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Fiscal Consequences for Mexico of Adopting the Dollar

Dollarization implies a reduction in the menu of assets available to the government and to the private sector in managing risk. Whatever the gains from dollarization, the costs of reducing the asset menu need to be weighed against them. This paper presents models, one a simple generalization of a well-known model of tax smoothing by Barro, in which these costs are explicit. Along the way, it suggests that there is likely to be no reduction in interest costs to the government from dollarization.

RECENTLY ECONOMISTS have been paying increasing attention to a dynamic general equilibrium approach to the theory of the price level that is often called the fiscal theory of the price level, or FTPL. This way of thinking emphasizes the role of fiscal and monetary policy in determining the risk and return properties of government liabilities. It is particularly useful in analyzing proposals for large-scale institutional changes that imply shifts in monetary and fiscal policies. When dollarization is considered from this perspective, some disadvantages are brought to light that may not be so apparent from other points of view.

Section 1 below lays out the main ideas of FTPL. Section 2 displays a model that extends an earlier one of Barro's to argue that optimal fiscal policy will use surprise inflation to achieve lower deadweight tax loss than would otherwise be possible. Section 3 considers the composition of government liabilities along the lines of the theory of corporate finance, asking if dollarization will reduce the cost of funds. Section 4 presents annual estimates of the unanticipated returns to holders of U.S. government debt, to show that these are substantial and are to some extent timed to match legitimate periods of fiscal stress, as the optimality theory of section 2 would suggest. Section 5 discusses the lender-of-last-resort function and its connection to these fiscal issues. Section 6 briefly discusses some alternatives to pure dollarization. In our concluding section 7 we sum up, finding much to worry about in the prospect of dollarization.

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Journal of Money, Credit, and Banking, Vol. 33, No. 2 (May 2001, Part 2)

1. THE BASICS OF THE FTPL

Consider a government that issues interest-bearing debt in both domestic currency units (we will call this fiat debt) and in a fixed-real-value unit (we will call this dollar debt). We leave money out of the story, because it keeps the equations simple and makes the analogy with private balance sheets more direct. We also assume that debt is all of one-year term. Allowing for the presence of money or for long-term debt would not affect the main qualitative conclusions of the analysis.

The government's period-by-period budget constraint is given by

$$B_t + e_t F_t + \tau_t P_t = G_t P_t + R_{t-1} B_{t-1} + e_t R^*_{t-1} F_{t-1}\ , \tag{1}$$

where B_t is fiat debt sold by the government at t, F_t is dollar debt sold at t, τ_t is revenue, G_t is government expenditures, P_t is the domestic price level, e_t is the exchange rate, R_t is the gross interest rate on fiat bonds issued at t, and R^*_t is the gross interest rate on dollar bonds issued at t. This constraint can be "solved forward" to produce an intertemporal budget constraint:

$$\frac{B_t}{P_t} = \sum_{s=1}^{\infty}\left(\prod_{v=1}^{s} \rho_{t+v}^{-1}\right)\left(\tau_{t+s} - G_{t+s} + \frac{e_t}{Pt}(F_{t+s} - R^*_{t+s-1}F_{t+s-1})\right), \tag{2}$$

where $\rho_{t+1} = P_t R_t / P_{t+1}$ is the ex post realized real interest rate on fiat debt. The validity of this equation does not depend on rational expectations or any fine points of optimizing behavior. It is a consequence of the one-period accounting identity (1) and the condition that

$$\lim_{t \to \infty} E\left[\beta_T \frac{B_T}{P_T}\right] = 0\,. \tag{3}$$

This latter condition can be derived from optimizing behavior of holders of the fiat debt, but it can be expected to hold even if the holders are rather irrational. For it to be violated, holders of the debt would have to be willing to hold ever-growing amounts of real wealth in the form of government debt, relative to their own consumption, without ever attempting to spend it.

In words, (2) asserts that the current real value of fiat debt is a discounted present value of future primary surpluses, net of the real value of foreign debt service. To see how this relationship leads to a theory of the price level, we add some further simplifying assumptions. Suppose the ex ante real interest rate on fiat debt $\bar{\rho}_t = E_t[R_t P_t / P_{t+1}]$, the primary surplus $\tau_t - G_t$, the real value of the dollar e_t/P_t, and the level of foreign debt F_t are all constant from the current date onward. Then we can apply the E_{t-1} operator to (1), solve the resulting equation forward, and conclude that

$$\frac{B_t}{P_t} = \frac{\tau - G - (R^* - 1)(e / P)F}{\bar{\rho} - 1}. \qquad (4)$$

While this equation assumes no uncertainty about the future values of the right-hand-side variables, it is forward looking, so it is valid even if those variables are discontinuously different from what they have been before t.

Since B_t cannot jump discontinuously at t,[1] this equation offers a simple theory of the price level. Increases in taxes τ or domestic real rate $\bar{\rho}$ are deflationary; increases in spending G, foreign interest rate R^*, or the real value of the dollar e/P are inflationary. (This all assumes $F > 0$.)

This relation is so simplified that it cannot be applied directly, but it is a useful intellectual benchmark, with roughly the same status as the $Mv = PT$ equation of the quantity theory of money. We can set up a very simple model without interest-bearing debt in which $Mv = PT$ holds exactly, just as we here have set up a very simple model in which (4) holds exactly. In a more complicated model containing non-interest-bearing money, there would be an $M^D = M^S$ equation that generalizes $Mv = PT$ and can be thought of as determining prices, and this equation would hold simultaneously with an equation like (4). One or the other may be more naturally thought of as the main causal mechanism relating government policy to the price level, depending on the configuration of monetary and fiscal policy. Each equation has to be borne in mind as a constraint, even when one is thinking primarily in terms of the other equation as causal.[2]

For the purposes of thinking about dollarization, the main point to emerge from (4) is that it implies a set of trade-offs for fiscal policy in the face of a surprise disturbance to current and expected future levels of the right-hand-side variables. Severe, sudden fiscal stress can arise from war, natural disaster, or a financial bailout impacting G. It can also arise from sudden shifts in the unit dollar value of domestic production P/e if there is a large amount of outstanding dollar debt. The government can maintain stable prices in the face of such a shock by simply increasing taxes by enough to cover the disturbance to (say) G. It can postpone increasing taxes by borrowing, while maintaining the price level constant, if it convinces the public that it will later increase taxes by enough to cover both the initial fiscal shock and the increased debt service generated by the borrowing. With a policy that maintains constant P, it will not matter much whether the borrowing is dollar or fiat. However, there is a third option: the government can make no change at all in τ, despite the in-

1. In a model with money, with a policy of smoothing interest rates, B_t could jump instantly. The same would be true in this model if we considered policies in which the government pegged e or R by offering to trade fiat bonds for dollar bonds at some fixed ratio. However, here we are assuming no money and constant F.

2. In their classic paper "Some Unpleasant Monetarist Arithmetic" (1981), Sargent and Wallace pointed out the need to keep the government budget constraint in mind when thinking about a monetary policy approach to controlling inflation. The FTPL literature goes beyond this point, to show that the roles of monetary and fiscal policy in determining the price level are logically symmetric.

crease in G. So long as the right-hand side of (4) remains positive (that is, so long as the increase in G has not wiped out the primary surplus), equilibrium will then be restored by an increase in P.

Absorbing fiscal shocks in P is possible only because of the existence of fiat government liabilities. If there were only dollar liabilities, this option would not exist. The argument of this paper is that this option has value. Of course, there is no possibility, in the absence of money, for the government to steadily raise revenue from inflation. Debtholders who anticipate an attempt by the government to inflate steadily will require higher nominal interest rates to compensate for the inflation. But short-lived governments may be tempted into a high-inflation equilibrium by the prospect of inflationary fiscal gains today whose negative consequences will be borne by future governments. The argument for dollarization is the claim that fiscal authorities are so naive, or so limited by political institutions, that high and variable inflation is the inevitable result of the existence of the option of inflationary finance, and that this high and variable inflation, by destabilizing and distorting the financial system, has severe real consequences. While I am skeptical of some aspects of these claims, this paper does not directly dispute them. It instead points out that, whatever the gains from these sources, they need to be compared to definite losses from giving up the option of using the price level as a fiscal shock absorber.

2. A MODEL OF DEBT AS SHOCK ABSORBER

Barro (1979) developed a model in which he demonstrated that, in the presence of distorting taxes, optimal fiscal policy involved "tax smoothing," so that the current tax level is always set equal to the discounted present value of future expenditures plus service on the existing debt. His results imply that it is not optimal to eliminate existing debt and that large, temporary increases in expenditure should be primarily debt financed. He did not take into account, though, the fact that the price level is systematically related to fiscal policy. It is therefore worthwhile to extend his model to take account of the possibility of surprise inflation.[3]

Barro's model adds to our discussion in the previous section a government objective, minimization of the present value, discounted at a fixed rate, of expected future tax collection costs

$$E\left[\sum_{t=0}^{\infty} \beta^s \tau_t f\left(\frac{\tau_t}{Y_t}\right)\right]. \tag{5}$$

We also follow him in ignoring the possibility of dollar debt, so that the government budget constraint is

3. Barro's paper considered the effects of unanticipated inflation. However, the paper did not recognize the possibility that surprise inflation could be an endogenous result of surprises in the time path of G. It considered only unanticipated changes in P unrelated to fiscal policy.

$$\frac{B_t}{P_t} \geq R_{t-1}\frac{B_{t-1}}{P_t} + G_t - \tau_t \,. \tag{6}$$

It simplifies notation if we rewrite this equation in terms of real debt $b_t = B_t/P_t$ and the rate of deflation $\phi_t = P_{t-1}/P_t$:

$$\partial\lambda\colon\; b_t \geq R_{t-1}\phi_t b_{t-1} + G_t - \tau_t \,. \tag{6$'$}$$

(The "$\partial\lambda$:" at the left above indicates the Lagrange multiplier that will be associated with this constraint in the optimization problem.)

Barro assumed, to avoid complications, that private consumption growth was uncorrelated with G_t, and we follow him in this. Optimizing behavior of private agents then imposes the condition that, when positive amounts of bonds are held, the expected real return on bonds matches β^{-1}, that is,

$$\partial\nu\colon\; 1 = R_t\beta E_t\phi_{t+1} \,. \tag{7}$$

This private-sector first-order condition becomes a constraint on the government. We assume the government is also constrained to have

$$\partial\mu_1\colon\; \tau_t \geq 0, \qquad \partial\mu_2\colon\; b_t \geq 0 \,, \tag{8}$$

$$\partial\mu_3\colon\; R_t \geq 0, \qquad \partial\mu_4\colon\; \phi_t \geq 0 \,. \tag{9}$$

As final simplifications, we assume $Y_t = \bar{Y}$ constant and $f(\tau_t/\bar{Y}) = \frac{1}{2}\tau_t$ in the objective function (5) (making it, as in Barro's analysis, quadratic). The optimizing government,[4] maximizing (5) with respect to $\{\tau_t, B_t, R_t, \phi_t\}$, subject to (6′)–(9), will have as its first-order conditions for all t after the initial period

$$\partial\tau\colon\; \tau_t = \lambda_t - \mu_{1t} \tag{10}$$

$$\partial b\colon\; \lambda_t = \beta R_t E_t[\lambda_{t+1}\phi_{t+1}] - \mu_{2t} \tag{11}$$

$$\partial R\colon\; \beta E_t[\lambda_{t+1}\phi_{t+1}]b_t] = \beta\nu_t E_t\phi_{t+1} - \mu_{3t} \tag{12}$$

$$\partial\phi\colon\; \lambda_t b_{t-1}R_{t-1} = \nu_{t-1}R_{t-1} - \mu_{4t} \,. \tag{13}$$

For the initial period $t = 0$, the last of these is replaced by

$$\partial P\colon\; \lambda_t b_{t-1}R_{t-1} = -\mu_{4t} \,. \tag{13$'$}$$

4. Here we assume a government capable of time-inconsistent commitment. This case may not be realistic, but it is a useful benchmark. Furthermore, it is more realistic than the opposite extreme of assuming the government is incapable of any commitment. Such a government would never be able to borrow.

Though these equations may look complicated, in periods where τ_t, R_t, and ϕ_t are nonzero, $b_{t-1} > 0$, and $t > 0$, the equations reduce by straightforward algebra to the simple result $\tau_t = \tau_{t-1}$. This is a stronger conclusion than Barro's $\tau_t = E_t[\tau_{t+1}]$, which he derived from (10), (11), and (7) under the assumption that P is either constant or stochastically independent of τ.

At $t = 0$, the optimal policy is to repudiate all outstanding debt by setting $\phi_0 = 0$.[5] To understand the nature of optimal policy after the first period, consider the case where G_t takes on only finitely many values $g_1 < g_2 < \ldots < g_n$. Suppose also that G_t is Markov, meaning the probability distribution of future Gs is entirely determined by the current value of G, and that it is persistent, so that the discounted present value of future Gs is ordered in the same way as g_i. In other words, periods of low current G are also periods of low discounted expected future G. Under these conditions, there will be at each date t a threshold $\bar{g}(t)$ such that if $G_t \geq \bar{g}(t)$, existing debt is repudiated. If $G_t \leq \bar{g}(t)$, $\tau_t = \tau_{t-1}$, but if $G_t > \bar{g}(t)$, $\tau_t > \tau_{t-1}$. When the economy has been operating long enough that $G_t = g_n$ has occurred, $\bar{g}(t)$ becomes fixed at $\bar{g}(t) = g_n$ for all subsequent periods. No further changes in τ_t occur, and debt is repudiated only when the state of greatest fiscal need, $G_t = g_n$, occurs. Since it always remains true that b_t is the expected discounted present value of future primary surpluses, the Markov structure of the problem implies that b_t remains constant so long as the economy persists in the same state (that is, has the same value of G). Once τ has achieved its permanent level, there is a unique value of b associated with each state. In states with positive primary surpluses, there is deflation and/or $R > \beta^{-1}$, so long as the state persists, so that the primary surpluses do not reduce b. In states with primary deficits, there is inflation and/or $R < \beta^{-1}$ while the state persists, so that the primary deficits do not increase b. Periods when $G_t > G_{t-1}$ will have high inflation, those with $G_t < G_{t-1}$ low inflation or deflation.

The detailed argument that the solution has this character goes as follows. First we verify the conditions that deliver $\tau_t = \tau_{t-1}$ at dates $t > 0$: τ_t, R_t, ϕ_t, and b_{t-1} all nonzero. Under these conditions, (10) tells us $\lambda_t = \tau_t$. We know that R_{t-1} must be nonzero because (7) from period t could not hold with $R_{t-1} = 0$ unless ϕ_t were known with certainty at $t - 1$ to be zero. Since our working hypothesis includes $\phi_t > 0$, and (13) implies λ_t is known at $t - 1$, we conclude that $\tau_t = \lambda_t$ is known at $t - 1$. We can use Barro's equations [(10), (11), and (7), as we have already noted] to conclude that $\tau_t = \tau_{t+1}$, that is, that τ_t is constant.

Now consider the initial date, or any other date at which debt has been repudiated. The current $G_0 > 0$ must be financed either by taxes or debt issue. Thus initial τ_0 and b_0 will take on some non-negative value, possibly zero. Applying the E_{t-1} operator to

5. To set $\phi_0 = 0$ requires that the initial price level be infinite. This cannot actually be achieved by simply running a deficit, so this fully optimal policy can only be approached, not exactly implemented, by ordinary fiscal policy. The method of approaching it is to issue a very large amount of nominal debt B_0, while keeping prospective real primary surpluses bounded. The newly issued debt, which the government uses to finance $G_0 - \tau_0$, then competes with the old debt $R_{-1}B_1$ in the marketplace and drives down the value of the old debt, while the total real value of the new debt is anchored by the prospective future primary surpluses. Or we can allow the government to overtly repudiate outstanding debt, freeing it to determine an initial price level in terms of a new unit of account by choosing a nominal quantity of new debt, in the new unit of account, to sell.

(6′) and solving forward, we conclude, because of the constancy of τ, that if $b_0 > 0$, then

$$b_0 = (\tau_0 - \Gamma(G_0))/(\beta^{-1} - 1)\,, \tag{14}$$

where $\Gamma(G_t)$ is the expected present value, discounted at the rate β, of government spending from $t + 1$ onward given that spending is G_t at t. But at the same time,

$$b_0 + \tau_0 = G_0\,.$$

These two equations in b_0 and τ_0 determine their values uniquely. If the two equations imply $b_0 < 0$, then instead $\tau_0 = G_0$ and $b_0 = 0$. It is easy to verify that both b_0 and τ_0 are under our assumptions increasing functions of G_0. The rest of our claims above about the character of the solution then follow.

If for some reason the optimal first-period policy of debt repudiation is not followed, and a large enough real value of carried-over initial debt is allowed in that period, debt repudiation need never occur. It is not optimal to repudiate debt after the first period if the initial debt, and therefore the constant tax level $\bar{\tau}$, is set high enough so that taxes more than cover the primary deficit even in the worst state, that is, $\bar{\tau} > g_n$. While setting taxes and debt at such a level is not optimal initially, once it is done, it is not optimal thereafter to lower taxes or to temporarily raise them in order to reduce debt and thereby ultimately lower taxes.

If all debt were dollar debt, with the real exchange rate fixed, this model would apply, but with $\phi_t \equiv 1$ and (13) and (13′), the first-order conditions with respect to ϕ, eliminated from the system. This would return us to Barro's original conclusions, with τ a random walk that rises and falls with the level of G and b. This solution is clearly worse than the fully optimal policy, as it implies much wider variations in tax rates. In fact, the quadratic model it is based on would eventually surely cease to apply, as tax rates are presumably bounded, if only by 100 percent, and a random walk that tracks b plus the discounted present value of primary surpluses cannot satisfy such a bound. In effect the random-walk-τ policy puts no limits on the range of variation in b, even if the range of G itself is bounded, whereas the optimal policy, by using unanticipated deflation and inflation, keeps b in a fixed range so long as the range of G is fixed.

In the appendix a more general model is considered, in which the objective function is discounted utility of private agents, there is a labor-leisure choice, and agents are risk averse. In this setting it is no longer optimal to keep the tax rate constant. However, the main lesson of the simple Barro model is still valid. With real or dollar debt, an optimizing government is forced each period to update the tax rate to keep it in line with discounted future expenditures. With fiat debt an optimizing government instead sets the tax rate completely independently of expected future expenditures and of the current level of debt. The effect of fiscal shocks is absorbed entirely in surprise inflation, resulting in a less variable and more efficient time path for the tax rate.

These models are too abstract directly to imply policy conclusions, but they contain important lessons for policy. The most obvious is that abandoning the option of surprise inflation and deflation can lead, even with the best possible policy, to quite a different time path of real public debt than the best achievable when surprise inflation and deflation are kept in the policy tool kit.

A more realistic model, not considered here, would account for costs of surprise inflation and deflation. With sticky prices, surprise inflations and deflations may have inefficient real consequences. In the presence of non-interest-bearing high-powered money, surprise inflations and deflations may imply inefficient fluctuations in transactions costs. The first of these effects can be mitigated if there is long-term debt, as with long-term debt surprise changes in long interest rates can play the role of surprise inflation and deflation, so the optimal equilibrium is attained with a smooth path of prices. But these considerations would only moderate or modify our conclusions from this model, not change the basic point that such surprises in the market return on government debt are an important policy tool, whose abandonment has a definite cost.

It is interesting to note that the model implies that an economy with low levels of taxation and debt is likely optimally to repudiate its debt, or inflate at high rates, more frequently than an economy that has been through a period of major fiscal stress and thereby inherited a high level of debt and taxation. Such a low-debt economy, because of its higher probability of high inflation, will also optimally have a higher cost of capital than a similar economy with high levels of fiat debt, during periods when debt is not being repudiated or (nearly) inflated away. The high-debt economy can obtain insulation from fiscal shocks with modest levels of surprise inflation and deflation because of the large base of real debt on which the inflation and deflation rates operate.

While certainly not the complete story, these patterns may have something to contribute to understanding of historical developments in public finance. England's great expansion of public finances during the late seventeenth and early eighteenth century took place during an unprecedented period of major wars. As its debt expanded, there was a period in the early eighteenth century of suspension of convertibility. After the expansion of the debt, public debt became a very secure investment compared to what it had been before the expansion of debt began.[6] This story roughly fits the predictions of the theory. And perhaps countries nowadays without large amounts of outstanding debt and with a history of inflation or default on public debt do not have this record entirely because of a defect in their political or economic systems that prevents them from credibly committing to optimal intertemporal policies. Good policy, with complete credibility, is likely to avoid default and high inflation more consistently when it is operating with a large cushion of outstanding debt as a shock absorber.

Supporters of dollarization might argue that, in a country like Mexico with the outstanding market value of public debt low, there is little fiscal shock absorption to

6. These conclusions draw on Dickson (1967).

be had from this source, so abandoning it will have low cost. But the theory predicts that the real value of outstanding public debt will be lowest precisely in the wake of a period of major fiscal stress. And in the theory, these periods, and the fiscal reforms they induce, lay the foundation for the later expansion of public debt and consequent stabilization of public credit. Fiscal stress and low debt are therefore not in themselves arguments for dollarizing all public finances.

The model we have presented here is related to ideas and proposals that have appeared earlier. Bizer and Judd (1989) emphasize the fact that unanticipated capital taxation is not distorting, which implies that, were it feasible, it would be wise to absorb fiscal shocks in the rate of capital taxation. Taxation of private capital is difficult and expensive to administer, particularly if it fluctuates rapidly. The implicit tax on holdings of government debt that arises from unexpected shocks to fiscal balance, on the other hand, is automatic, with no administrative costs, and it is nondistorting for the same reason that unanticipated capital taxation is nondistorting. To the extent that shocks to fiscal balance can be absorbed by the implicit tax on nominal liabilities, rather than by fluctuations in the rates of distorting taxes or in expenditures, the result is likely to be increased efficiency. Friedman (1948) proposed letting the price level absorb fiscal shocks. He did not recognize explicitly the optimality of planning no reductions in the real value of debt, however. Woodford (1998) contains an analysis very close to that given here. He includes money in the model and solves for an optimal policy subject to a constraint the government imposes on itself to achieve time consistency.His approach applied to this model would uncover the long-term behavior of the fully committed equilibrium we have derived. As Woodford points out, this kind of analysis of nominal debt with surprise inflation can be thought of as a partial implementation of the abstract state-contingent debt considered by Robert E. Lucas and N. Stokey (1983). Chari, Christiano, and Kehoe (1994) postulate an ad hoc restriction that government is constrained to a certain nonzero gross real return on debt in the first period, and show that optimal inflation is counter-cyclical for the reasons developed in this paper's model. Marcet, Sargent, and Seppälä (2000) show how Barro's conclusions emerge approximately from the Lucas-Stokey framework when the government is constrained to issue only real debt.

3. WOULD DOLLARIZATION LOWER THE COST OF BORROWING?

In Mexico and other countries where dollarization is a realistic policy option, interest rates on dollar debt are considerably lower than those on fiat debt, even when corrected for the current inflation rate. It may seem that we can extrapolate this rate differential to the case of full dollarization, so that dollarization could be expected to lower the government's interest costs. In fact, though, it is quite clear that the differential in interest costs between fiat and dollar debt before dollarization has no implications for the postdollarization cost of borrowing.

If both fiat debt and dollar debt are being held by some of the same people, then absence of arbitrage implies that there is a market stochastic discount factor Φ_t such that

$$\bar{\rho}_t = R_t E_t \left[\frac{\Phi_{t+1} P_t}{\Phi_t P_{t+1}} \right] = R_t^* E_t \left[\frac{\Phi_{t+1} e_{t+1} P_t}{\Phi_t e_t P_{t+1}} \right]. \tag{16}$$

If we now multiply (1) through by Φ_t/P_t and apply the E_{t-1} operator to it, we arrive at

$$E_{t-1}\left[\frac{\Phi_t (B_t + e_t F_t)}{P_t} \right] = \bar{\rho}_{t-1} \frac{\Phi_{t-1}(B_{t-1} + e_{t-1} F_{t-1})}{P_{t-1}} - E_{t-1}[\Phi_t(\tau_t - G_t)]. \tag{17}$$

Solving this equation forward produces

$$\frac{(B_t + e_t F_t)}{P_t} = E_t \left[\sum_{s=1}^{\infty} \left(\prod_{v=1}^{s} \bar{\rho}_{t+v}^{s} \right)^{-1} \left(\frac{\Phi_{t+s}}{\Phi_t} \right) \frac{\tau_{t+s} - G_{t+s}}{P_t} \right]. \tag{18}$$

As mathematics, (16) and (18) are identical to the building blocks of the Modigliani-Miller theorem in corporate finance, which asserts that the market value of a firm and its overall cost of capital are independent of the way it divides its liabilities between equity and debt. The value of the firm is the properly discounted expected value of its future earnings. Therefore the overall excess yield on the firm's debt and equity is determined by the covariance of its discounted earnings stream with the market discount factor. As a firm shifts the liability side of its balance sheet from predominantly equity to predominantly risk-free debt, the variability of returns on its equity increases and the absolute value of the risk premium on its equity increases along with it. But the value of the firm and its overall cost of capital is unaffected. The same reasoning implies that the real value of a country's outstanding liabilities, $(B + eF)/P$, is invariant to changes in the composition of those liabilities between B and F and that consequently the overall interest burden of the debt is unaffected by such shifts in composition.

The implication of this reasoning is that so long as there remains a nontrivial amount of fiat debt outstanding, uncertainties about the stream of future primary surpluses are absorbed by the fiat debt, allowing the dollar debt to be insulated from these uncertainties and maintain a lower expected return. But as soon as dollar debt becomes the entire stock of debt, its return must reflect the full range of uncertainty about future primary surpluses.

Of course, this reasoning assumes, in the case of the firm, that the changes in the structure of liabilities occur while the nature of the future earnings stream remains fixed. In the case of a government, the corresponding condition is that the nature of the stream of future primary surpluses remains fixed as the liability structure is changed. If postdollarization dollar debt were to remain as near riskless as it was before dollarization, the stream of primary surpluses would *necessarily* change. In assessing the likely postdollarization rate of return on dollar debt, we are assessing the nature of the changes in fiscal policy it might induce or accompany.

It is well recognized that the ability of a government to reduce the real market value of its outstanding fiat debt via inflation and interest rate changes is a kind of option to default. Of course, no legal default is involved, as the fiat debt makes no promise to repay in real terms. It promises only a return denominated in more fiat government liabilities. But surprise inflation and interest rate changes can change the value of the debt just as would a default. Most sovereign debt does not contain explicit provision for adjusting nominal value in case of contingencies, and is therefore on its face a "safe" asset. However, public finance in a dollarized economy would be similar in many respects to a regime with which there is long historical experience—public finance under a gold standard. At times of fiscal stress, governments under the gold standard would "suspend specie payment," meaning that their liabilities, nominally promising payment in gold, could temporarily only be rolled over at maturity into new government liabilities. This contingency was not provided for explicitly in advance, but it was easy to implement. It would be correspondingly easy in a time of crisis for a dollarized Mexican government to "suspend dollar payment" on its debts. During such a suspension, there would be a discount on Mexican dollar liabilities, and there would in effect be a "Mexican debt dollar," with a non-unit rate of exchange with the actual dollar.

Thus dollarization would not create a high technological or institutional barrier against partial default. Indeed, it appears to me that the actual barriers would be lower than when the "default" had to be engineered through inflation. When fiscal stress leads to inflation, a cost is imposed on everyone who uses cash for transactions. Inflation is therefore unpopular, and recent history suggests that it may be becoming increasingly unpopular politically in Latin America. Purchasers of fiat government debt therefore know that if the assets they are purchasing are to be subject to a future inflationary tax, it will be at a substantial political cost. Once an economy is dollarized, on the other hand, the same relief of fiscal pressure, achieved through suspension of dollar payments on interest-bearing liabilities, has no direct consequences for anyone except holders of the debt. Especially if these debtholders are in substantial part foreigners, the short-term political costs of causing losses to this group of people may be small or even negative.

4. SOME ESTIMATES OF THE AMOUNT OF FISCAL RISK BORNE BY HOLDERS OF U.S. GOVERNMENT

In deciding how valuable the ability to shift fiscal risk to debtholders might be, it is worthwhile to calculate the size of historical unanticipated fluctuations in the real return on government debt. To this point, I have completed such calculations only for the United States, and there only for 1950–89.[7] The unanticipated return is calculated as (for year t)

7. For these calculations I have been greatly aided by the cooperation of George Hall and Tom Sargent, whose paper (1997) contains closely related calculations, and by the research assistance of Tao Wu. Hall and Sargent calculate the true interest cost of the debt. What is done here is to (approximately) isolate the unanticipated component of this interest cost, using the Hall and Sargent calculations as a base.

$$B(t) - B(t-1) - r(t-1)B(t-1) - \tau(t) - B(t-1)(\pi(t) - \hat{\pi}(t)) , \qquad (19)$$

where

$B(t)$ = Market value of outstanding debt at end of year t ;
$r(t)$ = One-year government bond interest rate at end of year t ;
$\tau(t)$ = Primary deficit during year t ;
$\pi(t)$ = inflation during year t ;
$\hat{\pi}(t)$ = anticipated inflation during year t, based on monthly; data through the end of the preceding year .

The expected inflation rate is computed from a monthly Bayesian VAR using the six-month commercial paper rate, the consumer price index, and industrial production. The primary deficit is computed, as it is by Hall and Sargent, by aggregating changes in outstanding government liabilities with given maturity dates.

While these calculations give a reasonable approximation to the unanticipated real return to government debt, not all of this unanticipated return is generated by shifts in fiscal and monetary policy. There could be unanticipated shifts in real interest rates generated by private sector disturbances, and these would change the value of outstanding debt. Also, these calculations treat all deviations of nominal returns over a year from what would be predicted by the beginning-of-year one-year rate as unanticipated. For holders of debt with maturity much less than a year, much of these "unanticipated" returns are not actually unanticipated at the time (within the year) of purchase of the securities, even though they were unanticipated at the start of the year. And finally, the returns are unanticipated only to the extent that the expectational theory of the term structure is valid. If there are systematic patterns of term risk premia, the unanticipated returns as calculated here could in fact have a predictable component.

Figure 1 shows the results. This period had no disturbances of the magnitude of World War II or the Great Depression, but it does include the two oil crises of the 70s. We see that between 1973 and 1980 all but two years produced negative unanticipated returns, as would be expected of an optimizing government offsetting the negative fiscal shocks of the oil crises. The 80s then are dominated by positive unanticipated returns, as inflation is brought under control again. The amounts involved are not large relative to the Federal deficit—on the order of $40 billion as the maximum annual capital loss in the 70s. But they are not negligible, either. And we should bear in mind that the capacity to absorb fiscal risk this way is likely to be most valuable in the extreme circumstances of war or natural or economic disaster, which did not occur in the United States during this period.

It is interesting to note that the increasing amplitude of fluctuations in the total return is due in large part to the increasing scale of the real value of the outstanding debt. When we view them as percentages, as in Figure 2, we see that the growth in fluctuations is not as strong.

In thinking about the implications of a calculation like this for the policy question of whether to issue only indexed or dollar debt, it is important to assess whether the

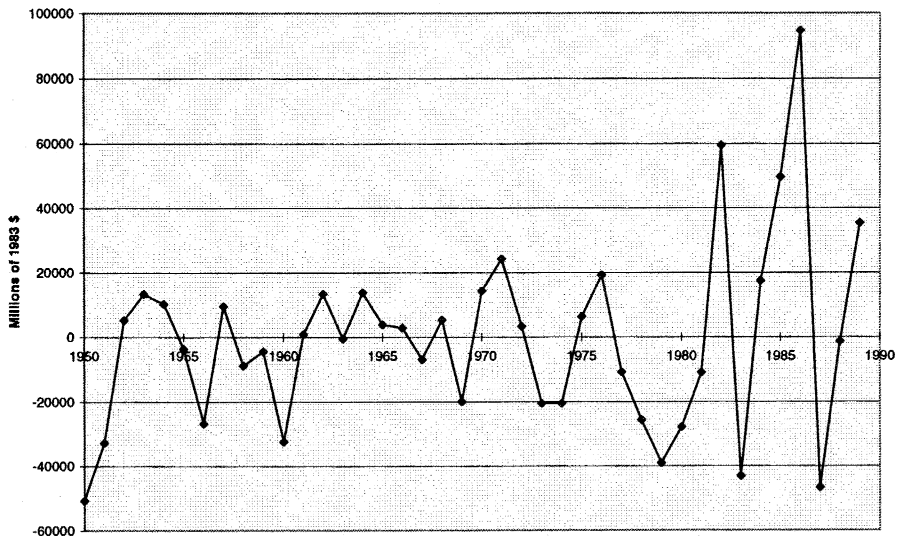

FIG. 1. Total Real Unanticipated Return on U.S. Government Debt

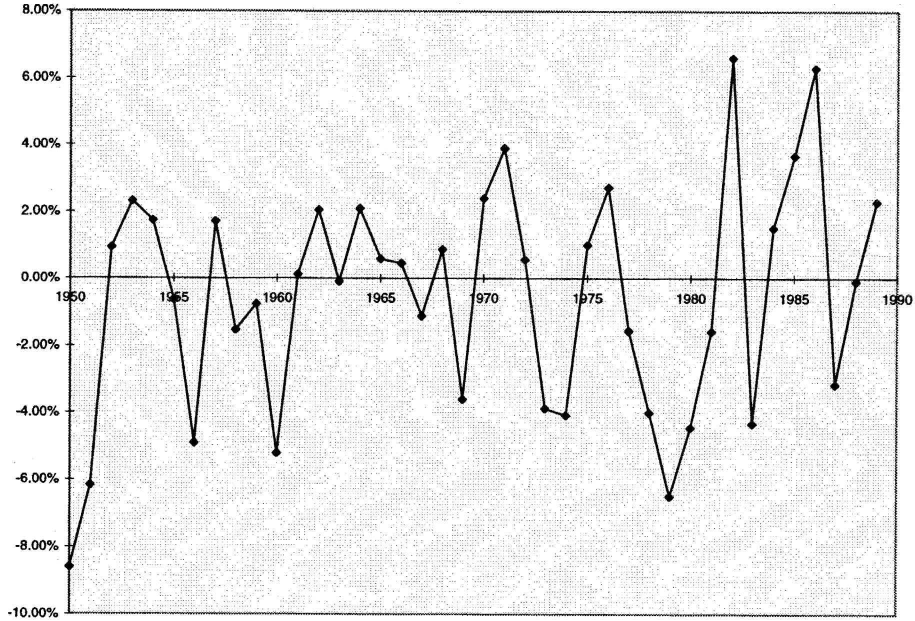

FIG. 2. Percentage Unanticipated Real Return on U.S. Debt

observed fluctuations have been due to erratic changes in monetary and fiscal policy that could have been easily and efficiently eliminated, or whether they are instead due to stickiness of tax rates and expenditures in the face of real shocks. In the latter case, abandoning fiat debt would have implied more volatility in tax rates or expenditures, which is likely to have been inefficient. The pattern of negative unexpected returns in the 70s following the oil shocks suggests that at least some of the fluctuations are not erratic, but further research is needed to check this more carefully.

Some explorations (not reported in detail) of how these unanticipated returns behave in a small VAR with interest rates, consumer prices, commodity prices, and output show that there is little predictability of the unanticipated returns in the sample. The unanticipated returns are negatively correlated both with interest rate innovations and with price level innovations—-both commodity prices and consumer prices. If positive "unanticipated" gains on debt with less-than-one-year maturities due to surprise rises in short rates were a major portion of the calculated unanticipated return, we would expect the correlation of interest rate innovations with the unanticipated returns to be weak or positive. That they are instead negative and fairly strong accords with Hall and Sargent's finding that by the end of the sample the average term of the outstanding U.S. debt was seven years, so that capital losses on long debt when interest rates rise is the dominant effect.

5. THE LENDER-OF-LAST-RESORT FUNCTION

If dollarization in Mexico were to entail takeover of Mexican banks by U.S. banks, with the Mexican banks then behaving as branches, the stability of the Mexican banking system would the same as the stability of the U.S. system, and the U.S. Federal Reserve would act as lender of last resort to the banks. But it is more likely, at least at first, that Mexico would maintain its own banking system, with institutions specializing in lending within Mexico and regulated by the Mexican government. It is sometimes argued that dollarization would in this case increase financial stability in Mexico, by reducing the chance for currency mismatch between assets and liabilities and thereby the chance of exchange rate–induced financial distress.

Any system in which loans are made denominated in some currency, to finance real investments, is subject to financial risk, however. Various sorts of developments—for example, changes in oil prices, news of potential political instability—can change the equilibrium real exchange rate between Mexico and the United States and thereby cause widespread financial distress. Financial institutions and firms, unless badly regulated, have incentives to minimize the risk of such distress, and their opportunities for doing so depend on the menu of assets and liabilities available to them. Eliminating the possibility of easily written and verified peso loan contracts would seem on its face to restrict the possibilities for hedging such real exchange rate risk.

At a time of financial crisis, a government can borrow to provide liquidity to firms that seem to be subject to a run. A government that is capable of issuing fiat debt can always borrow, so long as its discounted expected future surpluses are positive. A government that is capable only of dollar borrowing will not be able to borrow unless it can *increase* the discounted present value of its primary surpluses above its current level.[8] To the extent that runs on financial institutions are deterred by the existence of government backing for liquidity, therefore, the likelihood of widespread runs may rise with dollarization, rather than decline. In effect, speculation against the prospect of some form of Mexican government bankruptcy would be a source of much the same kind of instability that we see with fixed exchange rate regimes.

Proponents of dollarization sometimes argue that the lender-of-last-resort function can be maintained by an agreement with the United States to provide a kind of line of credit for use in crisis, or by accumulation of a large reserve fund. Reliance on crisis-time credit from the United States seems unwise. The United States is a country that has for years been in arrears on its legal obligations to international organizations, that recently went through a period when formal default on U.S. Treasury obligations was seriously discussed as an outcome of ideological political wrangling, and in which the credit the United States supplied to Mexico during its last major exchange crisis remains politically unpopular in many quarters, despite its having cost the United States nothing. A treaty to provide lender-of-last-resort facilities to Mexico seems unlikely to be approved, and if it were, it is not clear how well it could be relied upon.

A large reserve fund of dollar-denominated assets would provide a source of stability, but this is true whether or not the economy is dollarized, and accumulation of the fund would be costly. It would amount to substantially reducing total liabilities of the government, possibly even to making it, like Hong Kong, a net creditor. While this is feasible, analysis of optimal public finance, as we have already discussed, suggests that increasing taxes to make deliberate changes in the amount of outstanding debt is suboptimal.

6. HYBRID ALTERNATIVES TO DOLLARIZATION

A currency board has most of the same disadvantages as dollarization. It has the advantage that the currency board earns interest on the dollar securities that back domestic high-powered money, whereas a currency board that dollarizes loses this revenue. However, it is argued that a treaty arrangement could be worked out to limit this loss, and this seems possible. It also has the advantage that a distinction between the domestic currency accounting unit and the dollar is preserved, so that when in a time of stress it is necessary to suspend convertibility, the mechanics of doing so are clearer than with dollar-denominated debt. Of course, this advantage is the other side of an apparent disadvantage—abandonment of the commitment to a fixed exchange rate remains easily conceivable. But as we have already argued, the possibility of

8. It can also borrow by selectively defaulting on existing debt, suspending convertibility, or committing to subordinate existing debt to newly issued debt. These are all forms of default, or of abandoning the commitment to pure dollar debt, however.

suspension of convertibility would remain under dollarization, and might even grow more prominent in the minds of investors.

A policy option that seems not to have received much discussion would be dollarization of the currency, while retaining peso denomination for interest-bearing debt. It may be that this has received little discussion because conventional approaches to modeling the price level do not apply to a model with only interest-bearing debt. However, there is in fact no problem with determinacy of the peso price level in this framework. Dollarization of currency, and thus of prices for ordinary transactions, would tend to stabilize the economy's sticky prices, possibly providing important benefits. Preservation of peso-denominated interest-bearing debt would preserve much of the fiscal shock absorber and of the strength of the lender-of-last-resort function. There would be some loss in these respects because the government would be giving up the part of the base for the surprise inflation tax made up of real balances. But this part of the inflation tax, not considered formally in this paper's models, can be distorting, even when it is unanticipated. So long as government debt were peso denominated, it seems likely that at least some private contracts would still use pesos as well, preserving diversity in the menu of standard loan contracts.

7. CONCLUSION

There is a clear case for dollarization as one component of a sweeping increase in the integration of the Mexican with the U.S. economy. We could imagine the banking systems of the two countries becoming integrated, with single institutions operating across the two countries and a single, or at least tightly integrated, regulatory authority. We could imagine integration of public finances, along the lines of the integration of state and federal government finances in the United States. It is completely accepted among U.S. states that disaster relief is a common fiscal responsibility across the whole country, and regionally concentrated economic distress also generates compensatory fiscal flows at the federal level. It is out of the question that an individual state could have extraordinary, state-specific, defense spending for war, international or civil. For these reasons, though U.S. states have gone bankrupt, it has not happened for a long time.

But neither the U.S. nor the Mexican public seems to want integration on this scale, and probably rightly so. Dollarization in the context of separate and separately regulated banking systems and weak or absent fiscal integration carries clear costs and risks. To me at least, the claimed benefits for this kind of dollarization seem much less clear than the costs and risks.

APPENDIX A. FISCAL INSURANCE VIA THE PRICE LEVEL IN A MORE GENERAL MODEL

The simple modeling framework introduced by Barro gives the conclusion that a government constrained to issue only real debt should make the tax rate a martingale, with the current rate always set sufficient to back the current real value of the debt if the tax rate remained constant. The tax rate under these conditions is a forward-looking variable, in other words, and adjusts to every disturbance to the intertemporal government budget constraint. We have seen that in this framework a government that issues instead fiat debt, that promises to pay only government paper, can achieve higher welfare by setting the tax rate equal to a constant, letting unanticipated inflation absorb all disturbances to the intertemporal government budget constraint.

The constancy of the optimal tax rate emerges only because of the simplifying assumptions that agents are not risk averse or that for some other reason government purchases do not affect the marginal utility of consumption. But the conclusions from the simple Barro framework are not fundamentally misleading. In a more general setup the constancy of the optimal tax rate no longer holds, but it is still true that a government that issues real debt must adjust taxes to cover expected future primary surpluses, while a government that issues fiat debt optimally sets taxes in a way that is totally unresponsive to changes in expected future primary surpluses, so that all surprises in the intertemporal government budget constraint are absorbed in surprise inflation. Here we display a more general setup that shows how these conclusions emerge.

Representative agents solve

$$\max_{\{C_t, L_t, b_t\}_0^\infty} E\sum_{t=0}^{\infty} \beta^t U(C_t, L_t) \tag{20}$$

s.t.

$$C_t + b_t = (1-\tau_t)w_t L_t + \frac{R_{t-1}}{\pi_t} b_{t-1} + x_t \ , \tag{21}$$

where C is consumption, L is labor time, τ is the tax rate on labor income, R is the gross nominal interest rate, b is real government debt, $\pi_t = P_{t+1}/P_t$ is the gross inflation rate, and x_t is dividends from the firm, which is owned by the representative agent.

The representative firm solves a static dividend-maximization problem, hiring workers in a competitive labor market. That is, it solves

$$\max_{L_t} x_t \tag{22}$$

s.t.

$$x_t = f(L_t) - w_t L_t \ . \tag{23}$$

The government has the same objective function (20) as the agent, but takes as constraints

$$\mu: \qquad b_t + \tau_t w_t L_t = \frac{R_{t-1}}{\pi_t} b_{t-1} + G_t \tag{24}$$

$$\lambda: \qquad C_t + G_t = f(L_t) \tag{25}$$

and the first-order conditions characterizing maximizing behavior of the agents and firms. The Greek letters to the left of these equations are the symbols that will be used for the Lagrange multipliers in these equations in the government's first-order conditions. The social resource constraint (25) follows from the government budget constraint (24) and the constraints facing firms and agents, so that the two equations (24)–(25) capture all the technological constraints on the government.

The private first-order conditions, solved to eliminate w and private Lagrange multipliers from the system, are

$$\nu: \qquad D_2 U_t = D_1 U_t (1 - \tau_t) f_t' \tag{26}$$

$$\psi: \qquad D_1 U_t = \beta R_t E_t \left[\frac{D_1 U_{t+1}}{\pi_{t+1}} \right]. \tag{27}$$

The government's first-order conditions then are

$$\partial C: \qquad D_1 U_t = \nu_t (D_{21} U_t - D_{11} U_t (1 - \tau_t) f_t') + D_{11} U_t \left(\psi_t - R_{t-1} \frac{\psi_{t-1}}{\pi_t} \right) + \lambda_t \tag{28}$$

$$\partial L: \qquad D_2 U_t = \nu_t (D_{22} U_t - D_1 2 U_t (1 - \tau_t) f_t' + \tau_t D_1 U_t f_t'')$$

$$+ D_{12} U_t \left(\psi_t - R_{t-1} \frac{\psi_{t-1}}{\pi_t} \right) - \mu_t (f_t'' L_t + f_t') - \lambda_t f_t' \tag{29}$$

$$\partial b: \qquad \mu_t = \beta R_t E_t \left[\frac{\mu_{t+1}}{\pi_{t+1}} \right] \tag{30}$$

$$\partial \pi: \qquad R_{t-1} \frac{D_1 U_t}{\pi_t^2} \psi_{t-1} = \mu_t \frac{R_{t-1} b_{t-1}}{\pi_t^2} \tag{31}$$

$$\partial \tau: \qquad D_1 U_t \nu_t f_t' = \mu_t f_t' L_t \,. \tag{32}$$

Note that we omit the ∂R FOC because it is redundant. In this flex-price model without money, R only determines the anticipated inflation rate, which has no effect on welfare.

From the $\partial\pi$ and $\partial\tau$ FOC's (31) and (32) we can derive

$$\frac{\mu_t}{D_1 U_t} = \frac{\psi_{t-1}}{b_{t-1}} = \frac{\nu_t}{L_t}. \tag{33}$$

These equations, of course, hold only when $b_{t-1} > 0$, $\pi_t < \infty$, and $R_{t-1} > 0$. In other words, they hold when there is carryover of real debt from last period and the debt is not repudiated this period. They imply that both $\mu_t/D_1 U_t$ and ν_t/L_t are known at $t-1$, since they are equal to a random variable dated $t-1$.

Now if we divide the ∂b FOC by $D_1 U_t$ and apply our result that $\mu_t/D_1 U_t$ is known one period in advance, we get

$$\frac{\mu_t}{D_1 U_t} = \beta R_t E_t\left[\frac{\mu_{t+1}}{D_1 U_{t+1}} \frac{D_1 U_{t+1}}{D_1 U_t \pi_{t+1}}\right] = \frac{\mu_{t+1}}{D_1 U_{t+1}} \beta R_t E_t\left[\frac{D_1 U_{t+1}}{D_1 U_t \pi_{t+1}}\right] = \frac{\mu_{t+1}}{D_1 U_{t+1}}, \tag{34}$$

where at the last step we have used (27). From this we conclude that $\mu_t/D_1 U_t$ is constant across t, and from (33) that ψ_t/b_t and ν_t/L_t are also constant.

Observe now that

$$\psi_t - R_{t-1}\frac{\psi_{t-1}}{\pi_t} \propto b_t - \frac{R_{t-1}}{\pi_t} b_{t-1} = G_t - \tau_t f_t' L_t\,. \tag{35}$$

The proportionality follows from our observation that ψ_t/b_t is constant, and the equality follows from the government budget constraint (24).

Consider the equation system formed by (28), (29), (25), and (26). If in this system we substitute a constant times $D_1 U_t$ for every occurrence of μ_t, a constant times L_t for every occurrence of ν_t, and the right-hand side of (35) for the occurrences of that equation's left-hand side in (28) and (29), we will have a system of four equations in the unknowns C_t, L_t, τ_t, and λ_t, with G_t as forcing variable. The equations do not contain π or b or expectation terms or leads or lags. They can be solved each period to determine all four of these variables as functions of G. The stochastic process followed by G has no influence on the form of this dependence, nor does the level of real debt b. The forward-looking part of the model does have an influence on the equation, but only via determination of the constants of proportionality relating μ_t and ν_t to $D_1 U_t$ and L.

Of course, shocks to G and the level of b are central to the government's intertemporal budget balance, and shocks to expected future G matter to the budget balance even if they do change expected future G without changing current G. But in this model, optimal policy does not use τ to balance the budget. The budget is balanced instead via unanticipated fluctuations in π_t.

LITERATURE CITED

Barro, R. J. "On the Determination of the Public Debt." *Journal of Political Economy* 87:5 Pt. 1 (1979), 940–71.

Bizer, D. S., and K. L. Judd. "Taxation and Uncertainty." *American Economic Review* 79:2 (1989), 331–36.

Chari, V., L. J. Christiano, and P. J. Kehoe. "Optimal Fiscal Policy in a Business Cycle Model." *Journal of Political Economy* 102:4 (1994), 617–52.

Dickson, P. *The Financial Revolution in England: A Study in the Development of Public Credit, 1688–1756*. London: MacMillan-St. Martin's Press, 1967.

Friedman, M. "A Monetary and Fiscal Framework for Economic Stability." *American Economic Review* 38:3 (1948), 245–64.

Hall, G. J., and T. J. Sargent. "Accounting for the Federal Government's Cost of Funds." *American Economic Review* (1997), 18–28.

Lucas, Robert E., and N. Stokey. "Optimal Fiscal and Monetary Policy in an Economy without Capital." *Journal of Monetary Economics* 12:1 (1983), 55–93.

Marcet, A., T. J. Sargent, and J. Seppälä. "Optimal Taxation without State-Contingent Debt." Discussion paper, Hoover Institution, Stanford University. http://www.stanford.edu/~sargent/.

Sargent, T. J., and N. Wallace. "Some Unpleasant Monetarist Arithmetic." *Quarterly Review of the Minneapolis Federal Reserve Bank* (Fall 1981), 1–17.

Woodford, M. "Public Debt and the Price Level." Discussion paper, Princeton University, 1998.