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Fiscal Rules and Countercyclical Policy: Frank Ramsey meets Gramm-Rudman-Hollings*

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Abstract: Fiscal rules -- legal restrictions on government borrowing, spending, or debt accumulation (like the Gramm-Rudman-Hollings act in the US) -- have recently been adopted or considered in several countries, both industrialized and developing. Previous literature stresses that such laws restrict countercyclical government borrowing, thus preventing the intertemporal equalization of marginal deadweight losses of taxation, as Frank Ramsey might have prescribed. However, such literature typically abstracts from persistent current deficits that are financed by future tax increases. Eliminating such deficits may substantially reduce tax rate variability and favor countercyclical policy *over a finite horizon*. Thus, Gramm-Rudman-Hollings and Frank Ramsey are not necessarily enemies and they may even be good friends!

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I Introduction

Fiscal rules -- legal restrictions on government borrowing, spending, or debt accumulation -- have recently been adopted in several countries and are being discussed in several others (both industrialized and developing). While the details of fiscal rules may differ across countries, debates regarding their adoption involve similar issues.

Opponents of fiscal rules emphasize that they prevent the government from smoothing tax rates and expenditures over the business cycle, and may even prohibit discretionary countercyclical policy. [1] By contrast, their proponents argue that fiscal rules supplement weak institutions to promote fiscal responsibility and credibility. [2] This issue may be especially important in those Latin American countries that have suffered from chronic fiscal indiscipline. [3] [4]

Economic theory should be able to help policy makers evaluate alternative fiscal policies, including fiscal rules (legal restrictions like balanced budget restrictions or debt

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[1] Fiscal rules may also encourage governments to use questionable accounting procedures, as Milesi-Ferretti (2000) notes.

[2] Drazen (2000, 2002) argues that fiscal rules compensate for inherent pro-deficit biases. Aizenman, Gavin, and Hausmann (2000) and Stockman (2001a,b) formally model the credibility gains from fiscal rules.

[3] Fiscal rules have been recently enacted in Argentina, Brazil, and Chile, and they have been proposed in several other Latin American countries.

[4] Empirical evidence on fiscal rules (largely for industrialized countries) supports both claims. For example, Bayoumi and Eichengreen (1995) suggest that jurisdictions (US states) that have more restrictive fiscal rules do also run smaller deficits. At the same time, fiscal policy in such jurisdictions tends to be more procyclical in nature than jurisdictions without fiscal rules.

ceilings). A sizeable literature already examines fiscal policy from a welfare theoretic perspective. Much of this work builds on Robert Barro's (1979) application of Frank Ramsey's (1927) insight: as a first-best, governments should equate the marginal deadweight losses of taxation across periods of time. Under certain assumptions, this logic implies *tax smoothing*; fiscal policy is thus optimally countercyclical since the government is permitted to borrow during economic recessions (but must save during upturns). [5]

In this vein, several recent papers have compared a balanced-budget fiscal rule like the US's Gramm-Rudman-Hollings (GRH) Act with the optimal (Ramsey) policy discussed above. [6] Unsurprisingly, such research has generally confirmed that welfare under the Ramsey policy is higher than under the more restrictive fiscal rule. [7]

However, it may be relevant to compare such a fiscal rule against a broader range of policies. For example, consider a government that runs primary deficits today but is nonetheless expected to finance its debt service with future surpluses. Since tax rates are not smoothed over time such a policy is not optimal. Nonetheless, such a policy may more

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[5] As Barro (1979) showed that if output, interest rates, debt, and discounted expenditures, are fixed, tax rates should be exactly constant over time. Under specific types of uncertainty, tax rates should follow a random walk. However, Lucas and Stokey (1983) modify this result; they instead suggest that tax rates should be approximately constant. Also, if output is uncertain, as Chari and Kehoe (1999) confirm, tax rates should be *approximately* constant over time. For a more recent discussion, see Aiyagari, Marcet, Sargent and Seppälä (2002). Note also that the 'countercyclical policy' in this paper refers specifically to the smoothing of taxes or expenditures; the issues like endogenous countercyclical spending (automatic stabilizers) or discretionary policy are left for another paper.

[6] Reference to Gramm-Rudman-Hollings (GRH) is for rhetorical purposes only. Fiscal rules outside the US may differ considerably from GRH.

[7] For example see Schmitt-Grohe and Uribe (1997).

closely resemble those of actual governments than the optimal (Ramsey) policy. [8] How would a country's tax rates – level and variability – change if the government replaced such a policy with a GRH-like fiscal rule? Which regime would the country's residents prefer?

This paper compares a restrictive fiscal rule – a law that prohibits government beyond the minimum required to keep debt-GDP constant -- against several policy alternatives.[9] Under a benchmark policy, tax rates are completely smooth. Also, a general fiscal reaction function that may resemble more closely policies of actual governments is considered. This policy links tax rates to debt (thus ensuring long-run solvency) but also allows for constant (potentially deficit) component. [10] Uncertainty from two sources is assumed: output and borrowing constraints. Under these assumptions, countercyclical fiscal policy is synonymous with smooth tax rates.[11] Welfare is assumed to fall when either the mean or the variance of tax rates rises.

Previous literature has stressed that the restrictive nature of a fiscal rule like Gramm - Rudman - Hollings hinders tax smoothing and countercyclical fiscal policy (the Ramsey prescription). By contrast, this paper notes that the removal of persistent current primary

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[8] For simplicity, such a policy can only be modeled in an *ad-hoc* fashion in this paper. However, such a policy might reflect the government's desire to favor current taxpayers at the expense of future ones.

[9] *Ex-ante*, the rule permits just enough borrowing to keep the debt ratio constant. However, since tax rates before output is known, *ex-post* borrowing also reflects a forecasting error. Such net borrowing might be thought of as variations in public sector bank deposits.

[10] Other papers have formally derived the tax-smoothing proposition. By contrast, in this paper, a tax-smoothing policy posited as an optimum, but not formally derived.

[11] That is, there is no uncertainty in spending.

deficits – through either a fiscal rule or a once-and-for-all fiscal reform – permits smoother tax rates than otherwise. [12]

Over an infinite horizon, the welfare gains implied by moving closer to a Ramsey regime – lower and less variable tax rates – should be immediately apparent. However, over shorter horizons, the issue is not as clear-cut. If policy makers choose to finance some level of government expenditures today by accumulating debt accumulation (delaying tax financing), taxes *today* may be more variable, but they will be lower. Simulations presented in this paper provide a qualitative idea of this tradeoff. [13] These simulations suggest that, under certain conditions, a fiscal rule may facilitate rather than hinder countercyclical fiscal policy -- even in the *short-run*. Put differently, Frank Ramsey and Gramm-Rudman-Hollings are not necessarily enemies. In fact, they may be good friends! [14]

The paper is organized as follows. In Part II, basic identities are presented. In Part III, fiscal regimes with uncertain output and borrowing restrictions are discussed and results

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[12] In the model, the deficit is eliminated by raising taxes. Potential examples of such a policy might include a *one-time* tax rate increase or improvement in tax collection. More broadly, *one-time, permanent expenditure reductions* may also help reduce the deficit. In this sense, there may be a distinction between a fiscal *rule* and a fiscal *reform*. A fiscal rule, according to Kopits and Symanski (1998) is a permanent restriction on fiscal policy, while a reform occurs at one point in time. Of course, the two measures may compliment one another. And, as a legal matter, the two may be combined. For example, Brazil's Fiscal Responsibility Law (FRL) not only limits borrowing but also mandated a one-time, permanent reduction in public sector employment. For further details, see Guardia and Messenberg (2002).

[13] Whether or not the costs of increased tax rate variability exceeds the benefits of from lower tax rate *levels* depends on the precise form of the utility function -- how risk averse consumers are.

[14] Note that, in Latin America fiscal policy in the region has generally been procyclical even *without* fiscal rules (see, for example Gavin and Perotti (1997), Talvi and Végh (2000)).

from some simulations are presented. Part IV extends the model to include variable government expenditures. Part V presents some evidence regarding public sector *size* and expenditure variability. Part VI summarizes and concludes.

II Solvency, Tax Smoothing, and Fiscal Rules: Basic Identities

In any period, the government's budget constraint is:

(1) $$b_{t-1}\theta - ps_t = b_t$$

where b is the ratio of government debt to GDP, θ is the growth adjusted discount factor $(1+r)/(1+\lambda)$, r = real interest rate (constant), λ = permanent real GDP growth, $\lambda < r$, ps_t is the primary surplus (ratio to GDP). The intertemporal budget constraint is obtained by successive substitution of (1) over an infinite horizon:

(2) $$b_{t-1} - \sum_{t=0}^{\infty} ps_t/\theta^{t-1} = \lim_{t\to\infty} b_t/\theta^{t-1}$$

The transversality (or "no-Ponzi game") condition is:

(3) $$\lim_{t\to\infty} b_t/(1+r)^{t-1} = 0$$

The primary surplus is the difference between tax ratio τ and non-interest expenditures γ. For convenience, we assume a constant and exogenous expenditure ratio. [15] The deadweight loss function for taxes $\phi(\tau)$ increases in both first and second derivatives: $\phi'>0$, $\phi''>0$. [16]

The government thus must choose a path of tax rates over time τ_t that satisfies (3) without resorting to inflation or default. [17] The link between tax rates, primary expenditures and debt is assumed to be:

(4) $$\tau_t = \gamma - \kappa + \beta b_{t-1}$$

Fiscal policy is therefore summarized by the government's choice of κ and β (for given values of initial b, and constants γ. λ and r). The term κ may be thought of as a persistent tax gap. [18]

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[15] Other authors have used such an expression; see for example Leeper (1991). In this section, since growth is constant, actual and permanent output are identical. Note also that the assumption of constant γ is made for simplicity. An extension to the case of variable expenditure ratios is presented later in the paper.

[16] Previous literature in this area typically specifies household preferences. For a closed economy doing so is important, since intertemporal fluctuations in the tax rate may affect intertemporal allocations of consumption and leisure. By contrast, for an open economy such a specification would be inessential, since households smooth their consumption streams over time through international capital markets (the current account). Instead, the impacts of tax rate variability falls entirely on the production side.

[17] One kind of default is unanticipated inflation. For simplicity, we do not consider the issue of seignorage or inflation tax revenue in this paper.

[18] The tax gap may reflect a policy decision to keep taxes low or inefficient tax collection.

Barro (1979), borrowing Ramsey's (1928) insight, noted that deadweight losses should be equated at the margin. Under certain conditions, tax rates should be constant over time ($\tau_t = \tau_{t+1}$, all t). Barro's *tax-smoothing* result implies that an optimizing government will choose $\kappa=0$ and $\beta=(r-\lambda)/(1+\lambda)$. Doing so also ensures both that (3) is satisfied without default *and* that the debt ratio b remains constant at permanent level b^P.

According to subsequent research (discussed later) this result holds only approximately if income is uncertain. Note also that this expression resembles one presented by Blanchard et. al. (1990) and Talvi and Végh (2000). [19] In both papers, the permanent primary surplus required for *sustainability* -- satisfaction of (3) without default -- is shown to be $[r-\lambda]/[1+\lambda]*b^P$ ($\kappa=0$ and $\beta = [r-\lambda]/[1+\lambda]$).

However, strict satisfaction of (3) does *not* require $\kappa = 0$ and $b = [r-\lambda]/[1+\lambda]$. Rather, all that is required is that $\beta > 0$. However, as discussed above, a sustainable policy $\kappa \neq 0$ and $b \neq [r-\lambda]/[1+\lambda]$ has an important drawback: debt and tax rates increase over time. [20]

As Table 1 suggests, governments do not necessarily pursue the optimal policy $\kappa = 0$ and $\beta = [r-\lambda]/[1+\lambda]$. This table presents selected fiscal variables – the primary surplus and debt (in percent of GDP) and real GDP growth – for selected Latin countries, for recent years. In several key cases – Argentina, Brazil, Colombia, Peru, Uruguay – government debt

[19] This idea has become standard in the literature regarding fiscal sustainability. See, for example Chalk and Hemming (2000), Chalk (2002) and Juan-Ramón and Croce (2002).

[20] In some cases, the discounted debt may also grow, but only initially. Note also that formally debt *per se* is not 'bad', since both government and creditor behavior is completely credible. The case of less-than-perfect credibility is discussed below.

grows substantially, while primary balances are persistently below values consistent with $\kappa = 0$ and $\beta = [r-\lambda]/[1+\lambda]$. [21]

III Fiscal Regimes With Uncertain Output and Borrowing Restrictions

Debates regarding fiscal regimes generally address the way in which governments respond to certain economic shocks. In this section, we introduce uncertain shocks from two sources. In Section III.a, to incorporate the essential issue of smoothing tax rates over the business cycle, we introduce uncertainty in output. In this context, we define alternative fiscal regimes. Then, in Section III.c, we also introduce constraints on borrowing that occur randomly. Doing so permits us to address issues related to default motive, but only in a rudimentary and indirect way.

III.a. Uncertainty in Output and Alternative Fiscal Regimes

In any period, output Y is the sum of its permanent and temporary components:

$$Y_t = Y_t^P + \upsilon_t \tag{5}$$

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[21] Of course, policies dramatically changed in some countries over the period covered. For example, Brazil's fiscal adjustment began in 1999. As the table notes, the reporting basis for the primary balances and debt levels may vary across countries.

where $Y_t^P = Y_t^P (1+\lambda)$ is permanent (trend) output, and υ_t is mean-zero temporary income (deviation from trend) whose known variance is constant relative to Y_t^P.[22]

The fiscal regime that gives the government the most freedom to borrow over the business cycle while at the same time maintaining solvency is similar to the tax smoothing regime under certainty. The constant tax rate is:

$$\text{(R0)} \qquad \tau(0) = \gamma + (r-\lambda)/(1+\lambda)b^{P}$$

Access to borrowing is unfettered. To see that the debt remains in the long run close to b^P and that solvency condition (3) is satisfied, note first that the primary surplus / GDP ratio in any period is:

$$\text{(6)} \qquad ps(0)_t = \gamma[1 - w_t] + (r-\lambda)/(1+\lambda)b^P$$

where $w_t = Y_t^P / Y_t$ is the ratio of permanent to total output in any period and $E(w_t) = 1$.[23] Thus, the borrowing borrowing requirement br_t (beyond the minimum required to keep debt / GDP constant) is:

[22] In a future version of this paper, I plan to incorporate deadweight losses of taxation into the output function: $Y_t = Y^P - \phi(\tau) + \upsilon_t$

[23] Note also that $E(1-w_t) = 0$. Thus, solvency is ensured, since discounted debt converges over an infinite horizon to:

$$\lim_{t\to\infty} b_t/\theta^t = \gamma \sum_{t=0}^{\infty} [w_t - 1]/\theta^t$$

(continued)

(7) $$br(0)_t = \gamma[w_t-1] + (r-\lambda)/(1+\lambda)[b_{t-1} - b^P]$$

Consider next a fiscal rule that explicitly ties today's tax rates to the previous period's debt. The tax rate is chosen when b_{t-1} is known but *before* Y_t is known. According to (5) Y_t^P is also the expected value of Y_t. Thus, taxes are set according to:

(R1) $$\tau(1)_t = \gamma + (r- \lambda_t^*)/(1+ \lambda_t^*)b_{t-1}.$$

where $\lambda_t^* = [Y_t^P / Y_{t-1} - 1]$ is *expected* output growth in any period. Thus, this rule aims *ex-ante* to maintain a constant debt / GDP ratio. Debt inherited from the previous period limits new borrowing more under (R1) than (R0). *Ex-post*, governments may borrow or save. [24] The primary surplus ratio in any period is:

(8) $$ps(1)_t = \gamma[1 - w_t] + [(1+r)/(1+\lambda^*)]b_{t-1}$$

while the *ex-post* borrowing requirement is

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[24] We might assume that such ex-post variations in the debt ratio are reflected in changes in government bank deposits or other liquid assets.

(9) $$br(1)_t = \gamma[w_t - 1] + [(1+r)/(1+\lambda^*)\varepsilon_t]b_{t-1}$$

where $\varepsilon_t = (\lambda_t-\lambda_t^*)/(1+\lambda_t)$ reflects the forecasting error in period t.

Regimes (R0) and (R1) appear similar: in both cases $\kappa = 0$ and $\beta = r-\lambda/(1+\lambda)$. Therefore, average tax rates should be roughly equal across the two regimes. Tax rate variance is zero under (R0) but is positive under (R1). It is difficult to compare rule (R1) and (R0) without reference to institutional context.[25] We assume that rule (R1) is *explicitly* specified while (R0) is not. As Drazen (2000) argues, explicit rules can bolster otherwise weak credibility and institutions.

If institutions are weak and there is no fiscal rule, choice of b^P may be problematic; there may be incentives to revise b^P on a period-by-period basis. Without a rule like (R1), such revisions would likely be asymmetric: instead of adjusting, a government might simply raise its debt ceiling (b^P).

However, (R0) may not be the relevant alternative to (R1). Instead, we may want to compare (R1) against a broader range of alternative fiscal regimes. Left without an explicit rule, a country's institutional structure may not abide by optimality conditions $\kappa = 0$ and $\beta = r-\lambda/(1+\lambda)$. Rather, the tax rule might take a more general form:

(R2) $$\tau(2)_t = \gamma-\kappa + \beta b_{t-1}\ , \ \ \kappa > 0, \beta > 0.$$

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[25] However, Schmitt-Grohe and Uribe (1997) do so in the context of a growth model.

Critically, while (R1) is assumed to be a formal law, (R2) is not. As mentioned above $\kappa > 0$ reflects a tax gap. The primary surplus as a fraction of GDP is:

(10) $$ps(2)_t = -\kappa + \beta b_{t-1};$$

Incremental new borrowing is

(11) $$br(2)_t = \kappa + [(r-\lambda)/(1+\lambda)-\beta]b_{t-1}.$$

III.b. Random Borrowing Constraints

Under (R2), debt grows. In a world of perfect credibility, this should not be a problem: as mentioned above, so long as $\beta > 0$, the discounted debt converges to zero over an infinite horizon. Both borrower and lender must behave credibly: the borrower must credibly commit to κ and β; and, the lender must credibly commit to continue lending – even if debt temporarily builds up.

Less than full credibility on the borrower's side may involve default (full or partial). An explicit default model is not presented in this paper but is left for another one. Instead we model imperfect credibility on the lenders side by introducing a random element to market

access, π^c. If $\pi^c = 0$, borrowing is unconstrained. If π^c is, say, 0.5, there is a 50 percent chance that the country will not be able to borrow. [26]

If a borrowing government is denied access to credit in a period that it would have otherwise have borrowed, it must raise taxes in that period. Governments with lower debt burdens – those benefiting from discipline in the past like regimes (R0) or (R1) – will be suffer lower tax increases; Governments with higher debt burdens – those that suffered from past indiscipline, like regime (R1) will also suffer higher tax increases. [27] The cutoff is asymmetric: it does not limit a country's surplus. Also, even under the constrained regime, countries may borrow in order to cover their forecasting error. [28] Therefore, under (R1), neither taxes nor borrowing will be affected. For regimes (R0) and (R2), if a borrowing constraint holds in a given period, borrowing is the maximum of what obtains under (R1) (namely, $br(1)_t = [w_t - 1] + [(1+r)/(1+\lambda^*)\varepsilon_t]b_{t-1}$) and the amount that would have been

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[26] The borrowing constraint is assumed to have a uniform distribution.

[27] Introducing a random exclusion from borrowing also indirectly brings in the issue of default. If borrowers know with certainty that they will be cut off from all borrowing in the present and future, and there is no other default penalty, the borrower will default. By contrast, if the government knows with certainty that they will never be cut off from credit markets – assuming a solvent regime like (R2) – default is less likely than otherwise. In the scheme presented here, governments find themselves somewhere between these two extremes. More realistically, the probability of a borrowing cutoff should be modeled as a function of debt itself. Such a task is left for another paper.

[28] As mentioned above, such borrowing might reflect reductions in government bank deposits.

borrowed otherwise; the tax rate is the minimum of $\tau(1)_t = \gamma + (r-\lambda)/(1+\lambda_t^*)b_{t-1}$ and the unconstrained rate.[29]

Under random borrowing constraints, κ=0 may no longer be optimal. Instead, governments may want to self-insure against prospective borrowing cutoffs. In this sense, a policy maker faces a problem similar to that for precautionary saving. As a simple two period example, suppose that the government wishes to equate current (period 1) marginal deadweight loss with expected future (period 2) deadweight loss, by choosing the optimal surplus $(r-\lambda)/(1+\lambda)b_0 - \kappa_1^*$ ($\kappa_1 < 0$) in period 1. That is, κ_1^* is chosen such that:

(12)	$\phi'(\tau(0)-\kappa_1)$	=	$(1-\pi^C)\,\phi'(\tau(0))$	+	$\pi^C\,E(\tau(1)_2)$
	Current marginal deadweight loss		Future marginal deadweight loss, Unfettered access to borrowing		Future expected marginal deadweight loss, No access to borrowing

where $\phi'(\tau(0)-\kappa_1) = \phi'(\gamma + (r-\lambda)/(1+\lambda) - \kappa_1)$ is the marginal loss from taxation in the current period, $(1-\pi^C)\,\phi'(\tau(0)) = (1-\pi^C)\,\phi'(\gamma+(r-\lambda)/(1+\lambda)b_0)$ is the future marginal loss in the case that the government is able to borrow, and $\pi^C E(\tau(1)_2) = \pi^C \int_{Y_1} f_Y \phi'\{\gamma+(r-\lambda_2^*)/(1+\lambda_2^*)\,[(1+r)(1-\varepsilon_1)/(1+\lambda_1^*)+\kappa 1]b_0\}dY$ is the expected marginal loss from taxation in the case that the

[29] More precisely, borrowing and taxes under borrowing constraints are: $br(0^C)_t = \max\{br(1)_t, br(0)_t\}$, $\tau(0^C)_t = \min\{\tau(1)_t, \tau(0)_t\}$, $br(2^C)_t = \max\{br(1)_t, br(2)_t\}$, and $\tau(2^C)_t = \min\{\tau(1)_t, \tau(2)_t\}$.

government cannot borrow (where f_Y is the distribution function for output and $\varepsilon_t = (1+\lambda^*_t)/(1+\lambda)$ is the forecast error in period t). In (12), note that if $\pi^C=0$, $\kappa_1^*=0$. More generally, $\partial \kappa_1^*/\partial \pi^C <0$: with borrowing restrictions more probable, the optimal government surplus is higher.

III.c. Simulation Results

It should be immediately apparent – without simulations – that over an infinite horizon, the level of tax rates under (R0) and (R1) should be close to one another, but taxes are more variable under (R1). [30] By contrast, under a regime like (R2), with values of κ and β that differ from their optima (0, $(r-\lambda)/(1+\lambda)$, respectively) tax rates will be higher and more variable than under either (R0) or (R1).

However, such a distinction is not as clear-cut over shorter horizons. Policy makers choose (R2) if they want to provide a given level of government expenditures today but delay tax financing until some future date. Doing so may entail a noticeable impact on both tax rate variance and debt accumulation over this shorter horizon. That is, as κ and β move further away from their optimal values, tax rate variability rises, thus reducing the scope for countercyclical policy. Whether or not the costs of increased tax rate variability exceed the benefits of from lower tax rate *levels* depends on how risk averse consumers are. Also, as κ

[30] Taxes under (R0) only vary if there are borrowing constraints.

and β move further away from their optimal values, more debt is accumulated, an important factor if credibility is imperfect.

Tables 2 through 4 present simulations of regimes (R0), (R1) and (R2). These simulations are intended to convey a flavor of how such regimes differ for shorter horizons -- 5, 10, and 20 years. The tables show the mean, variance, minima and maxima for three key variables: the tax rate (τ_t), the primary surplus (ratio to GDP) (ps_t), and the end of period debt (b_T, T = 5, 10, 20). In all cases, 500 random draws are taken.

In all cases, the initial debt ratio is assumed to be 50% ($b^P = .5$); permanent growth λ is assumed to be 4 percent; the variance of temporary income is assumed to be 5% of permanent income; the constant interest rate is 7% (r=.07), and the permanent spending ratio is $\gamma = 20$ percent. Assumption that borrowing restrictions will be imposed with probabilities $\pi^c = 0$, 0.3, and 0.5 are presented in Tables 2, 3, and 4, respectively. For regime (R2), all tables present alternative values for κ and β, namely $\kappa = .03$, β=.8 and $\kappa = .05$, β=.8.

Consider first the case of no borrowing constraints π^c=0 in Table 2. Note that for (R0) the (benchmark) constant tax rate is $\tau = .2144$ (21.44%) over all horizons. Moving to the near-balanced budget regime (R1) reduces tax rates (but only slightly) while variability becomes positive. [31] For example, during the first five years (T = 5) tax rate variance rises from zero under (R0) to 0.05 percent of GDP under(R1). Thus, in this period, tax rates range from a minimum of 18.9 percent to a maximum of about 23.5 percent under (R1). For longer horizons (T = 10, 20) the variance of τ rises, as does the gap between the between minima

[31] Note that results for (R1) are invariant to π^c.

and maxima. Note also that, under both regimes, the primary surpluses range from 1.1 to 1.3 percent of GDP. And, end-period debt b_T remains on average close to its initial value of 0.5 under regimes.

Unsurprisingly, for horizons presented here, taxes are lower under regime (R2) -- in both cases -- than either (R0) or (R1); tax rate variability is about the equal under (R1) and (R2) for T = 5; However, as T rises to 10 and 20, tax rate variability does as well. For example, for $\kappa = 0.03$ -- a regime under which primary *deficits* average about 2 percent of GDP – tax rates in the first five years (T = 5) range from just under 16% to just over 20%. However, over a ten-year horizon (T = 10), tax rates range from about 14% to 22%, and for a twenty-year horizon (T = 20) tax rates range from about 12% to about 25%. In all cases, tax rates become more variable κ is increased to 0.05 (primary *deficits* of 3 to 4 percent of GDP).

Unsurprisingly, debt accumulation is also substantially greater under (R2), and debt builds up ever more as the period grows. For example, in the case of T =5, debt accumulation averages about 60% of GDP for $\kappa = 0.03$ and 65% for $\kappa = 0.05$. For T = 10, the end-period debt ratio b_T rises to about 72% and 85%; for T = 20, the debt ratio rises to just under 100% and 127%, respectively.

As Tables 3 and 4 show, if uncertain borrowing constraints are assumed (π^c=0.3 and π^c=0.5), regime (R0) becomes slightly less attractive relative to (R1): both the level and variability of tax rates under (R0) rise for the cases shown. [32] Unsurprisingly, (R0) debt accumulation is greater under $\pi^C = 0$ than $\pi^C > 0$ (since borrowing is not always available).

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[32] Note that, at some point, an increase in π^c should *decrease* both tax levels and variability under (R0) and (R2), since π^c =1 is the same as an (R1) regime.

Tables 3 and 4 also show, that the (R2) regimes become less attractive relative to both (R0) and (R1). As π^c rises from 0 to 0.3 and 0.5, so do both the level and variability of tax rates under (R2).

Furthermore tax rates are always more variable under (R2) than (R1) if $\pi^c > 0$. For example, for $\kappa = 0.03$ – a regime under which primary *deficits* average between 0.5 and 1 percent of GDP – tax rates in the first five years (T = 5) range from about 16.5% to about 21%. However, over a ten-year horizon (T = 10), tax rates range from about 15% to just under 24%, and over a twenty-year horizon (T = 20) tax rates range from about 13% to about 27%. As before, tax rates become more variable when κ is increased to 0.05 (primary deficits of 1.6 to 2 percent of GDP). Note also that debt buildup under (R2) falls when π^c rises, but is nonetheless substantially higher than under (R0) or (R1).

IV Extension: Variable Government Expenditures

In the preceding discussion, expenditures have been assumed to be constant (exogenously set) fraction of permanent GDP. While such an assumption is standard in the literature, it is made primarily for convenience rather than realism. [33] Typically, expenditures

[33] It is easier to make welfare statements about tax rates than about expenditures. For example, government expenditures in the form of lump-sum transfers have no welfare implications.

also suffer cuts during adverse periods. Thus, consider a more general framework. Expenditures and taxes, without borrowing constraints, are determined by: [34]

(13a) $$\tau_t = \gamma^P - \kappa + \phi\beta b_{t-1}$$

(13b) $$\gamma_t = \tau_t + \kappa - (1-\phi)\beta b_{t-1}$$

where γ^P and γ_t are permanent and total government expenditures respectively, and $0 \leq \phi \leq 1$. In expressions (13a) and (13b) the exogenous (long-run), fiscal adjustment is distributed between taxes and expenditures according to ϕ: if $\phi = 1$, the entirety of the adjustment falls on taxes (equivalent to the previous section's model). By contrast, if $\phi = 0$ all adjustment falls on expenditures. In this case, τ is constant and $\gamma^P \equiv \tau + \kappa$. [35]

Under borrowing constraints, the corresponding expressions are:

(14a) $$\tau^C_t = \max\,[\gamma^P - \kappa + \phi\beta b_{t-1},\ \gamma^P - \phi(r-\lambda)/(1+\lambda_t^*) b_{t-1}]$$

(14b) $$\gamma^C_t = \min\,[\tau_t + \kappa - (1-\phi)\beta b_{t-1},\ \tau_t - (1-\phi)(r-\lambda)/(1+\lambda_t^*) b_{t-1}]$$

In (14b), if $\phi = 0$, if a borrowing government is denied access to credit, it cuts expenditures in that period.

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[34] Note that, under (R0), both taxes and expenditures are exogenous.

[35] Presumably, political considerations would determine the value of ϕ. However, this topic is left for another paper.

V Extension: Public Sector Size and Volatility

Fiscal reforms generally envisage *permanent* cuts of less productive expenditures.[36] Doing so helps transfer resources to either higher priority public expenditures, the private sector (through tax cuts), or both. This is perhaps the most widely recognized benefit of such an adjustment. However, doing so may also permit essential public goods and services to be provided more *smoothly* -- with fewer cuts or interruptions.

Moreover, the previous discussion suggests that level of permanent government expenditures γ^P and their volatility should be related. For example, under the endogenous expenditure regime (ϕ=0) the average level of government expenditures ($\gamma^P = \tau+\kappa$) and the variability of expenditures var(γ) should be positively related. [37] For more general cases, ($0 \leq \phi \leq 1$) higher γ^P should raise the variability of both expenditures and revenues.

To investigate this issue in Latin America, Figure 1 presents a plot of the level of *real consumption* expenditures (relative to GDP) against its coefficient of variation (variance / mean). (The average ratio of government consumption / GDP thus proxies for the

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[36] That is, alignment between taxes and primary expenditures – removal of the 'tax gap' κ – may be achieved by a once-and-for-all reduction in γ. Moreover, as Alesina and Ardanga (1998) suggest, fiscal adjustments that emphasize expenditure reduction rather than tax increases are both more durable and more likely to increase economic growth.

[37] For discussions of related issues in Latin America see Gavin and Perotti (1996) and Talvi and Végh (2000).

permanent expenditure ratio γ). According to this chart, casual observation may favor such a positive relationship among Latin American countries.

What is the relationship between the level of government expenditures and real GDP volatility? [38] In the traditional public finance literature, stabilization was a key role of the public sector. Moreover, according to recent evidence presented by Fatas and Mihov (2001), amongst industrialized countries, a larger public sector is associated with *lower* output variability. However, such a relationship is not evident for Latin America. Figure 2 presents a plot of the level of *real consumption* expenditures (relative to GDP) against the variance of real GDP. According to this chart, casual observation may also favor such positive relationship among Latin American countries between these two variables. This should not be surprising, since more variable government expenditures should be associated with more variable GDP.

VI Summary and Conclusions

This paper attempted to clarify several loose notions regarding restrictive fiscal rules and the conduct of fiscal policy over the business cycle. Fiscal rules (like Gramm-Rudman-Hollings) are often cast as an "enemy" of the first-best (Ramsey) optimum of tax smoothing. Of course, in any welfare comparison, it is essential to be clear about exactly *what* are the

[38] This idea is not undisputed. For example, in the traditional public finance literature stabilization was one of the public sector's key roles. More recently, Fatas and Mihov (2001) provide evidence – for *industrialized* countries – that a larger public sector is associated with lower output variability.

alternatives under consideration. Fiscal policy in many emerging markets – and particularly in Latin America – is plagued by budgetary rigidities, weak primary balances, and volatile tax rates, expenditures, and debt / GDP ratios.

As a theoretical construct, the benefits of a Ramsey-style tax smoothing regime are clear: over an infinite horizon, consumers benefit from lower and less variable tax rates. A more difficult question involves shorter horizons. If a persistent tax gap is eliminated (through once-and-for-all measure tax and expenditure measures) will tax rates or expenditures become appreciably smoother? Simulations presented in this paper suggested that the answer to this question is 'yes.' Moreover, while such once-and-for-all measures may be distinct from a balanced-budget law or other fiscal restriction, the two may nonetheless complement one another. In these ways, that Gramm-Rudman-Hollings and Frank Ramsey may be "friends" rather than "enemies."

While the assumptions in this paper were simple, more realistic ones might be used in future work. For example, both expenditures and taxes might share some of the burden in further simulations. Also, future work might specify consumer preferences and the production technology more fully. And, budgetary rigidities, purely ad-hoc in nature in this paper, might instead reflect some optimization process in a future one.

There were also some key topics that, while omitted, would be fruitful extensions in future work. For example, an extension of this work might include a motivation for default and endogenous borrowing constraints, as discussed in previous sections. Also, the model might be extended to include changes in the price level, interest rate changes, or both (according to, for example, the recently-developed 'fiscal theory of the price level.')

Ultimately, economic theory ought to be able compare a GRH-like rule against polices that countries currently pursue. The agenda for future research on this topic thus remains sizeable.

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Table 1
Primary Surplus, Debt and GDP Growth
Selected Latin American Countries

	1996	1997	1998	1999	2000		
Argentina							
Primary surplus (ps_t)		0.3	0.5	-0.8	0.5	Period avg.	0.1
Debt (b_t)		38.1	41.3	47.4	50.8	Period avg. chg	4.2
GDP Growth (λ_t)		8.1	3.8	-3.4	-0.5	Period avg.	2.0
Brazil							
Primary surplus (ps_t)	-0.1	-1	0	3.1	3.5	Period avg.	1.1
Debt (b_t)	33.3	34.6	42.4	47	49.2	Period avg. chg	4.0
GDP Growth (λ)	2.7	3.3	0.2	0.8	0.8	Period avg.	1.5
Chile							
Primary surplus (ps_t)	2.7	0.4	-1.6	-3.2	-2.1	Period avg.	-0.8
Debt (b_t)	6.7	6.5	8.1	9.2	8.4	Period avg. chg	0.4
GDP Growth	7.4	7.4	3.9	-1.1	5.4	Period avg.	4.6
Colombia							
Primary surplus (ps_t)	-0.1	-1.4	-0.7	-2.1	0.8	Period avg.	-0.7
Debt (b_t)	24.5	26.7	29.9	38.2	35.5	Period avg. chg	2.8
GDP Growth	2.1	3.4	0.5	-4.2	2.8	Period avg.	0.9
Costa Rica							
Primary surplus (ps_t)			2	1.4	1	Period avg.	1.5
Debt (b_t)			33.6	27.7	30.3	Period avg. chg	-1.7
GDP Growth			8.4	8.4	1.7	Period avg.	6.2
Dominican Republic							
Primary surplus (ps_t)			-1.2	-1.2	-1.1	Period avg.	-1.2
Debt (b_t)			28.4	26.8	26	Period avg. chg	-1.2
GDP Growth			7.3	8	7.8	Period avg.	7.7
El Salvador							
Primary surplus (ps_t)			-0.1	-0.2	-0.2	Period avg.	-0.2
Debt (b_t)			24.8	25.6	27.5	Period avg. chg	1.4
GDP Growth			3.2	3.4	2	Period avg.	2.9
Guatemala							
Primary surplus (ps_t)			-0.3	-1.4	-0.7	Period avg.	-0.8
Debt (b_t)			15.5	18.4	18	Period avg. chg	1.3
GDP Growth			5.1	3.8	3.6	Period avg.	4.2
Honduras							
Primary surplus (ps_t)			5.6	1.8	0.2	Period avg.	2.5
Debt (b_t)			76.1	78.6	72.4	Period avg. chg	-1.8
GDP Growth			2.9	-1.9	5.0	Period avg.	2.0
Mexico							
Primary surplus (ps_t)	3.5	2.2	0.4	1	1.5	Period avg.	1.3
Debt (b_t)	50	46.6	50	46.7	41.7	Period avg. chg	-2.1
GDP Growth	5.2	6.8	5.0	3.6	6.6	Period avg.	5.5
Peru							
Primary surplus (ps_t)			1.2	-0.8	-0.9	Period avg.	-0.2
Debt (b_t)			42.7	42.8	45.9	Period avg. chg	1.6
GDP Growth			-0.5	0.9	3.1	Period avg.	1.2
Uruguay							
Primary surplus (ps_t)	0.5	0.5	0.9	-2.1	-1.2	Period avg.	-0.8
Debt (b_t)	31.3	31.8	34.2	40.1	45.8	Period avg. chg	4.7
GDP Growth	5.6	4.9	4.7	-3.2	-1.0	Period avg.	0.2

Sources: IMF Staff Reports / Recent Economic Developments (various); for Central American / Caribbean Countries, Offerdahl (2002).

Table 2
Alternative Fiscal Regimes: Simulation Results
Probability of borrowing constraint $\pi^C = 0.0$

	5-year horizon (T=5)			10-year horizon (T=10)			20-year horizon (T=20)		
	τ	ps	b_T	τ	ps	b_T	τ	ps	b_T
	tax rate	pri. sur	debt (end per.)	tax rate	pri. sur	debt (end per.)	tax rate	pri. sur	debt (end per.)
Smoothing (R0)									
Average	0.2144	0.0137	0.5033	0.2144	0.0137	0.5027	0.2144	0.0138	0.5065
Variance	0.0000	0.0001	0.0017	0.0000	0.0001	0.0025	0.0000	0.0001	0.0050
Minimum	0.2144	0.0029	0.3931	0.2144	-0.0022	0.3818	0.2144	-0.0062	0.3360
Maximum	0.2144	0.0238	0.6476	0.2144	0.0279	0.6773	0.2144	0.0312	0.7539
"Balanced Budget" Rule (R1)									
Average	0.2127	0.0119	0.5105	0.2125	0.0118	0.5220	0.2131	0.0125	0.5418
Variance	0.0005	0.0005	0.0057	0.0006	0.0007	0.0124	0.0007	0.0008	0.0273
Minimum	0.1889	-0.0104	0.3305	0.1734	-0.0277	0.2897	0.1616	-0.0404	0.1915
Maximum	0.2347	0.0334	0.7395	0.2485	0.0494	1.0340	0.2611	0.0636	1.0905
Gen'l Fiscal Reaction (R2), $\kappa = .03$, $\beta = .8$									
Average	0.1812	-0.0196	0.6425	0.1827	-0.0180	0.8241	0.1869	-0.0137	1.2099
Variance	0.0004	0.0004	0.0052	0.0007	0.0007	0.0135	0.0012	0.0013	0.0440
Minimum	0.1598	-0.0395	0.4614	0.1427	-0.0584	0.5624	0.1198	-0.0815	0.7195
Maximum	0.2012	0.0000	0.8703	0.2205	0.0211	1.3335	0.2540	0.0546	1.9449
Gen'l Fiscal Reaction (R2), $\kappa = .05$, $\beta = .8$									
Average	0.1618	-0.0389	0.7237	0.1644	-0.0363	1.0099	0.1709	-0.0297	1.6197
Variance	0.0005	0.0004	0.0056	0.0009	0.0009	0.0162	0.0019	0.0020	0.0620
Minimum	0.1390	-0.0601	0.5325	0.1189	-0.0819	0.7177	0.0873	-0.1136	1.0277
Maximum	0.1834	-0.0180	0.9624	0.2084	0.0086	1.5650	0.2581	0.0580	2.5098

Notes: *Unconstrained* regimes are: (R0) smoothing: $\tau(0)=\gamma+(r-\lambda)/(1+\lambda)b^P$, $ps(0)_t = \gamma[1-w_t]+(r-\lambda)/(1+\lambda)b^P$; (R1) near-balanced budget: $\tau(1)_t=\gamma+(r-\lambda_t^*)/(1+\lambda_t^*)b_{t-1}$, $ps(1)_t = \gamma[1-w_t]+[(1+r)/(1+\lambda^*)]b_{t-1}$; (R2) general reaction: $\tau(2)_t= \gamma-\kappa+\beta b_{t-1}$, $\kappa>0$, $\beta>0$, $ps(2)_t = -\kappa + \beta b_{t-1}$;

Constrained regimes are: (R0): $\tau(0^C)_t = \max\{\tau(1)_t, \tau(0)_t\}$, $ps(0^C)_t = \max\{ps(1)_t, ps(0)_t\}$; (R2): $\tau(2^C)_t = \max\{\tau(1)_t, \tau(2)_t\}$, $ps(2^C)_t = \max\{br(1)_t, br(2)_t\}$;

π^C = probability of constraint in any period, τ = tax rate, γ = ratio of government expenditures to permanent output, r = interest rate, λ = growth of permanent output, λ^*_t = *expected* output growth, b=ratio of debt to output, w_t = ratio, permanent/total output in period t;

For all simulations, $\lambda = 4\%$, r = 7%, b(initial)=b^P=0.5, γ= 0.2, variance of temporary output = 0.5 * permanent output. Number of draws = 500.

Table 3
Alternative Fiscal Regimes: Simulation Results
Probability of borrowing constraint $\pi^C = 0.3$

	5-year horizon (T=5)			10-year horizon (T=10)			20-year horizon (T=20)		
	τ	ps	b_T	τ	ps	b_T	τ	ps	b_T
	tax rate	pri. sur	debt (end per.)	tax rate	pri. sur	debt (end per.)	tax rate	pri. sur	debt (end per.)
Smoothing (R0)									
Average	0.2164	0.0157	0.4949	0.2168	0.0161	0.4789	0.2168	0.0162	0.4480
Variance	0.0001	0.0001	0.0023	0.0001	0.0002	0.0037	0.0001	0.0002	0.0074
Minimum	0.2144	0.0038	0.3361	0.2144	-0.0012	0.3173	0.2144	-0.0055	0.2208
Maximum	0.2220	0.0281	0.6476	0.2305	0.0362	0.6657	0.2403	0.0442	0.7332
"Balanced Budget" Rule (R1)									
Average	0.2127	0.0119	0.5105	0.2125	0.0118	0.5220	0.2131	0.0125	0.5418
Variance	0.0005	0.0005	0.0057	0.0006	0.0007	0.0124	0.0007	0.0008	0.0273
Minimum	0.1889	-0.0104	0.3305	0.1734	-0.0277	0.2897	0.1616	-0.0404	0.1915
Maximum	0.2347	0.0334	0.7395	0.2485	0.0494	1.0340	0.2611	0.0636	1.0905
Gen'l Fiscal Reaction (R2), $\kappa = .03$, $\beta = .8$									
Average	0.1908	-0.0099	0.6007	0.1919	-0.0088	0.7267	0.1951	-0.0055	0.9857
Variance	0.0007	0.0007	0.0062	0.0009	0.0010	0.0149	0.0013	0.0014	0.0400
Minimum	0.1645	-0.0356	0.3848	0.1485	-0.0529	0.4148	0.1300	-0.0714	0.4244
Maximum	0.2183	0.0177	0.8091	0.2394	0.0398	1.1669	0.2685	0.0697	1.6753
Gen'l Fiscal Reaction (R2), $\kappa = .05$, $\beta = .8$									
Average	0.1774	-0.0233	0.6576	0.1792	-0.0215	0.8573	0.1842	-0.0164	1.2697
Variance	0.0011	0.0011	0.0081	0.0015	0.0015	0.0208	0.0022	0.0023	0.0595
Minimum	0.1454	-0.0549	0.4171	0.1277	-0.0735	0.4871	0.1043	-0.0968	0.5569
Maximum	0.2136	0.0132	0.8715	0.2410	0.0412	1.3886	0.2813	0.0820	2.1524

Notes: *Unconstrained* regimes are: (R0) smoothing: $\tau(0)=\gamma+(r-\lambda)/(1+\lambda)b^P$, $ps(0)_t = \gamma[1-w_t]+(r-\lambda)/(1+\lambda)b^P$; (R1) near-balanced budget: $\tau(1)_t=\gamma+(r-\lambda_t^*)/(1+\lambda_t^*)b_{t-1}$, $ps(1)_t = \gamma[1-w_t]+[(1+r)/(1+\lambda^*)]b_{t-1}$; (R2) general reaction: $\tau(2)_t= \gamma-\kappa+\beta b_{t-1}$, $\kappa >0$, $\beta>0$, $ps(2)_t = -\kappa + \beta b_{t-1}$;

Constrained regimes are: (R0): $\tau(0^C)_t = \max\{\tau(1)_t, \tau(0)_t\}$, $ps(0^C)_t = \max\{ps(1)_t, ps(0)_t\}$; (R2): $\tau(2^C)_t = \max\{\tau(1)_t, \tau(2)_t\}$, $ps(2^C)_t = \max\{br(1)_t, br(2)_t\}$;

π^C = probability of constraint in any period, τ = tax rate, γ = ratio of government expenditures to permanent output, r = interest rate, λ = growth of permanent output, λ^*_t = *expected* output growth, b=ratio of debt to output, w_t = ratio, permanent/total output in period t;

For all simulations, $\lambda = 4\%$, r = 7%, b(initial)=b^P=0.5, γ= 0.2, variance of temporary output = 0.5 * permanent output. Number of draws = 500.

Table 4
Alternative Fiscal Regimes: Simulation Results
Probability of borrowing constraint $\pi^C = 0.5$

	5-year horizon (T=5)			10-year horizon (T=10)			20-year horizon (T=20)		
	τ	ps	b_T	τ	ps	b_T	τ	ps	b_T
	tax rate	pri. sur	debt (end per.)	tax rate	pri. sur	debt (end per.)	tax rate	pri. sur	debt (end per.)
Smoothing (R0)									
Average	0.2178	0.0171	0.4894	0.2183	0.0176	0.4639	0.2181	0.0175	0.4135
Variance	0.0001	0.0002	0.0025	0.0001	0.0002	0.0042	0.0001	0.0002	0.0079
Minimum	0.2144	0.0048	0.3311	0.2144	-0.0004	0.2979	0.2144	-0.0050	0.2022
Maximum	0.2261	0.0302	0.6476	0.2373	0.0400	0.6657	0.2463	0.0486	0.7286
"Balanced Budget" Rule (R1)									
Average	0.2127	0.0119	0.5105	0.2125	0.0118	0.5220	0.2131	0.0125	0.5418
Variance	0.0005	0.0005	0.0057	0.0006	0.0007	0.0124	0.0007	0.0008	0.0273
Minimum	0.1889	-0.0104	0.3305	0.1734	-0.0277	0.2897	0.1616	-0.0404	0.1915
Maximum	0.2347	0.0334	0.7395	0.2485	0.0494	1.0340	0.2611	0.0636	1.0905
Gen'l Fiscal Reaction (R2), $\kappa = .03$, $\beta = .8$									
Average	0.1973	-0.0034	0.5729	0.1980	-0.0027	0.6631	0.2004	-0.0002	0.8448
Variance	0.0007	0.0007	0.0063	0.0010	0.0010	0.0146	0.0012	0.0013	0.0355
Minimum	0.1689	-0.0312	0.3311	0.1530	-0.0480	0.3585	0.1367	-0.0648	0.3827
Maximum	0.2254	0.0248	0.7835	0.2456	0.0460	1.0272	0.2696	0.0711	1.5422
Gen'l Fiscal Reaction (R2), $\kappa = .05$, $\beta = .8$									
Average	0.1879	-0.0128	0.6134	0.1891	-0.0116	0.7566	0.1928	-0.0078	1.0482
Variance	0.0012	0.0012	0.0086	0.0015	0.0016	0.0205	0.0020	0.0021	0.0527
Minimum	0.1517	-0.0487	0.3311	0.1343	-0.0669	0.3987	0.1149	-0.0864	0.4878
Maximum	0.2239	0.0235	0.8715	0.2489	0.0492	1.2082	0.2811	0.0823	1.9347

Notes: *Unconstrained* regimes are: (R0) smoothing: $\tau(0)=\gamma+(r-\lambda)/(1+\lambda)b^P$, $ps(0)_t=\gamma[1-w_t]+(r-\lambda)/(1+\lambda)b^P$; (R1) near-balanced budget: $\tau(1)_t=\gamma+(r-\lambda_t^*)/(1+\lambda_t^*)b_{t-1}$, $ps(1)_t=\gamma[1-w_t]+[(1+r)/(1+\lambda^*)]b_{t-1}$; (R2) general reaction: $\tau(2)_t=\gamma-\kappa+\beta b_{t-1}$, $\kappa>0$, $\beta>0$, $ps(2)_t=-\kappa+\beta b_{t-1}$;

Constrained regimes are: (R0): $\tau(0^C)_t=\max\{\tau(1)_t, \tau(0)_t\}$, $ps(0^C)_t=\max\{ps(1)_t, ps(0)_t\}$; (R2): $\tau(2^C)_t=\max\{\tau(1)_t, \tau(2)_t\}$, $ps(2^C)_t=\max\{br(1)_t, br(2)_t\}$;

π^C = probability of constraint in any period, τ = tax rate, γ = ratio of government expenditures to permanent output, r = interest rate, λ = growth of permanent output, λ^*_t = *expected* output growth, b=ratio of debt to output, w_t = ratio, permanent/total output in period t;

For all simulations, λ = 4%, r = 7%, b(initial)=b^P=0.5, γ= 0.2, variance of temporary output = 0.5 * permanent output. Number of draws = 500.

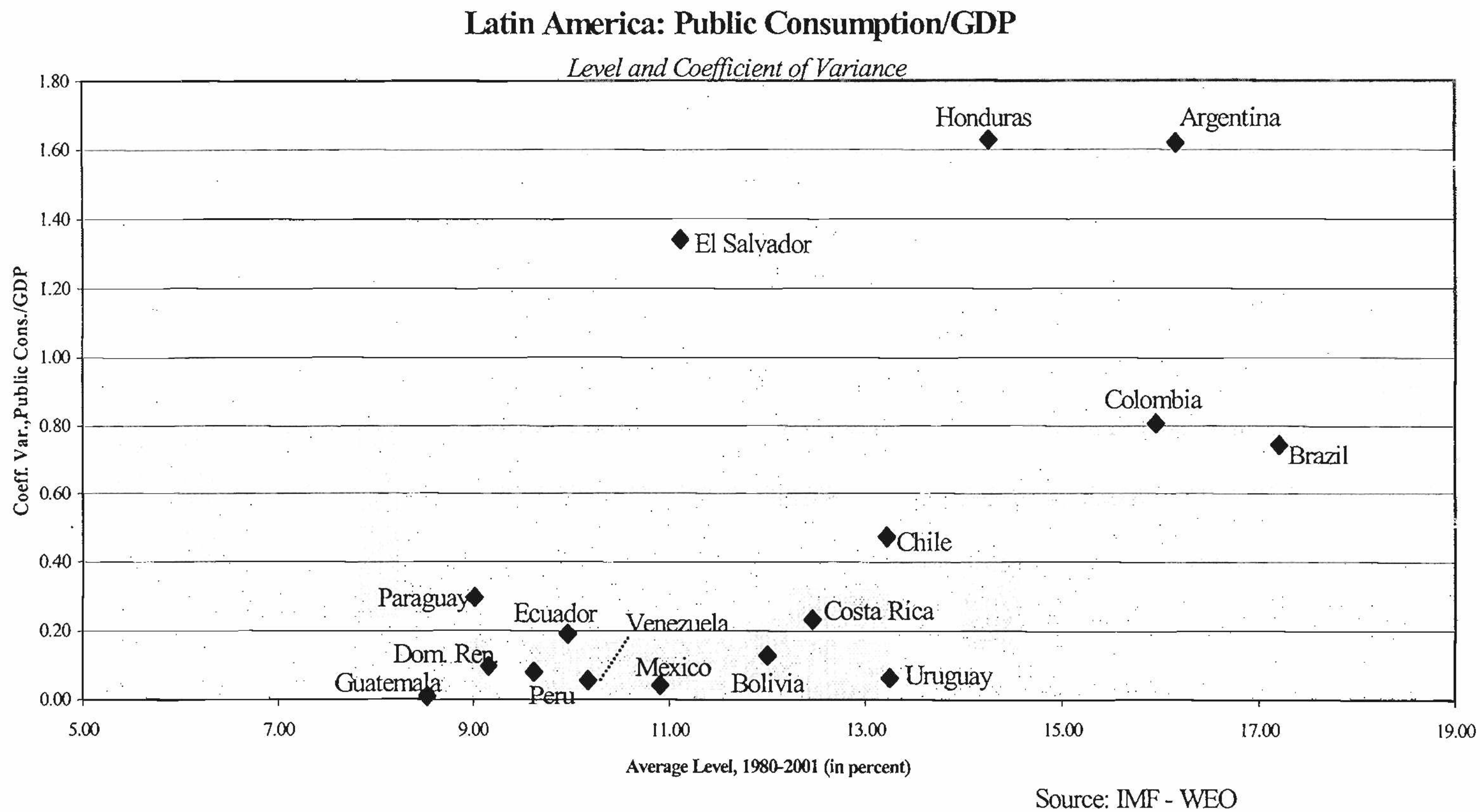
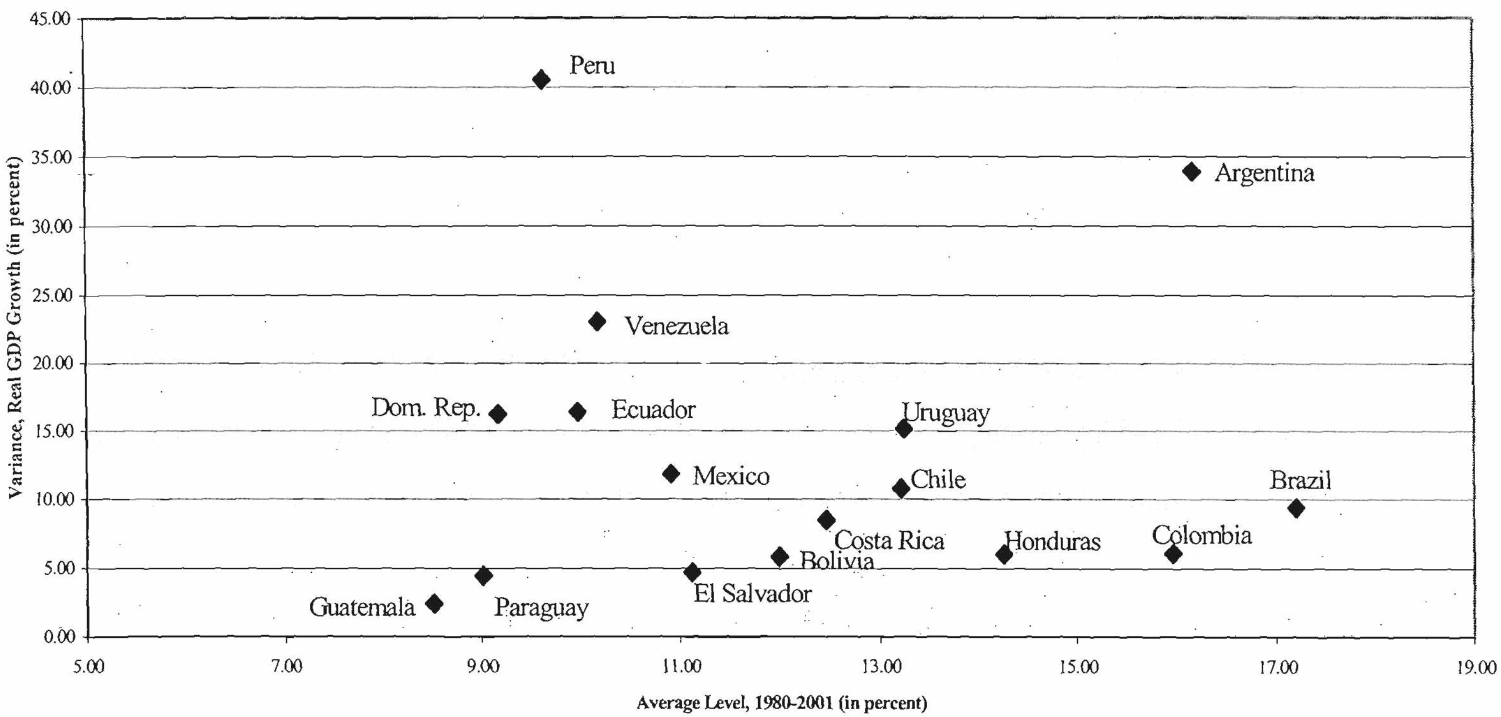

Latin America: Public Consumption/GDP
Level and Coefficient of Variance
Coeff. Var.,Public Cons./GDP
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
5.00
7.00
9.00
11.00
13.00
15.00
17.00
19.00
Average Level, 1980-2001 (in percent)
Honduras
Argentina
El Salvador
Colombia
Brazil
Chile
Paraguay
Ecuador
Venezuela
Costa Rica
Dom. Rep.
Mexico
Bolivia
Uruguay
Guatemala
Peru
Source: IMF - WEO

Figure 1.

Latin America: Public Consumption/GDP and Output Volatility



Source: IMF - WEO

Figure 2.