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Fiscal Rules and the Sovereign Default Premium

Juan Carlos Hatchondo, Leonardo Martinez, and Francisco Roch

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Prepared by Juan Carlos Hatchondo, Leonardo Martinez, and Francisco Roch[1]

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Abstract

This paper finds optimal fiscal rule parameter values and measures the effects of imposing fiscal rules using a default model calibrated to an economy that in the absence of a fiscal rule pays a significant sovereign default premium. The paper also studies the case in which the government conducts a voluntary debt restructuring to capture the capital gains from the increase in its debt market value implied by a rule announcement. In addition, the paper shows how debt ceilings may reduce the procyclicality of fiscal policy and thus consumption volatility.

JEL Classification Numbers: F34, F41.

Keywords: fiscal rules, debt ceiling, fiscal consolidation, default, sovereign default premium, debt exchange, countercyclical policy, endogenous borrowing constraints, long-term debt, debt dilution

Author's E-Mail Address: juancarlos.hatchondo@rich.frb.org, lmartinez4@imf.org, froch@chicago.edu

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I. Introduction

This paper intends to shed light on the optimal value of fiscal rules' parameters and on the effects of imposing fiscal rules. Fiscal rules are restrictions imposed (often in laws or in the constitution) to the future governments' ability to choose fiscal policy. We focus on the effects a fiscal rule would have if a government could commit to enforce it.[1]

A consensus has emerged among policymakers about the desirability of targeting low sovereign debt levels that would facilitate implementing a more countercyclical fiscal policy. There is also a widespread consensus about the necessity of establishing new fiscal objectives through fiscal rules.[2]

Nevertheless, significant uncertainty remains about the optimal value of fiscal rules' parameters. For instance, Blanchard (2011) asks: "what levels of public debt should countries aim for? Are old rules of thumb, such as trying to keep the debt to GDP ratio below 60 percent in advanced countries, still reliable?"

The first contribution of this paper is to shed light on the optimal value of fiscal rules' parameters. The paper studies a sovereign default framework à la Eaton and Gersovitz (1981) with long-duration bonds.[3] This framework is commonly used for quantitative studies of sovereign debt.[4] First, we calibrate this model to an economy that pays a significant sovereign default premium without a rule. The no-rule calibration generates plausible values for debt levels and the mean and standard deviation of the interest rate spread paid by the sovereign—i.e., the difference between the sovereign bond yield and the risk-free interest rate.

The paper then finds the optimal parameter values for fiscal rules to be implemented in the benchmark no-rule economy. We study simple rules establishing a sovereign debt ceiling and the number of periods between the announcement of the rule and the period after which the ceiling in enforced. According to the IMF fiscal rules database, sixty-two of the eighty-two countries with fiscal rules had debt-to-GDP ceilings in their rules in 2009. It is also common that transition periods are granted when fiscal rules are established. For instance, in 2009, Germany amended its constitution to introduce a fiscal rule to be enforced after 2016 for the federal government and 2020 for regional governments. Similarly,

[1]Fiscal crises occur in countries with fiscal rules in part because of the lack of enforcement of these rules. However, countries have been able to overcome enforcement issues, for instance, giving stability to their rules by making them part of their constitutions (see IMF (2009)).

[2]For instance, in an IMF Staff Position Note, Blanchard et al. (2010) argue that "A key lesson from the crisis is the desirability of fiscal space to run larger fiscal deficits when needed." They also note that "Medium-term fiscal frameworks, credible commitments to reducing debt-to-GDP ratios, and fiscal rules (with escape clauses for recessions) can all help in this regard."

[3]Chatterjee and Eyigungor (forthcoming) and Hatchondo and Martinez (2009) show that long-term debt is essential for accounting for interest rate spread dynamics with a sovereign default framework.

[4]See, for instance, Aguiar and Gopinath (2006), Arellano (2008), Benjamin and Wright (2008), Boz (2011), Lizarazo (2005, 2006), and Yue (2010). These models share blueprints with the models used in studies of household bankruptcy—see, for example, Athreya et al. (2007), Chatterjee et al. (2007), Li and Sarte (2006), Livshits et al. (2008), and Sanchez (2010).

in 2011, Spain amended its constitution to introduce a fiscal rule to be enforced after 2020.

We study economies with a pre-rule debt level of 38 percent of mean income (typical in the data for the pre-2001-default Argentina used to calibrate the model) and different income levels that are reflected in different levels of sovereign risk premium. The pre-rule income level and associated default risk do not affect significantly the rule to which the government would like to commit: A debt ceiling of 30 percent of mean income, with a delay of four years between the rule announcement period and the first period in which the ceiling is enforced.

The government benefits from committing to such a rule because this commitment creates new borrowing opportunities. This is, for a given level of indebtedness the government is able to borrow paying a lower interest rate. With the rule, lenders expect lower future debt levels and this accounts for the decline of the interest rate at which the government borrows. The interest rate decline allows the government to implement the debt ceiling without a large decline in its borrowing level: The mean borrowing level only falls from 3.6 percent to 3.1 percent of average income.

The second contribution of this paper is to study the trade-off between larger bondholders' capital gains and the cost of a stronger fiscal adjustment. With a rule imposing a lower debt ceiling that is enforced sooner, creditors would enjoy a larger capital gain from the increase in the market value of the bonds they hold. We study the case in which the government conducts a voluntary debt restructuring to capture these capital gains and, thus, evaluates the trade-off between larger capital gains and the cost of a stronger fiscal adjustment. In this case, the government chooses a 25 percent ceiling to be enforced less than two years after its announcement. In exchange for the announcement of this rule, bondholders are willing to forgive a fraction of the government's debt. This fraction in increasing with respect to the pre-rule spread. With a pre-rule spread of 5 (15) percent, bondholders are willing to forgive up to 21 (44) percent of the government's debt. Discussions of the trade-off between larger bondholders' capital gains and the cost of a stronger fiscal adjustment, and on the distribution of the gains from fiscal adjustments are relevant not only for the imposition of fiscal rules, but also for other fiscal consolidation programs.

Our third contribution is to measure the effects of fiscal rules on the procyclicality of fiscal policy and, through that, on the volatility of private consumption. Without a fiscal rule, a high and countercyclical interest rate implies that the government (a sequential decision-maker) chooses to borrow less when income is low and thus, it chooses procyclical policy (see Cuadra et al. (2010)).[5] With lower debt ceilings, the interest rate becomes less responsive to income shocks and, therefore, fiscal policy becomes less procyclical. Consequently, consumption volatility declines. In addition, the paper shows that a countercyclical debt ceiling (that is higher when income is lower) increases the level and countercyclicality of the interest rate. Therefore, a countercyclical ceiling does not

[5] This is consistent with evidence for emerging economies (that pay a high and volatile interest rate), as documented by Gavin and Perotti (1997), Ilzetzki and Vegh (2008), Kaminsky et al. (2004), Talvi and Vegh (2009), and Vegh and Vuletin (2011).

necessarily result in lower consumption volatility. For the case we study, countercyclical ceilings are only preferred among ceilings that impose excessively low average debt levels (the government prefers the no-rule benchmark over rules imposing such low ceilings). Furthermore, the government prefers procyclical ceilings (e.g., a ceiling on the debt-to-income ratio) over constant debt ceilings (we only study ceilings that are linear functions of current income). It should be mentioned that our analysis of the cyclicality of fiscal policy is limited because we do not study a model with production.

In spite of the great interest on fiscal rules among policymakers, theoretical studies of these rules are relatively scarce. In previous theoretical studies, rules do not affect the default premium through the expectations about future indebtedness (the main focus of our analysis). In these studies, rules may be beneficial because of a conflict of interest between the government and private agents (for instance, because the government is myopic or because of political polarization), or a conflict of interest among different governments (for instance, in the European Union). In contrast, we analyze a single government that maximizes the expected utility of private agents but faces a time inconsistency problem.

Several theoretical studies focus on the desirability of a balanced-budget rule for the U.S. federal government, which does not pay a significant default premium (see Azzimonti et al. (2010) and the references therein). Garcia et al. (2011) compare a balanced budget rule with a structural surplus rule. Beetsma and Uhlig (1999) show how by imposing lower debt levels, the Stability and Growth Pact may help control inflation in the European Monetary Union. Beetsma and Debrun (2007) discuss how additional flexibility in the Stability and Growth Pact may improve welfare. Pappa and Vassilatos (2007) and Poplawski Ribeiro et al. (2008) find that debt ceilings may be preferable over constraints on the government's deficit. Medina and Soto (2007) use a model of the Chilean economy to show that a structural balance fiscal rule mitigates the macroeconomic effects of copper-price shocks.

Several empirical studies analyze the relationship between fiscal rules and fiscal policy (for instance, Poterba (1996) reviews the literature for U.S. states, and Debrun et al. (2008) present evidence for Europe), and between fiscal rules and the government's financing costs (see, for example, Eichengreen and Bayoumi (1994), Heinemann et al. (2011), Iara and Wolff (2011), Lowry and Alt (2001), and Poterba and Rueben (1999)). However, difficulties for identifying the effects of fiscal rules are well documented (see, for instance, Poterba (1996) and Heinemann et al. (2011)). We measure these effects through the lens of a baseline default framework à la Eaton and Gersovitz (1981). When comparing predictions in this paper with past experiences with fiscal rules, one should keep in mind that we are assuming that the government can commit to enforcing a rule while this is not necessarily the case in reality.

The rest of the article proceeds as follows. Section II introduces the model. Section III discusses the calibration. Section IV presents the results. Section V concludes.

II. The model

We first present the benchmark model without a fiscal rule. There is a single tradable good. The economy receives a stochastic endowment stream of this good y_t, where

$$\log(y_t) = (1-\rho)\,\mu + \rho\log(y_{t-1}) + \varepsilon_t,$$

with $|\rho| < 1$, and $\varepsilon_t \sim N\left(0, \sigma_\epsilon^2\right)$.

The government's objective is to maximize the present expected discounted value of future utility flows of the representative agent in the economy, namely

$$E\left[\sum_{t=0}^{\infty} \beta^t u\left(c_t\right)\right],$$

where E denotes the expectation operator, β denotes the subjective discount factor, and the utility function is assumed to display a constant coefficient of relative risk aversion denoted by γ. That is,

$$u\left(c\right) = \frac{c^{(1-\gamma)} - 1}{1-\gamma}.$$

As in Hatchondo and Martinez (2009) and Arellano and Ramanarayanan (2010), we assume that a bond issued in period t promises an infinite stream of coupons, which decreases at a constant rate δ. In particular, a bond issued in period t promises to pay one unit of the good in period $t+1$ and $(1-\delta)^{s-1}$ units in period $t+s$, with $s \geq 2$.

Each period, the government makes two decisions. First, it decides whether to default. Second, it chooses the number of bonds that it purchases or issues in the current period.

As in previous studies of sovereign default, the cost of defaulting is not a function of the size of the default. Thus, as in Arellano and Ramanarayanan (2010), Chatterjee and Eyigungor (forthcoming) and Hatchondo and Martinez (2009), when the government defaults, it does so on all current and future debt obligations. This is consistent with the behavior of defaulting government in reality. Sovereign debt contracts often contain an acceleration clause and a cross-default clause. The first clause allows creditors to call the debt they hold in case the government default on a payment. The cross-default clause states that a default in any government obligation constitute a default in the contract containing that clause. These clauses imply that after a default event, future debt obligations become current. Following previous studies, we also assume that the recovery rate for debt in default—i.e., the fraction of the loan lenders recover after a default—is zero.

We assume that there are two costs of defaulting. First, a defaulting sovereign is excluded from capital markets. In each period after the default period, the country regains access to capital markets with probability $\psi \in [0,1]$.[6] Second, if a country has defaulted on its debt,

[6]Hatchondo et al. (2007) solve a baseline model of sovereign default with and without the exclusion cost and show that eliminating this cost affects significantly only the debt level generated by the model.

it faces an income loss of $\phi(y)$ in every period in which it is excluded from capital markets. Following Chatterjee and Eyigungor (forthcoming), we assume a quadratic loss function $\phi(y) = d_0 y + d_1 y^2$.

Following Arellano and Ramanarayanan (2010), we assume that the price of sovereign bonds satisfies a no arbitrage condition with stochastic discount factor $M(y', y) = exp(-r - \alpha\varepsilon' - 0.5\alpha^2\sigma_\epsilon^2)$, where r denotes the risk-free rate at which lenders can borrow or lend. This allows us to introduce a risk premium. Several studies document that the risk premium is an important component of sovereign spreads and that a significant fraction of the spread volatility in the data is accounted for by the volatility in the risk premium (see, for example, Borri and Verdelhan (2009), Broner et al. (2007), Longstaff et al. (2011), and González-Rozada and Levy Yeyati (2008)).

The model of the discount factor we use is a special case of the discrete-time version of the Vasicek one-factor model of the term structure (see Vasicek (1977) and Backus et al. (1998)). With this formulation, the risk premium is determined by the income shock in the borrowing economy. It may be more natural to assume that the lenders' valuation of future payments is not perfectly correlated with the sovereign's income. However, the advantage of our formulation is that it avoids introducing additional state variables to the model. In this paper, benefits from introducing fiscal rules result from the mitigation of the debt dilution problem. Hatchondo et al. (2010b) show that the effects of debt dilution on default risk are robust to assuming that there is a shock to the cost of borrowing that is not perfectly correlated with the sovereign's income, and to assuming that lenders are risk neutral.

We focus on Markov Perfect Equilibrium. That is, we assume that in each period, the government's equilibrium default and borrowing strategies depend only on payoff-relevant state variables. As discussed by Krusell and Smith (2003), there may be multiple Markov perfect equilibria in infinite-horizon economies. In order to avoid this problem, we solve for the equilibrium of the finite-horizon version of our economy, and we increase the number of periods of the finite-horizon economy until value functions and bond prices for the first and second periods of this economy are sufficiently close. We then use the first-period equilibrium functions as the infinite-horizon-economy equilibrium functions.

A. Recursive formulation

Let b denote the number of outstanding coupon claims at the beginning of the current period, and b' denote the number of outstanding coupon claims at the beginning of the next period. A negative value of b implies that the government was a net issuer of bonds in the past. Let d denote the current-period default decision. We assume that d is equal to 1 if the government defaulted in the current period and is equal to 0 if it did not. Let V denote the government's value function at the beginning of a period, that is, before the default decision is made. Let V_0 denote the value function of a sovereign not in default. Let V_1 denote the value function of a sovereign in default. Let F denote the conditional cumulative distribution function of the next-period endowment y'. For any bond price function q, the function V satisfies the following functional equation:

$$V(b,y) = \max_{d\epsilon\{0,1\}} \{dV_1(y) + (1-d)V_0(b,y)\}, \tag{1}$$

where

$$V_1(y) = u(y - \phi(y)) + \beta \int [\psi V(0,y') + (1-\psi) V_1(y')] F(dy' \mid y), \tag{2}$$

$$V_0(b,y) = \max_{b' \leq 0} \left\{ u(y + b - q(b',y)[b' - (1-\delta)b]) + \beta \int V(b',y') F(dy' \mid y) \right\}. \tag{3}$$

The bond price is given by the following functional equation:

$$\begin{aligned} q(b',y) &= \int M(y',y)[1 - h(b',y')] F(dy' \mid y) \\ &\quad + (1-\delta) \int M(y',y)[1 - h(b',y')] \; q(g(h(b',y'),b',y'),y') F(dy' \mid y), \end{aligned} \tag{4}$$

where h and g denote the future default and borrowing rules that lenders expect the government to follow. The default rule h is equal to 1 if the government defaults, and is equal to 0 otherwise. The function g determines the number of coupons that will mature next period. The first term in the right-hand side of equation (4) equals the expected value of the next-period coupon payment promised in a bond. The second term in the right-hand side of equation (4) equals the expected value of all other future coupon payments, which is summarized by the expected price at which the bond could be sold next period. Chatterjee and Eyigungor (forthcoming) demonstrate that this equilibrium price function exist and is decreasing with respect to the debt level.

Equations (1)-(4) illustrate that the government finds its optimal current default and borrowing decisions taking as given its future default and borrowing decision rules h and g. In equilibrium, the optimal default and borrowing rules that solve problems (1) and (3) must be equal to h and g for all possible values of the state variables.

Definition 1 *A Markov Perfect Equilibrium is characterized by*

1. a set of value functions V, V_1, and V_0
2. a default rule h and a borrowing rule g,
3. a bond price function q,

such that:
(a) given h and g, V, V_1, and V_0 satisfy functional equations (1), (2), and (3), when the government can trade bonds at q;
(b) given h and g, the bond price function q is given by equation (4); and
(c) the default rule h and borrowing rule g solve the dynamic programming problem defined by equations (1) and (3) when the government can trade bonds at q.

B. Fiscal policy

Fiscal policy is very stylized in the sovereign default framework proposed by Eaton and Gersovitz (1981). In each period, the government chooses the (possibly negative) level of tax revenues τ. When the country is in default, $\tau = 0$ and private agents consume all available resources ($c = y - \phi(y)$). When the country is not in default, private agents pay taxes ($c = y - \tau$) and the government uses tax revenues and issuance revenues to service debt, i.e., $\tau - q\,(b', y)\,[b' - (1-\delta)b] = -b$.

C. Fiscal rules

We study a set of fiscal rules defined by $(\bar{b}(y), n)$, where $\bar{b}(y) = a_0 + a_1 y$ denotes the debt ceiling, and n denotes the number of periods between the announcement of the rule and the period after which the ceiling in enforced. After the first enforcement period, the government solves the optimization problem described in equation (3) with the additional constraint $b' \geq \bar{b}(y)$.

III. Calibration

As in most previous quantitative studies on sovereign default, we use Argentina before the 2001 default as a case study. Following Hatchondo et al. (2010a), we solve the models numerically using value function iteration and interpolation.[7]

Table 1 presents the calibration. We assume that the representative agent in the sovereign economy has a coefficient of relative risk aversion of 2, which is within the range of accepted values in studies of business cycles. A period in the model refers to a quarter. The risk-free interest rate is set equal to 1 percent. As in Hatchondo et al. (2009), parameter values that govern the endowment process are chosen so as to mimic the behavior of GDP in Argentina from the fourth quarter of 1993 to the third quarter of 2001. The parametrization of the income process is similar to the parametrization used in other studies that consider a longer sample period (see, for instance, Aguiar and Gopinath (2006)). As in Arellano (2008), we assume that the probability of regaining access to capital markets (ψ) is 0.282.

With $\delta = 0.0341$, bonds have an average duration of 4.19 years in the simulations of the baseline model.[8] Cruces et al. (2002) report that the average duration of Argentinean

[7]We use linear interpolation for endowment levels and spline interpolation for asset positions. The algorithm finds two value functions, V_1 and V_0. Convergence in the equilibrium price function q is also assured.

[8]We use the Macaulay definition of duration. Thus, with the coupon structure in this paper, duration is given by

$$D = \frac{1 + r^*}{\delta + r^*},$$

where r^* denotes the constant per-period yield delivered by the bond.

Borrower's risk aversion	σ	2
Interest rate	r	0.01
Income autocorrelation coefficient	ρ	0.9
Standard deviation of innovations	σ_ϵ	0.027
Mean log income	μ	(-1/2)σ_ϵ^2
Exclusion	ψ	0.282
Duration	δ	0.0341
Discount factor	β	0.961
Default cost	d_0	-0.69
Default cost	d_1	1.017
Risk premium	α	3

Table 1: Parameter values.

bonds included in the EMBI index was 4.13 years in 2000. This duration is not significantly different from what is observed in other emerging economies. Using a sample of 27 emerging economies, Cruces et al. (2002) find an average duration of 4.77 years, with a standard deviation of 1.52.

We calibrate the discount factor, the income cost of defaulting (two parameter values), and the lenders' risk premium parameter to target four moments: a mean spread of 7.4 percent, a standard deviation of the spread of 2.5 percent, a mean debt to (annual) GDP ratio of 40 percent in the pre-default samples of our simulations, and a default frequency of three defaults per 100 years. The targets for the spread distribution are taken from the spread behavior in Argentina before its 2001 default. The target for the mean debt to (annual) GDP ratio consists of the average public external debt between 1993 and 2001. Even though it is not clear which data values for the default frequency one should target, we choose to target this statistic because it received considerable attention in the literature, it is clearly influenced by lenders' risk premium parameter, and influences the welfare gains from the imposition of fiscal rules. We target a frequency of three defaults per 100 years because this frequency is often used in previous studies (see, for example, Arellano (2008) or Aguiar and Gopinath (2006)).[9]

IV. Results

First, we show that simulations of the benchmark economy fit the data reasonably well. Second, we discuss optimal fiscal rules. Third, we show how previously issued debt

[9] Hatchondo et al. (2010b) show that the effects of debt dilution are similar in model economies with three and six defaults per 100 years. The discount factor value we obtain is relatively low but higher than the ones assumed in previous studies (for instance, Aguiar and Gopinath (2006) assume $\beta = 0.8$). Low discount factors may be a result of political polarization in emerging economies (see Amador (2003) and Cuadra and Sapriza (2008)).

	Data	Benchmark
$E(R_s)$	7.44	7.42
$\sigma(R_s)$	2.51	2.52
Mean debt-to-income ratio	0.40	0.39
Defaults per 100 years	3.00	2.99
$\sigma(c)/\sigma(y)$	0.94	1.23
$\rho(c, y)$	0.97	0.99
$\rho(R_s, y)$	-0.65	-0.79

Table 2: Business cycle statistics.

appreciate upon the announcement of a rule and discussed how the government's preferred rule depends on how capital gains from this appreciation are distributed. Fourth, we explain how fiscal rules benefit the government by creating expectations of lower future indebtedness. Fifth, we discuss the extent to which fiscal rules promote less procyclical fiscal policy. Sixth, we study cyclically adjusted fiscal rules.

A. The no-rule benchmark

Table 2 reports moments in the data and in the simulations of the benchmark model.[10] As in previous studies, except for the computation of default frequencies, we report results for pre-default simulation samples. We simulate the model for a number of periods that allows us to extract 500 samples of 32 consecutive periods before a default. We focus on samples of 32 periods because we compare the artificial data generated by the model with Argentine data from the fourth quarter of 1993 to the third quarter of 2001.[11] In order to facilitate the comparison of simulation results with the data, we only consider simulation sample paths in which the last default was declared at least two periods before the beginning of each sample. Default frequencies are computed using all simulation data.

The moments reported in Table 2 are chosen so as to illustrate the ability of the model to replicate distinctive business cycle properties of emerging economies. These economies feature a high, volatile, countercyclical interest rate, and high consumption volatility. The interest rate spread (R_s) is expressed in annual terms. The logarithm of income and consumption are denoted by y and c, respectively. The standard deviation of x is denoted by $\sigma(x)$ and is reported in percentage terms. The coefficient of correlation between x and z is denoted by $\rho(x, z)$. Moments are computed using detrended series. Trends are computed

[10]The data for income and consumption is taken from the Argentinean Finance Ministry. The spread before the first quarter of 1998 is taken from Neumeyer and Perri (2005), and from the EMBI Global after that. For the default frequency, we report the value we targeted, as discussed in Section III.

[11]The qualitative features of this data are also observed in other sample periods and in other emerging markets (see, for example, Aguiar and Gopinath (2007), Alvarez et al. (2011), Boz et al. (2011), Neumeyer and Perri (2005), and Uribe and Yue (2006)). The only exception is that in the data we consider, the volatility of consumption is slightly lower than the volatility of income, while emerging market economies tend to display a higher volatility of consumption relative to income.

using the Hodrick-Prescott filter with a smoothing parameter of $1,600$. Table 2 also reports the mean debt-to-income ratio, where the debt face value is computed dividing b by $\delta + r$.

Table 2 shows that the baseline model matches the data reasonably well. As in the data, in the simulations of the baseline model, consumption and income are highly correlated and the spread is countercyclical. Consumption volatility is higher than income volatility, which is consistent with the findings in Neumeyer and Perri (2005) and Aguiar and Gopinath (2007). The model also matches well the moments we targeted.

In addition, Figure 1 shows that fiscal policy is procyclical in the benchmark: taxes tend to be higher (or transfers tend to be lower) when income is lower. This is consistent with the findings of Cuadra et al. (2010), who introduce a richer model of fiscal policy into a sovereign default framework and show that fiscal policy is procyclical.

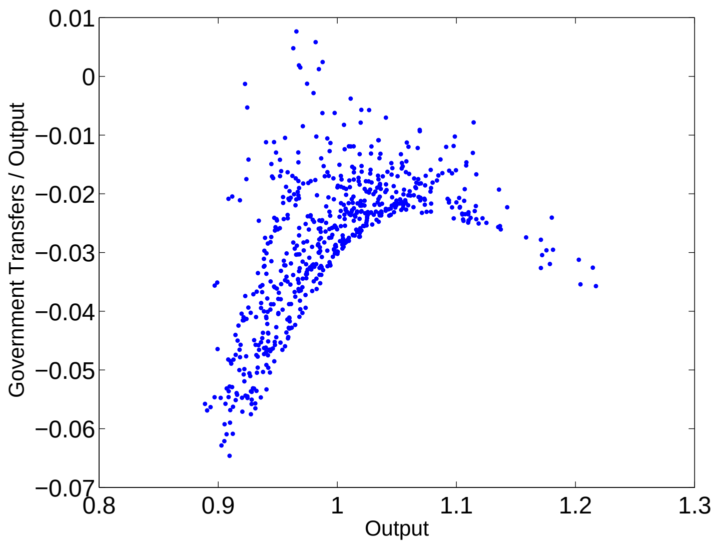

Figure 1: Income and government transfers in the benchmark simulations.

The intuition for the optimality of a procyclical fiscal policy is the following: In bad times, since the cost of borrowing is higher, the government chooses to finance more of its debt service obligations with taxes instead of new issuances. Figure 2 shows that the price at which the government can sell bonds is lower in bad times and that taxes tend to be higher when the sovereign interest rate spread is higher.

B. Fiscal rules

In this subsection we study the effect of imposing in the benchmark economy simple fiscal rules establishing a constant debt ceiling and the number of periods between the rule announcement and the period after which the ceiling in enforced. We focus on pre-rule states with a debt level of 38 percent of mean income and different income levels that are reflected in the pre-rule default premium. In particular, we present results for transitions

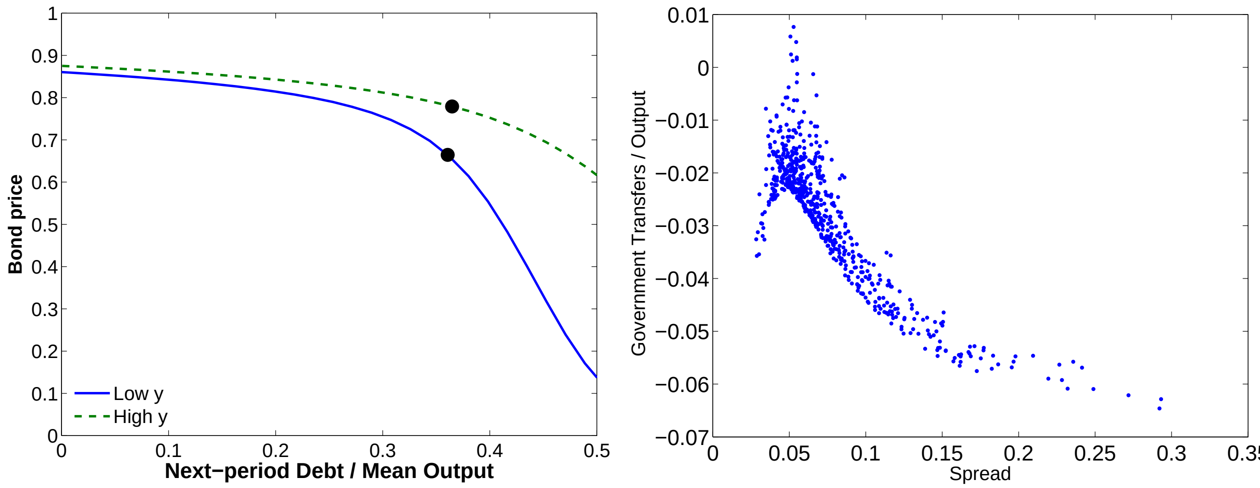

Figure 2: Borrowing cost and government transfers in the benchmark simulations. The left panel presents the menu of combinations of bond prices and next-period debt levels ($\frac{-b'}{\delta+r}$) from which the government can choose. Solid dots illustrate the optimal decision of a government that inherits a debt level equal to the average debt observed in our simulations. The low (high) value of y corresponds to an endowment realization that is one standard deviation below (above) the unconditional mean. The right panel present spreads and government transfers in the simulations.

from three points of the no-rule benchmark simulations: A relatively low-risk case with a spread of 5.1 percent, a normal-risk case with a spread of 7.4 percent, and a high-risk case with a spread of 15 percent.

Figure 3 illustrates how the government prefers to delay the date in which the debt ceiling will start to be enforced. We measure welfare gains as the constant proportional change in consumption that would leave a consumer indifferent between continuing living in the benchmark economy (without a fiscal rule) and moving to an economy with a fiscal rule. Let V^{B} and V^{R} denote the value functions in the benchmark economy and an economy with a fiscal rule, respectively. The welfare gain of moving from the benchmark economy to an economy with a fiscal rule is given by

$$\left(\frac{V^{\mathrm{R}}(b,y)}{V^{\mathrm{B}}(b,y)}\right)^{\left(\frac{1}{1-\sigma}\right)} - 1.$$

Table 3 presents the optimal fiscal rule for each of the three cases described above. The table shows that the level of the pre-rule default risk premium does not affect significantly the rule to which the government would like to commit. For all cases, welfare is maximized with a fiscal rule that imposes a debt ceiling of 30 percent of mean income, with a delay of about four years between the announcement period and the period in which the ceiling starts to bind. Table 3 also presents the welfare gain from implementing the optimal rule.

The government prefers to delay the date in which the debt ceiling will start to be enforced

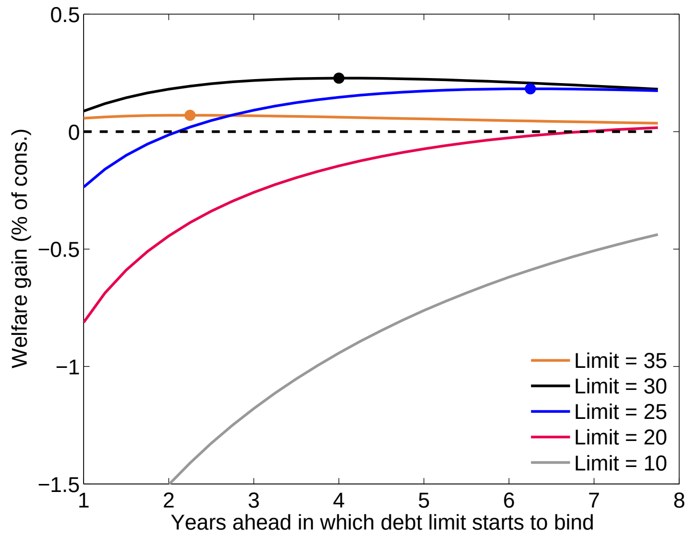

Figure 3: Welfare gains for different transition lengths.

	5.1%	7.4%	15.0%
Optimal debt ceiling	30%	30%	30%
Optimal transition length (quarters)	18	17	17
Welfare gain	0.23%	0.23%	0.22%
Spread decline at the announcement period	0.9%	1.4%	0.3%

Table 3: Optimal fiscal rules for different levels of the pre-rule sovereign risk premium.

because it wants to reduce the cost of adjusting its debt level. However, the government chooses a delay of four years and it typically chooses to delay the reduction of its debt level until the last two years of the transition period. The latter is illustrated in Figure 4, which presents the post-announcement debt path when the innovation shocks to income takes its expected value (zero) and thus income reverts to its long-run mean value.

For the first two years of the transition period, the government expects to enjoy lower spreads without necessarily reducing its debt level. Even before any reduction of the debt level, the rule announcement causes investors to bid up sovereign bond prices and thus reduces the spread. As illustrated in Figure 4, the government's commitment to a future debt ceiling lowers future debt levels. This lowers future default probabilities and, consequently, reduces the spread. Table 3 shows that the initial level of default risk has a significant effect on the spread decline implied by the announcement of the rule preferred by the government: This decline is significantly lower for the high-risk case. Figure 5 presents the post-announcement spread path when the income shock always takes its expected value. The figure shows how the spread is expected to decline continuously after the announcement of a rule. In particular, for the high-risk economy, the spread is expected to decline to almost half of its pre-rule value after one year.

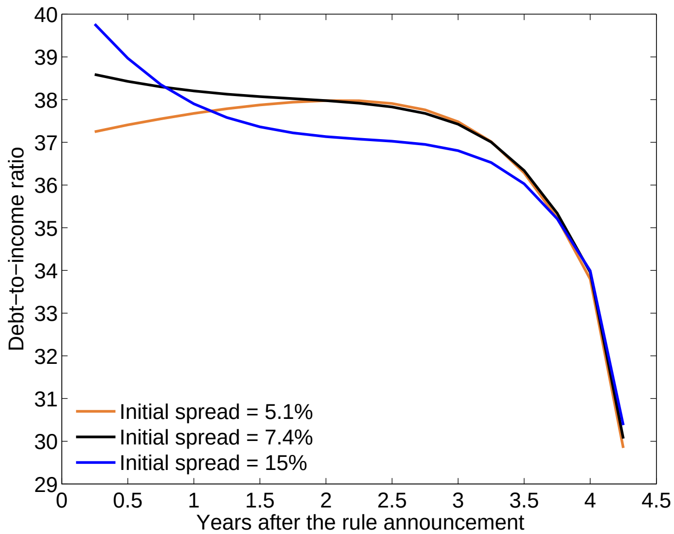

Figure 4: End-of-period debt (b') after the announcement of the rule preferred by the government when income shocks are equal to zero.

Figure 6 presents the post-rule-announcement spread as a function of the length of the transition path to the rule, for the case with a 7.4 percent pre-rule spread. The figure shows that the government could double the spread decline implied by the rule announcement by choosing a transition period of two years (the time it typically takes to adjust its debt level) instead of a transition period of four years. The spread decline reflects the increase in the value of sovereign bonds and thus capital gains for holders of previously issued debt. The government does not benefit from these capital gains. Thus, there is a conflict of interest between the government and its creditors because the latter would prefer a shorter transition period (and also a lower debt ceiling). In the next subsection, we show how the government's fiscal rule choice would change when the government captures these capital gains.

C. Fiscal rules after a debt restructuring

How would the government's choice of a fiscal rule change if the government could capture the capital gains from the increase in the market value of its debt implied by the rule? In order to shed light on this question, we now assume that, before the rule announcement, the government makes a take-it-or-leave-it debt buyback offer with the promise that the fiscal rule will be announced only if the offer is accepted. Thus, the government offers existing lenders to buyback previously issued bonds at the price that would have been observed if a rule is never implemented. As explained before, that price is lower than the post-announcement price at which the government would be able to issue debt after implementing the rule. By assuming that the government makes a take-it-or-leave-it offer, we focus on the extreme case in which all capital gains from the increase in the debt market value are reaped by the government (in the previous subsection we studied the

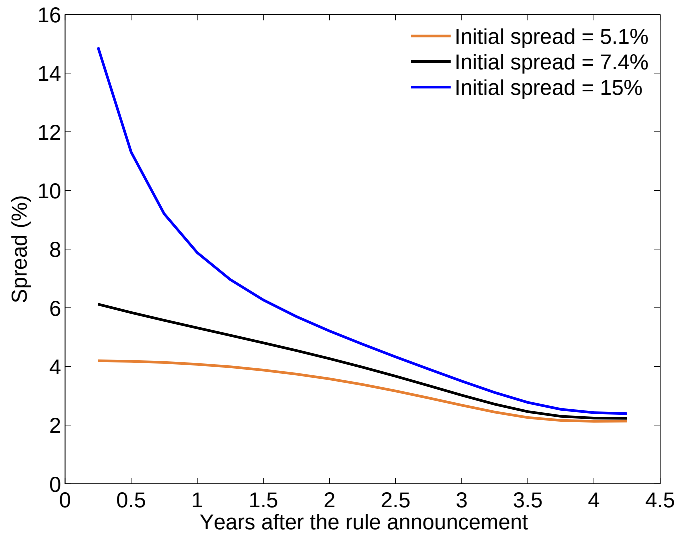

Figure 5: End-of-period spread after the announcement of the rule preferred by the government when income shocks are equal to zero.

	5.1%	7.4%	15.0%
Optimal debt ceiling	25%	25%	25%
Optimal transition length (quarters)	7	6	3
Debt forgiveness	21%	25%	44%
Welfare gain	1.02%	1.29%	2.28%

Table 4: Optimal fiscal rules after a voluntary debt restructuring for different levels of the pre-rule sovereign risk premium.

other extreme case in which bondholders enjoy all these gains).[12]

We find that when the government captures capital gains, it chooses a lower debt ceiling that is enforced sooner. Table 4 shows that for three cases presented above, the government chooses a 25 percent ceiling to be enforced less than two years after its announcement.

The exercise presented in this subsection can be thought of as a voluntary debt restructuring. Table 4 shows that for the low-risk, normal-risk, and high-risk cases we study, in exchange for the implementation of the optimal rule the government would choose for each case, lenders are willing to forgive 21%, 25%, and 44% of the governments debt, respectively. The shorter transition periods for cases with higher levels of pre-rule risk are consistent with the lager debt forgiveness for these cases. Table 4 also shows that the welfare gain from the combination of the announcement of a fiscal rule and a voluntary debt restructuring is increasing with respect to the pre-rule level of risk, and may be substantial.

[12] Analyzing the difficulties of implementing a voluntary debt exchange is beyond the scope of this paper (see, for instance, Gulati and Zettelmeyer (2012)).

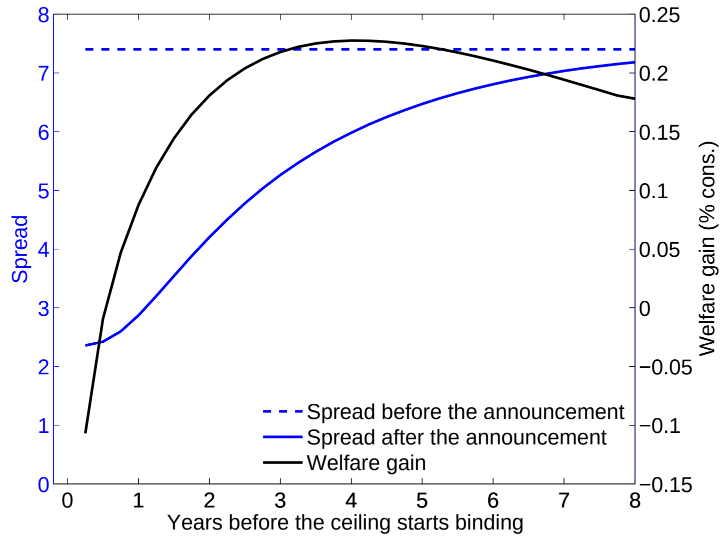

Figure 6: Spread decline implied by the announcement of a fiscal rule.

D. Fiscal rules and borrowing opportunities

A large literature discusses how, in the presence of default risk, the debt dilution problem implies that the government could benefit from a commitment to lower future borrowing levels (see Hatchondo et al. (2010b) and the references therein). The government is better off with a fiscal rule because of the additional commitment the rule gives to the government. Commitment to lower future debt levels generates lenders' expectations of lower future indebtedness. This allows the government to borrow at a lower rate today. This is illustrated in Figure 7 that presents the spread asked by lenders as a function of the face value of next-period debt—defined as the present value of future payment obligations discounted at the risk-free rate, as a percentage of the mean annual income. Figure 7 shows that imposing a debt ceiling creates new borrowing opportunities for the government: The rule allows the government to pay a lower interest rate for the same debt level (because of the expectation of lower future debt levels).

Table 5 shows that economies with a debt ceiling that implies a significantly lower debt levels do not display much lower borrowing levels. This is the case because a debt ceiling may allow the government to pay significantly lower interest rate. For instance, with the ceiling of 25 percent of mean income, the mean interest rate spread decreases from 7.4 to 1.7 percent, while mean borrowing only decreases from 3.6 to 3.1 percent of mean income.

E. Fiscal rules and the cyclicality of fiscal policy

In this subsection, we discuss how lower debt levels implied by the imposition of a fiscal rule weaken the government's incentives to implement a procyclical fiscal policy. Recall that fiscal policy is procyclical in the benchmark economy because in low-income periods,

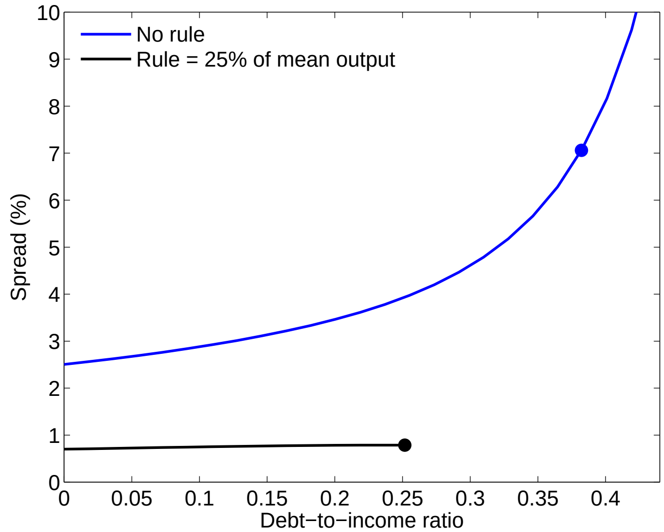

Figure 7: Menu of combinations of spreads and end-of-period debt levels from which a mean-income government can choose.

	No ceiling	35%	30%	25%	20%
$E(R_s)$	7.42	6.64	3.6	1.66	0.54
$\sigma(R_s)$	2.52	2.85	1.93	1.29	0.7
Mean debt-to-income ratio	0.39	0.38	0.34	0.35	0.24
Defaults per 100 years	2.99	2.86	1.33	0.42	0.09
$\sigma(c)/\sigma(y)$	1.23	1.12	1.08	1.05	1.02
$\rho(c, y)$	0.99	0.99	0.99	0.99	0.99
$\rho(R_s, y)$	-0.79	-0.72	-0.68	-0.62	-0.53
Mean borrowing /average income (%)	3.65	3.63	3.48	3.14	2.63

Table 5: Simulation results for different debt ceilings.

the higher cost of issuing debt induces the government to finance more of its debt service obligations with taxes.

Table 5 shows that debt ceilings reduce default risk and thus reduce both the mean spread and the responsiveness of the spread to income shocks (as reflected in a lower standard deviation of the spread). As the cost of borrowing becomes less responsive to income shocks, the argument presented above in favor of a procyclical fiscal policy becomes weaker. A less procyclical fiscal policy is reflected in a lower volatility of consumption relative to income. These findings support the consensus among policymakers about the desirability of targeting low sovereign debt levels to create room for the implementation of countercyclical fiscal policy (see, for instance, Blanchard et al. (2010)).

	2	1	0.5	0	-0.5	-1	-2
$E(R_s)$	0.09	0.59	1.00	1.66	2.10	2.41	2.63
$\sigma(R_s)$	0.03	0.46	0.81	1.29	1.40	1.41	1.47
Mean debt-to-income ratio	0.23	0.25	0.27	0.30	0.30	0.31	0.31
Defaults per 100 years	0.03	0.13	0.25	0.42	0.65	0.75	0.79
$\sigma(c)/\sigma(y)$	1.73	1.49	1.27	1.05	0.97	1.04	1.05
$\rho(c,y)$	0.99	0.99	0.99	0.99	0.99	0.99	0.99
$\rho(R_s,y)$	-0.86	-0.65	-0.62	-0.62	-0.62	-0.67	-0.67
Mean borrowing /average income (%)	2.67	2.76	2.97	3.14	3.26	3.30	3.34

Table 6: Simulation results with a debt ceiling $\bar{b} = a_0 + a_1 y$, for different values of a_1, and values of a_0 such that the average ceiling is equivalent to 25 percent of mean annual income.

F. Cyclically adjusted fiscal rules

In this subsection, we investigate whether one would want to allow for extra room for countercyclical fiscal policy by making the debt ceiling higher (lower) when income is lower (higher). For simplicity, we search for the ex-ante optimal ceiling to be enforced immediately ($n = 0$) for a government that currently does not have debt. This case is also interesting as a first approximation for cases with relatively low debt levels (e.g., post-default debt levels).

We find that the optimal rule imposes a limit on the debt-to-income ratio of 25 percent of annualized income (i.e., has $a_1 = 1$ and $a_0 = 0$), and thus is procyclical. Table 6 shows that, among rules with and average ceiling equal to 25 percent of mean annual income, those with a more countercyclical ceiling (i.e., a lower a_1) do not necessarily imply a lower consumption volatility. Since the default probability is more sensitive to increases in debt levels during lower-income periods, a ceiling that allows for more debt in lower-income periods implies that the government loses commitment to future low default probabilities, especially in lower-income periods. This increases the level and the countercyclicality of the government's borrowing cost, making it more difficult to conduct countercyclical fiscal policy. Figure 8 presents the welfare gain from allowing the debt ceiling to depend on current income among rules with an average debt ceiling of 25 percent of mean annual income. Our findings are a warning against "escape clauses" commonly used in fiscal rules (see IMF (2009)) to allow for more discretionary fiscal behavior during crisis periods.

Among fiscal rules that impose low average debt ceilings, the government prefers rules that allow for extra room for countercyclical fiscal policy (a negative a_1). For the case we study, such debt ceilings are too low (below 10 percent of mean annual income) and leave the government worse off compared with the no-rule benchmark. We do not observe defaults in the simulations with such low ceilings. Figure 9 presents the welfare gain from allowing the debt ceiling to depend on current income among rules with an average debt ceiling of 10 percent of mean annual income.

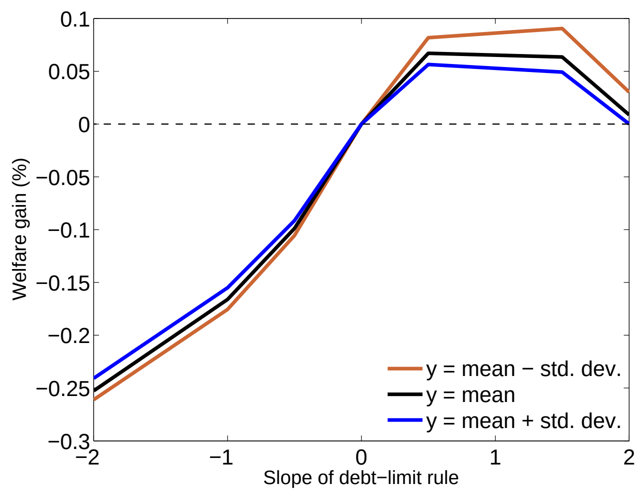

Figure 8: Welfare gain from allowing the debt ceiling to depend on current income among rules with an average debt ceiling of 25 percent of mean annual income, when current income is low (one standard deviation below the mean), average, or high (one standard deviation above the mean).

V. Conclusions

We used a sovereign default framework to show how a government may benefit from implementing a debt ceiling. The expectation of lower future debt levels makes possible that small borrowing declines lead to substantial interest rate declines that in turn lead to non-trivial debt declines. We also showed that if the government could capture the capital gains from the increase in the market value of its debt implied by the rule announcement (otherwise accrued by foreign investors), it would choose lower debt ceilings to be enforced sooner. In addition, we demonstrated how rules may promote a decline of consumption volatility and showed that rules allowing for more borrowing in bad times may not further decrease consumption volatility.

We chose to make our analysis more transparent by respecting the simplifying assumptions often used in quantitative studies of sovereign defaults. Future work could enrich our analysis by relaxing these assumptions.

One interesting extension of our work could be to study the impact of less-than-perfectly-credible fiscal rules. For instance, we abstract from political shocks that could threaten the enforcement of a rule.[13]

As in Chatterjee and Eyigungor (forthcoming) and Hatchondo and Martinez (2009), we assumed that the government cannot choose the duration of its debt. Relaxing this assumption could enhance our understanding of the effects of fiscal rules but it would increase the computation cost significantly.[14]

[13] Alfaro and Kanczuk (2005), Amador (2003), Cole et al. (1995), Cuadra and Sapriza (2008), D'Erasmo (2008), and Hatchondo et al. (2009) study sovereign default models with political shocks.

[14] If one allows the government to choose a different duration of sovereign bonds each period, one would

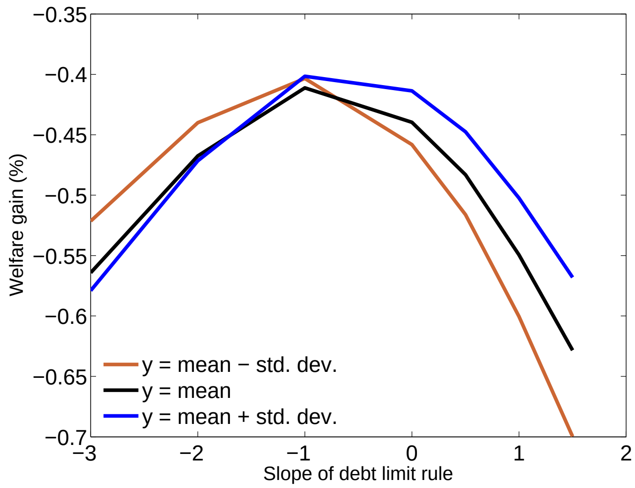

Figure 9: Welfare gain from allowing the debt ceiling to depend on current income among rules with an average debt ceiling of 10 percent of mean annual income, when current income is low (one standard deviation below the mean), average, or high (one standard deviation above the mean)

Extending our framework to include production could also expand our understanding of the effects of fiscal rules. We found large effects of fiscal rules on the level and volatility of interest rates. Several studies find evidence of interest rates playing a significant role in affecting productivity (through investment and the allocation of factors of production), and of a significant role of interest rate fluctuations in the amplification of shocks (see, for example, Mendoza and Yue (forthcoming), Neumeyer and Perri (2005), and Uribe and Yue (2006)). Since there is no production in our setup, we do not allow for these roles of the interest rate. Furthermore, our analysis of the cyclicality of fiscal policy is limited because we do not allow for taxes and government expenditure to affect income.

Studying a setup in which the sovereign simultaneously holds assets and liabilities may also expand our understanding of fiscal rules and thus may be an interesting avenue for future research. Fiscal rules often aim at controlling the sovereign's accumulation of both assets and liabilities. For simplicity, as is standard in default models, we assume that the government cannot simultaneously have assets and liabilities (Alfaro and Kanczuk (2009) show that in a sovereign default model the government typically does not choose to simultaneously hold assets and liabilities).

One could also enrich our analysis of fiscal rules by studying a model where difficulties to promise contingent debt payments are consistent with difficulties to establish contingent limits through fiscal rules. When we study countercyclical debt ceilings, we assume that the government can commit to a fiscal rule establishing targets that are contingent to the

have to keep track of how many bonds the government has issued for each possible value of duration to determine government's liabilities (see Arellano and Ramanarayanan (2010)). The computation cost of including additional state variables may be significant (Hatchondo et al. (2010a) show that the computation cost of obtaining accurate solutions in default models may be significant, and Chatterjee and Eyigungor (forthcoming) explain how the cost increases when long-duration bonds are assumed).

realized income. However, we still do not allow the government to issue state-contingent debt.[15]

[15]We follow the most common approach of assuming that GDP shocks are the only shocks in the economy and that sovereign debt contracts are not GDP indexed. The overwhelming majority of sovereign debts are not GDP-indexed (see Bolton and Jeanne (2009), Borensztein and Mauro (2004), Durdu (2009), and Sandleris et al. (2009)). Furthermore, sovereigns' willingness to repay has many other determinants besides domestic GDP. Tomz and Wright (2007) argue that these other determinants (e.g., political shocks) play an important role as predictors of sovereign defaults. Richer models that incorporate determinants of sovereign default other than GDP would feature market incompleteness even with GDP-indexed bonds.

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