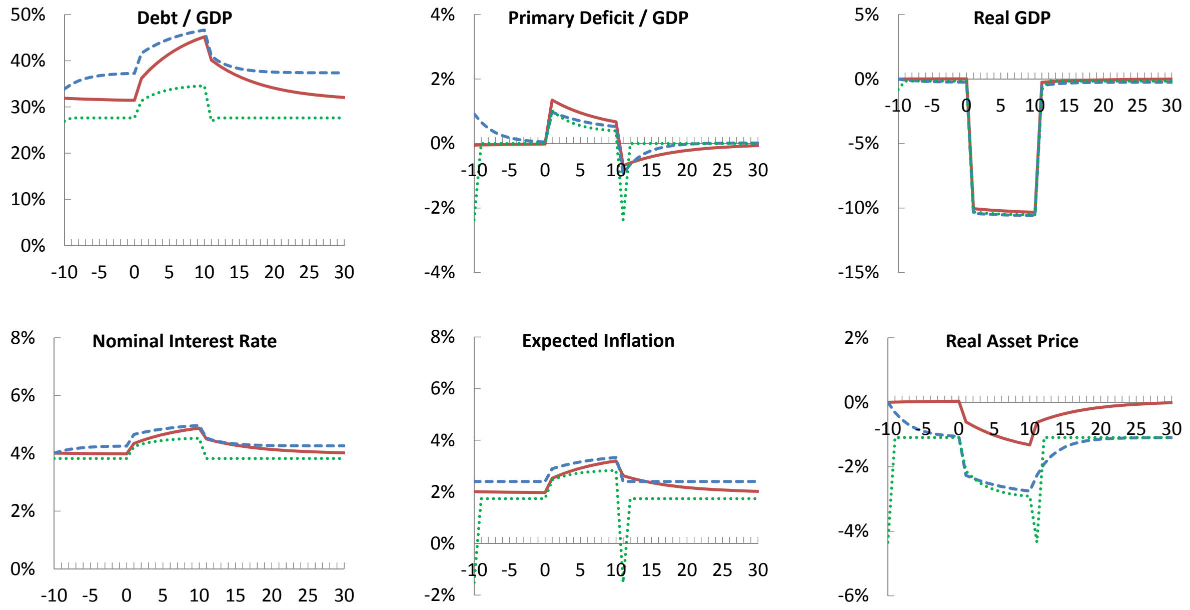
6.2 Expenditure shocks

Table 6 summarizes the welfare effects of imposing constraints on policy in an economy facing non-valued expenditure shocks.

Again, a primary deficit ceiling improves welfare the most and the lessons derived from the economy with a demand shock apply for this case as well. Since the rise in expenditure stems from the government becoming less benevolent, the gains from imposing fiscal constraints in bad times are large, about the same as those stemming from imposing them in normal times.

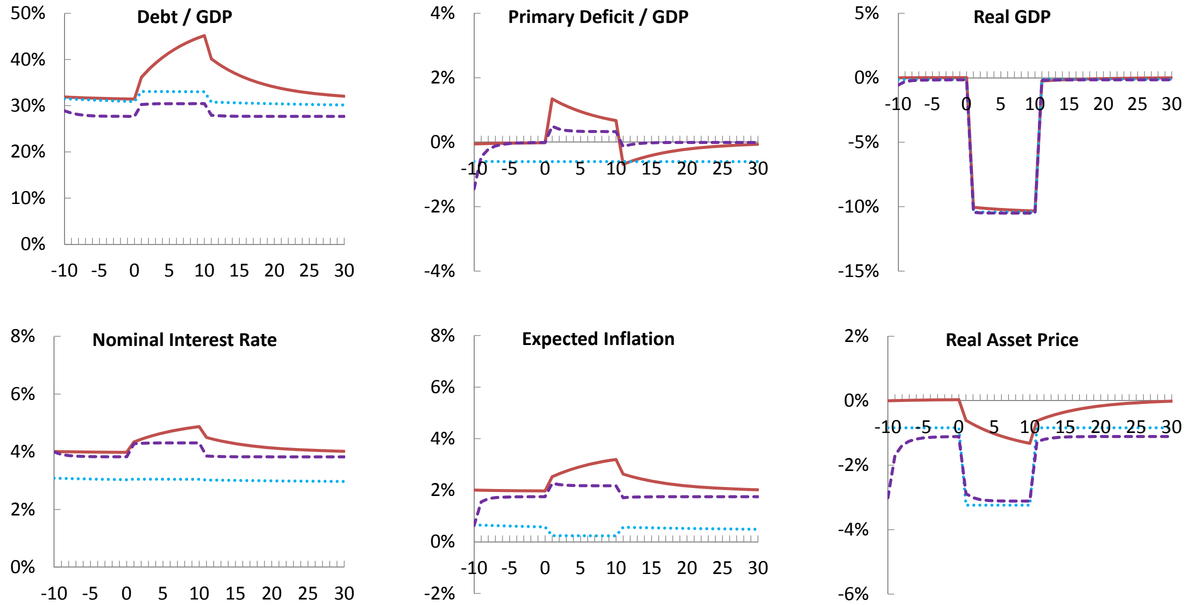
Figure 4 compares the policy response to an adverse expenditure shock under full discretion vs the optimal inflation and interest rate targets. Figure 5 compares the full discretion response to the optimal primary deficit and debt ceilings. Monetary policy constraints are only imposed during normal times, while fiscal constraints are not ever suspended, as suggested by the welfare

Figure 2: Demand shock: full discretion vs optimal monetary constraints



Note: full discretion (red solid line), inflation target (blue dashed line) and interest rate target (green dotted line).

Figure 3: Demand shock: full discretion vs optimal fiscal constraints



Note: full discretion (red solid line), primary deficit ceiling (light blue dotted line) and debt ceiling (purple dashed line).

Table 6: Expenditure shocks—Welfare gains over full discretion

Constraint	Value	Always	In normal or good times	Only in normal times
Inflation	0.023	0.0%	0.1%	0.1%
Interest rate	0.039	0.2%	0.1%	0.2%
P. Deficit	−0.005	1.1%	0.5%	0.5%
Deficit	0.002	0.7%	0.3%	0.3%
Debt	0.283	0.4%	0.3%	0.3%

Note: debt ceiling is imposed on its nominal value, but is expressed here as end-of period debt as a fraction of GDP, in the steady state of the non-stochastic economy.

results of Table 6.

As we can see in Figures 4 and 5, the behavior of policy variables in all regimes is qualitatively very similar to the response to a demand shock. Thus, the analysis for that case applies here as well. The only difference is the behavior of debt over GDP; but this difference comes entirely from the fact that output increases when the economy gets hit by an expenditure shock , whereas it falls when hit by a demand shock.

6.3 Productivity shocks

Table 7 summarizes the welfare effects of imposing constraints on policy in an economy facing productivity shocks.

Table 7: Productivity shocks—Welfare gains over full discretion

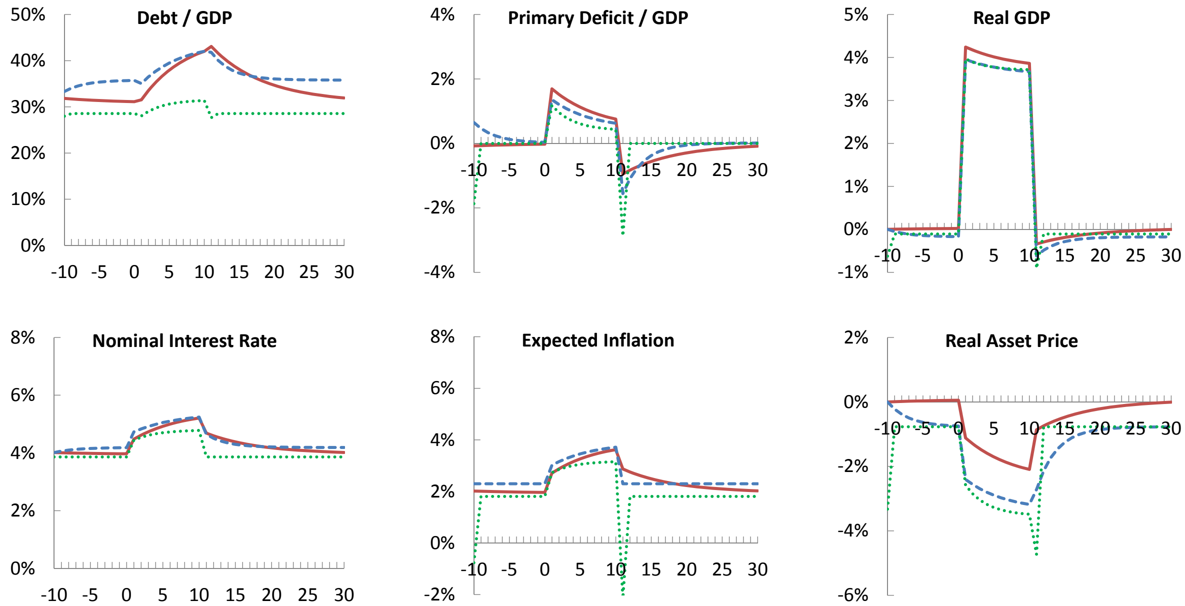
Constraint	Value	Always	In normal or good times	Only in normal times
Inflation	0.025	−0.4%	−0.2%	0.1%
Interest rate	0.038	−0.3%	−0.1%	0.1%
P. Deficit	−0.006	0.7%	0.7%	0.5%
Deficit	0.001	0.5%	0.5%	0.4%
Debt	0.283	0.3%	0.3%	0.3%

Note: debt ceiling is imposed on its nominal value, but is expressed here as end-of period debt as a fraction of GDP, in the steady state of the non-stochastic economy.

For an economy facing productivity shocks, the lessons for policy constraints are the same as for the economies described above. The best constraint is to always impose a minimum surplus of about 0.5% of output.

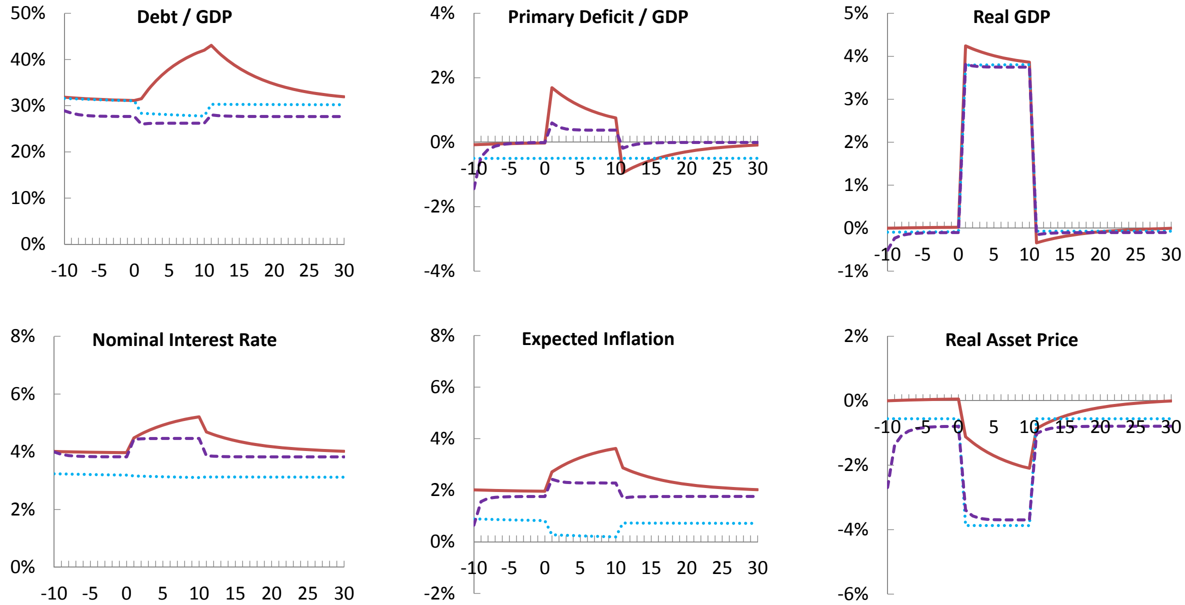
Figure 6 compares the policy response to an adverse productivity shock under full discretion vs the optimal inflation and interest rate targets. Figure 7 compares the full discretion response to the optimal primary deficit and debt ceilings. Again, monetary policy constraints are only imposed during normal times, while fiscal constraints always imposed, as suggested by the welfare results of Table 7.

Figure 4: Expenditure shock: full discretion vs optimal monetary constraints



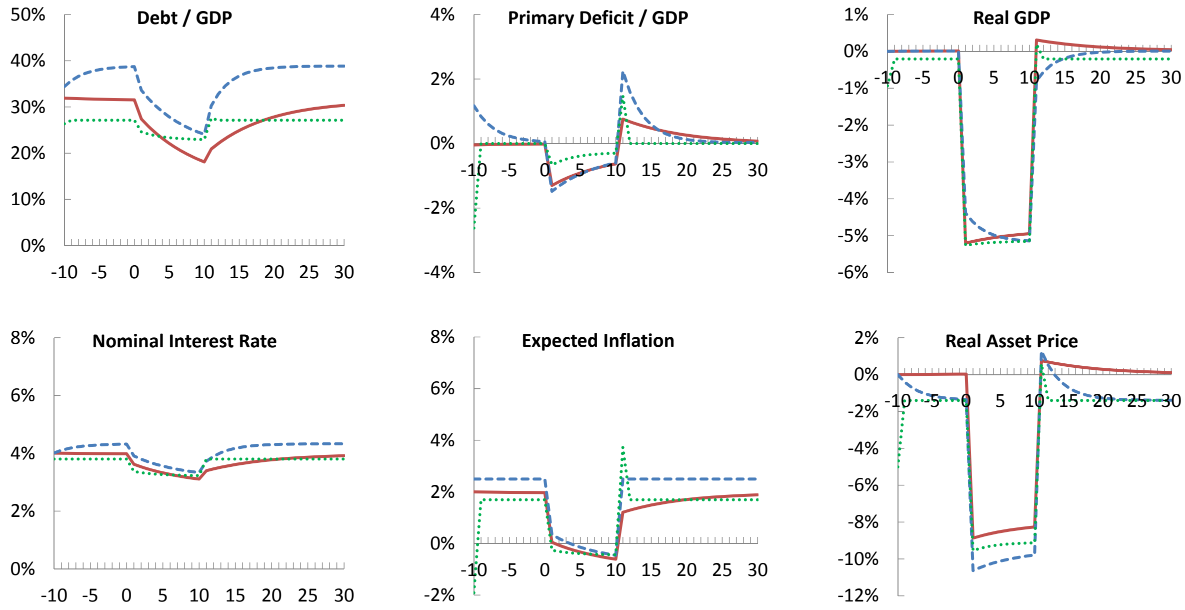
Note: full discretion (red solid line), inflation target (blue dashed line) and interest rate target (green dotted line).

Figure 5: Expenditure shock: full discretion vs optimal fiscal constraints



Note: full discretion (red solid line), primary deficit ceiling (light blue dotted line) and debt ceiling (purple dashed line).

Figure 6: Productivity shock: full discretion vs optimal monetary constraints



Note: full discretion (red solid line), inflation target (blue dashed line) and interest rate target (green dotted line).

6.4 General lessons

There are several general lessons that can be drawn from the exercises above:

(i) A small primary surplus is always the best policy.

(ii) Strict monetary policy targets have small (and sometimes detrimental) welfare effects relative to full discretion.

(iii) The optimal values for fiscal policy constraints are nearly identical for stochastic and non-stochastic economies.

(iv) Most welfare gains come from imposing constraints in normal times.

(v) Constraints on monetary policy *should* be suspended during bad times.

(vi) Constraints on fiscal policy *should not* be suspended during bad times (especially in the presence of expenditure shocks).

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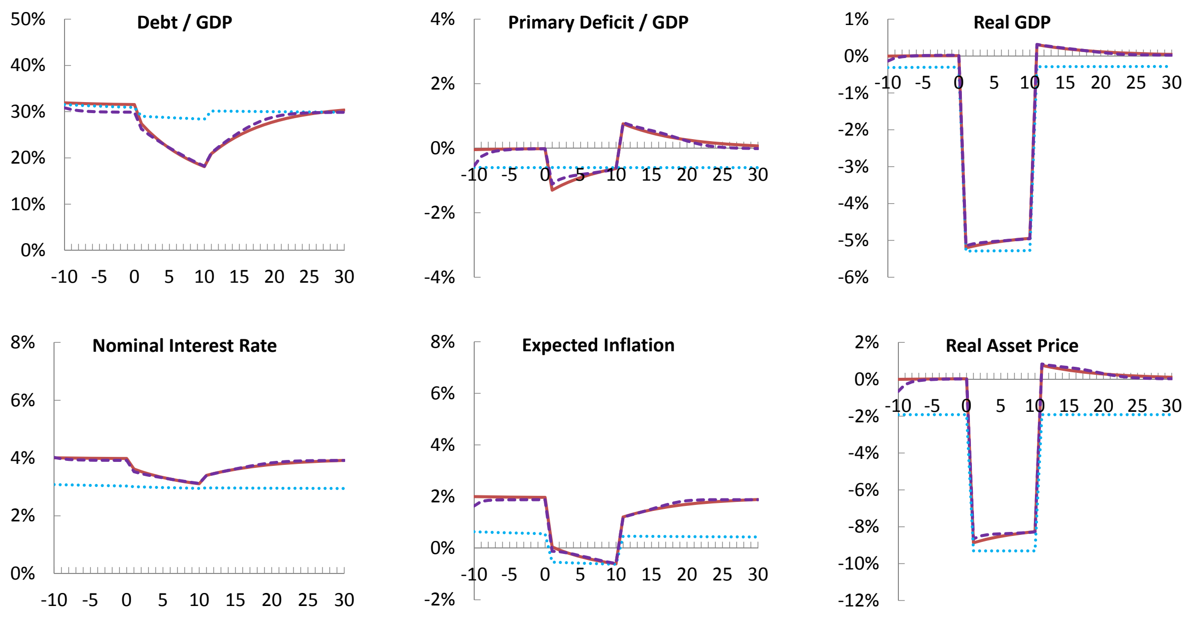
Figure 7: Productivity shock: full discretion vs optimal fiscal constraints



Note: full discretion (red solid line), primary deficit ceiling (light blue dotted line) and debt ceiling (purple dashed line).

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