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ABSTRACT

This paper extends and evaluates previous work on the positive theory of inflation. We examine the behavior of governments concerned solely with minimizing the deadweight loss from raising revenue through inflation and tax finance. We show that both governments that can commit to future policy actions, as well as those that cannot precommit, will choose a positive contemporaneous association between inflation and the level of tax burdens. We examine the empirical validity of this prediction using data from Britain, France, Germany, Japan, and the United States. Inflation and tax rates are as likely to be negatively as positively correlated, so the results cast doubt on the empirical relevance of simple models in which governments with time-invariant tastes choose monetary policy to equate the marginal deadweight burdens of inflation and taxes.

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A government can satisfy its budget constraint either by printing money or by levying taxes. Each method of finance has efficiency costs. Higher inflation rates may adversely affect the economy's transaction mechanism and lead to inefficiencies in contracting. Higher taxes may distort labor supply, saving, and investment decisions. Numerous authors[1] have examined the optimal inflation rate in the presence of tax finance, describing the behavior of governments concerned only with minimizing the deadweight burden of raising a given revenue. Whether these prescriptions are consistent with actual government behavior is an unresolved and relatively unstudied issue. Mankiw (1987) reports a striking positive correlation between tax burdens and inflation rates in the postwar United States, a finding consistent with the predictions of these optimizing government models.

This paper extends and evaluates previous work on the interaction between taxes and inflation. First, we explore whether relaxing the assumption that governments can commit to future policies affects the predicted relationship between taxes and inflation. Second, we present new empirical evidence on the correlation between inflation and tax burdens in a sample of OECD countries. The findings suggest that optimizing models with time-invariant tastes cannot explain the observed correlations in most countries. This means that other considerations must be important determinants of inflation rates. One possibility is that governments choose inflation and tax levels based on stabilization objectives. It is also possible that the government's dislike for inflation varies over time for political or other reasons. We discuss these issues in the conclusion.

The first part of the paper examines how the government's ability to commit affects its inflation and tax choices. Calvo (1978) shows that the optimal

[1]Previous studies of the choice between inflation and taxation include Phelps (1973), Calvo (1978), Drazen (1979), Helpman and Sadka (1979), Kimbrough (1986), Lucas (1986), and Romer (1987).

inflationary policy when the government can commit to future inflation rates is different from that when it cannot. In his model, unanticipated inflation is more attractive ex post than anticipated inflation. Unanticipated inflation is at least in part a "taking," with the government expropriating consumers' wealth by reducing the value of real money balances. Anticipated inflation, on the other hand, also distorts behavior by leading consumers to economize on real money balances.

Since models with commitment lead to the first best level of inflation, optimizing governments will try to bind themselves when possible. The commitment case appears implausible on a priori grounds, however. We know of no examples in which monetary policy is regulated by law, much less by an irrevocable monetary constitution. Commitment, if it exists, must therefore be enforced by reputational considerations. Existing models in this spirit[2] rely on the ability of consumers to change their behavior if the government deviates from the reputational equilibrium, a discipline that will only operate if households can identify government deviations from equilibrium strategies. Such identification may however be extremely difficult in practice if the reputational equilibrium involves the kind of fluctuations in monetary policy that we regularly observe.

Models without commitment have a separate difficulty. Without commitment, the government at each point in time may view increases in the price level as a lump sum tax. Inflation is therefore a least-cost instrument for raising revenue, so other taxes would not be used. We believe models with this characteristic take an overly simplistic view of the government's preferences, and we follow Bohn (1987) in assuming that the government perceives even unanticipated

[2]Rogoff (1987) surveys the recent literature on reputational models in macroeconomics.

inflation as costly.

Models with and without commitment imply a positive relationship between the inflation rate and tax rates. In both cases, the marginal social cost of raising additional revenue with the inflation tax is an increasing function of the inflation rate. The marginal deadweight burden of tax finance also rises with the tax rate. An optimizing government which equates the marginal social costs of obtaining revenue from inflation and taxation will therefore raise both the inflation rate and tax rates in response to higher revenue demands.

Although it has no bearing on the prediction of a positive correlation between inflation and tax rates, resolving whether governments can precommit to monetary policy is of central importance for evaluating the welfare effects of inflation. On dimensions other than the contemporaneous correlation between tax rates and inflation, the possibility of committment affects the predictions of optimizing models. We focus on one such difference. Unanticipated inflation reduces the value of outstanding nominal government debt. A government that cannot restrict its future actions will therefore find it more attractive to inflate when the stock of outstanding nominal debt is large. This temptation does not arise for a government that has committed to future policies, so the correlation between the debt stock and inflation may prove useful in distinguishing models with and without commitment. Unfortunately we also show that if the government can tax outstanding government debt without resorting to the inflation tax, then the correlation of inflation with various measures of nominal liabilities does not depend on the possibility of commitment.

Readers who pay serious attention to the actual pronouncements of policy makers may believe that revenue considerations have no place in a positive theory of monetary policy. Central bankers rarely, if ever, mention the seigniorage that results from alternative monetary policies. While we view this as evidence against the class of optimizing models studied below, and this skepticism is confirmed by our empirical findings, it might nevertheless be possible to reconcile the actual speeches of policy-makers with the optimizing government models. When government spending is high governments tend to raise taxes and also to increase debt finance. Central bankers who react by purchasing government bonds with newly minted money, thereby raising seigniorage revenues, may rationalize this behavior with fear of high interest rates generated by large government debt stocks.[3] Their behavior may however be consistent with the predictions of positive models of government based on deadweight burden minimization.

Our analysis of inflation and taxation is divided into two parts. The first part, which consists of sections I through III, develops the theory while the second part presents the empirical tests. Section I considers the classic case of inflation and tax choice when the government is able to commit. Section II assumes instead that committment is impossible and that the government is unable to tax government bonds directly. The third section introduces bond taxation in a model without commitment and shows its implications are similar to those of the commitment case. Section IV studies the empirical relationship between taxes and inflation in the U.S., U.K., Japan, West Germany and France. We show that a positive association between inflation and the level of tax burdens obtains only in the U.S. and Japanese data; a negative relationship emerges in the other three countries. We therefore conclude that simple positive models of government behavior such as those analyzed here are incapable of explaining monetary and

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[3]Our analysis only applies if the central government and the central bank are actually cooperating. Alesina and Tabellini (1987) present a model in which these arms of government behave noncooperatively.

fiscal policy.

I. Inflation and Taxation with Precommittment

This section models an optimizing government's choice of inflation and tax rates when committment is possible and when these policies are chosen only with regard to their revenue effects. The government's objective is to minimize the total cost of raising revenue, given by

$$(1) \qquad W(t) = E_t \sum_{j=0}^{\infty} \rho^j \, k[h(\theta_{t+j}) - v(\frac{P_{t+j-1}}{P_{t+j}})].$$

The parameter ρ is a discount factor, θ_t represents the ratio of taxes to income in period t, and P_t is the price level at t. We assume that k( ) is a monotone increasing function while h( ), the tax distortion, is increasing and convex.

The increasing and concave function v( ) gives the benefits from deflation so that the costs of inflation are -v( ). This function is not just intended to capture the distortionary effects of inflation on the demand for money, as in the work of Drazen (1979), Phelps (1973), Kimbrough (1986) and Lucas (1986). Instead, it reflects the many possible consequences of inflation enumerated by Fischer and Modigliani (1978).[4] In particular, the government might be concerned with the distributional consequences of inflation as well as with the difficulties inflation introduces in a world with pervasive nominal contracts. The specification of inflation's cost in (1) is therefore more general than that which would emerge from explicit analysis of a representative consumer economy.

The government's budget constraint is described by the evolution of real

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[4]Because we consider relatively many effects of inflation, there is no presumption, as in the more narrow models of Kimbrough (1986) or Faig (1987), that the optimal tax rate on money is given by the Friedman rule. This presumption actually disappears as soon as money services are not viewed as perfect substitutes for other arguments in the utility function (see Romer (1987)).

government debt, b_t:

(2) $$b_t = [b_{t-1}(1+i_{t-1}) + m_{t-1}] \frac{P_{t-1}}{P_t} + g_t - \theta_t y_t - m_t$$

where m_t, g_t, and y_t denote real money balances, real government spending, and real income respectively. The nominal interest rate is i_t. We treat government spending as exogenous, but real income depends on the tax rate. Real money balances and the nominal interest rate at t depend on anticipated inflation between t and t+1. Real money balances could also depend on income and taxes without altering our substantive conclusions, although for simplicity we ignore these effects through most of our analysis.

Commitment can be modelled by allowing the government, which maximizes (1) subject to (2) at time t, to pick a contingency plan for tax rates and prices at t+1. This plan, which allows taxes and inflation to depend on the realizations of all t+1 variables including g_{t+1} and y_{t+1}, is chosen before households choose their money holdings. Thus real money demand and interest rates are determined after the government chooses the next period's taxes and inflation. Allowing the government to choose a contingency path for prices is only an expository device. It is equivalent to having the government pick the contingent path for the money supply in all future periods.

When the government at t chooses taxes and inflation for period t+1, it must take as given the end-of-period stock of government liabilities, $b_t + m_t$. This is the only state variable for the government's problem: tax and inflation choices beyond period t are affected by the past only through $b_t + m_t$. The division of these liabilities between money and bonds, however, depends on the government's decisions in period t. Because the stock of liabilities is the only state variable for the government's problem, it is the sole channel through which policy choices in period t affect future values of money demand, prices, and output. Holding constant the end-of-period stock of liabilities $(b_t + m_t)$, altering inflation between periods t and t+1 and taxes in period t+1 only affect interest rates and real money demand in period t and output in period t+1.[5] These shifts leave the path of government revenue unchanged, so at the optimum they cannot affect the government's welfare. Small revenue-neutral changes in the tax-inflation mix therefore do not affect the total cost of raising revenue.

This indifference can be formalized as follows. From equation (2) we can find the derivative change in the tax rate θ_{t+1} that raises enough revenue to offset a change in (P_t/P_{t+1}) holding constant the level of government liabilities at the end of period t+1. This is the period t budget constraint facing a government in period t that can commit to actions for t+1:

$$(3)\quad y_{t+1}(1+\epsilon_\theta)d\theta_{t+1} = \{ \frac{d[(b_t+m_t)(1+i_t)(P_t/P_{t+1})]}{d(P_t/P_{t+1})} - \frac{d[i_t m_t(P_t/P_{t+1})]}{d(P_t/P_{t+1})} \} d(\frac{P_t}{P_{t+1}})$$

where ϵ_θ is the elasticity of income with respect to taxes. If the real return $(1+i_t)P_t/P_{t+1}$ equals a constant (R), then since $b_t + m_t$ is taken as given by previous government actions, the first term on the right hand side is zero. The constancy of the real return implies that the expression being differentiated in the second term can be rewritten $[(P_t/P_{t+1})-R]m_t$, so (3) becomes

$$(4)\quad y_{t+1}(1+\epsilon_\theta)d\theta_{t+1} = [- m_t + (R - P_t/P_{t+1}) \frac{dm_t}{d(P_t/P_{t+1})}] d(\frac{P_t}{P_{t+1}})$$

The second term in brackets can be transformed into an expression depending on

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[5]Inflation in period t+1 is defined as the change in the price level between t and t+1.

the elasticity of money demand with respect to the nominal interest rate, m_i:

$$(4')\qquad y_{t+1}(1+\epsilon_\theta)d\theta_{t+1} = - m_t(1+m_i)d(P_t/P_{t+1}).$$

The government faces this constraint in minimizing the social losses defined by equation (1). The first order condition for this problem is:

$$(5)\qquad \frac{P_t}{P_{t+1}} = \phi\left(\frac{h'(\theta_{t+1})m_t(1+m_i)}{y_{t+1}(1+\epsilon_\theta)}\right)$$

where $\phi = (-v')^{-1}$, $\phi' < 0$. This expression equates the excess burden per unit revenue for each revenue source.

Equation (5) links the equilibrium level of inflation to the tax rate for given values of income and real money balances. It states that positive shocks to government spending that raise taxes and their associated excess burden should be accompanied by increases in inflation that raise the marginal excess burden from seigniorage. It also states that inflation between t and t+1 should be an increasing function of m_t/y_{t+1}. When this ratio is large, the revenue from a given inflation rate is high since, with commitment, revenue from inflation is obtained at t+1 as people replenish the money that has been depleted by inflation. The more money they carry over, the larger these replenishments must be and the lower the relative cost of inflation.[6]

II. Inflation and Tax Policy without Committment or Bond Taxes

We now consider the government's choice of inflation and tax rates when committment is impossible. This implies that the government in period t can only

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[6]It might be thought that this effect is offset by the fact that inflation is more costly when money holdings are higher. While this might be true when the only costs of inflation are the distortions in money holdings it is unlikely to be true for other costs of inflation.

choose the tax rate and the price level at t. Although it can cause unexpected inflation, if there were no exogenous uncertainty the government's problem at t would be known at t-1 so there would be no unexpected inflation in equilibrium. The equilibrium inflation rate is just that rate at which the government will not choose to induce any unexpected inflation.[7]

We begin by maintaining comparability with the previous section so that the objective function remains (1) while the budget constraint is (2). It is important to stress that without commitment inflation will only be finite if it remains costly so that the function v( ) does not become degenerate. Without commitment, some might argue that the costs of inflation are much lower. One of the costs of expected inflation, the increase in transaction costs due to economizing on money holdings at t-1, is immaterial for governments who cannot precommit since the government that picks the price level at t cannot alter the choice of money holdings at t-1. Many other costs nevertheless remain even when inflation is unanticipated. These costs can be of two kinds. First, the government may be averse to redistributing wealth between debtors and creditors. Reestablishing the original distribution of wealth may require the use of distortionary taxes and subsidies. Second, even unanticipated inflation may distort subsequent behavior by households and firms in ways the government finds undesirable. For example, workers may press for premature renegotiation of their contracts, firms may incur additional costs of changing prices and individuals may be forced to engage in additional financial transactions to restore their liquidity. Indeed, insofar the costs of inflation are due to its deleterious effects on nominal contracts, unexpected inflation may be more costly than

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[7]The structure of this model resembles that of Barro and Gordon (1983), although they do not consider the revenue created by inflation.

anticipated inflation because it has not been reflected in contracts.

In the absence of commitment, the only state variable when taxes and the price level at t are chosen is the total beginning of period level of liabilities, $\ell_t = b_{t-1}(1+i_{t-1}) + m_{t-1}$. The government at t then chooses both the tax rate and nominal money balances at t. These choices determine interest rates and the price level. As in the previous section the analysis is unchanged if the government is thought of as picking the price level with interest rates and money demand responding to the choices of θ_t and P_t. Of course, i_t and m_t depend on expectations at t of government actions at t+1. Since these actions in turn depend on $(1+i_t)b_t$ and m_t, i_t and m_t can only depend on b_t. Any tax-inflation switch that does not change b_t therefore will not affect future real money balances or nominal interest rates.

At the policy optimum, the government must be indifferent to small perturbations in the policy mix which leave b_t unchanged. Without commitment, the tradeoff between inflation and taxes that do not alter beginning of period government liabilities is:

(6) $$y_t(1+\epsilon_\theta)d\theta_t = -\ell_t\, d(P_{t-1}/P_t).$$

This differs from the tradeoff in the commitment case because it excludes the response of money demand and nominal interest rates to expected inflation. Maximizing (1) subject to (6) gives a first order condition for the no commitment case:

(7) $$\frac{P_{t-1}}{P_t} = \phi\left(\frac{h'(\theta_t)[m_{t-1} + b_{t-1}(1+i_{t-1})]}{y_t(1+\epsilon_\theta)}\right).$$

Equation (7) indicates that inflation is a positive function of both taxes and total government liabilities as a share of GNP. The positive link to taxes results because when high deadweight burdens are being imposed with the tax instrument, higher inflation taxes will also be appropriate. The positive effect of outstanding liabilities obtains because governments with large nominal obligations will find inflation more attractive than those with less heavy debt burdens, since inflation erodes the value of these obligations.[8]

The inflationary erosion of government liabilities is totally anticipated, at least in models without stochastic disturbances. It is nevertheless possible for governments to accumulate stocks of such obligations, provided they are willing to pay sufficiently high nominal yields. It is even possible for inflation to raise no revenue: the revenue raised <u>ex post</u> from reducing the value of bonds and money may be more than offset <u>ex ante</u> by increases in nominal interest rates and reductions in the demand for real money balances.

Since we are analyzing the time inconsistent solution to the government's optimization problem, inflation is generally suboptimal. For considering whether government policy is in some ex ante sense optimal, it is important to distinguish empirically between the commitment and the no commitment solutions. This is possible since the first order conditions for optimal inflation choice in economies with and without credible committment are different. While with commitment the stock of money balances influences inflation choices, the total stock of nominal government obligations (including nominal bonds) plays a similar role in the absence of commitment.

III. Inflation and Tax Policy: No Committment, with Taxes on Bonds

The previous section provides one channel for distinguishing the commitment

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[8]This raises the question of why governments choose to issue nominal liabilities. Bohn (1987) provides one possible explanation for this puzzle.

and no-commitment cases. This section shows that this approach is sensitive to the menu of taxes available to the government. The level of nominal bonds affects inflation in the previous section's model because inflation is the only way to tax these bonds. We now consider a model in which the government can also levy direct taxes on government bonds, and show that it is much more difficult to distinguish between scenarios with and without commitment.

If the government can tax government bonds at rate τ_t, real debt evolves as:

$$(8) \qquad b_t = [b_{t-1}(1+i_{t-1})z_t + m_{t-1}]\frac{P_{t-1}}{P_t} + g_t - \theta_t y_t - m_t.$$

where $z_t = 1 - \tau_t$. The existence of τ_t does not affect the results in the commitment case, since if a modification of the bond tax is known in advance, nominal interest rates will adjust to keep after-tax returns constant.

Without commitment, however, a government would not use distortionary taxes if increasing direct taxes on government bonds were possible and if such taxes were perceived to be costless. To explain the existence of other taxes and inflation, direct bond expropriations must therefore be perceived as costly.[9] We thus assume that the government now maximizes:

$$(9) \quad W(t) = E_t \sum_{j=0}^{\infty} \rho^j \; k[h(\theta_{t+j}) - v(\frac{P_{t+j-1}}{P_{t+j}}) - f(\frac{b_{t+j-1}(1+i_{t+j-1})z_{t+j}P_{t+j-1}}{P_{t+j}})]$$

where f( ), which is increasing and concave, represents the government's utility from repaying its debt. In this no-commitment scenario, the state variables that affect the government's choices in period t are the level of real debt obligations, $b_{t-1}(1+i_{t-1})$, and the level of past money balances, m_{t-1}.

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[9] One possible cost is the redistribution associated with bond taxation. Rotemberg (1987) explores a model in which the government cares directly for the welfare of the bondholders.

By the argument in the previous section, money demand as well as interest rates at t depend only on the level of bonds and not on the revenue mix between taxes and inflation. The government at t must therefore be indifferent to small changes in the composition of revenue which leave b_t unaffected. The same approach to analyzing optimal choices that we followed above then yields first order conditions equating the marginal cost of income tax finance with that from inflation and bond taxation:

$$(10) \qquad h'(\theta_t) = v'(\frac{P_{t-1}}{P_t}) \frac{y_t(1 + \epsilon_\theta)}{m_{t-1}}$$

$$(11) \qquad h'(\theta_t) = f'(\frac{b_{t-1}(1+i_{t-1})z_t P_{t-1}}{P_t}) \, y_t(1 + \epsilon_\theta).$$

Equation (10) describes equilibrium inflation as a function of real money balances, income, and the tax rate. It differs from the first order condition without commitment only in the absence of an m_i term.[10] Although the two first order conditions are empirically indistinguishable, it is plausible that inflation will be lower under (5). Regardless of whether the government can precommit, inflation raises revenue because individuals need more printed money to retain their real money balances. Commitment dampens this effect because the government realizes that raising expected inflation <u>reduces</u> desired real money balances. Without commitment the current government cannot affect future inflation, so raising prices appears to have a less deleterious effect on government revenue. This is only an illusion. Without commitment inflation tends to be higher, reducing earlier governments' revenue from money creation.

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[10] The elasticity of money demand with respect to expected price changes, m_i, will be treated as constant in what follows. As Mankiw (1987) notes, treating this elasticity as depending on inflation would not affect the analysis. This dependence would be confounded with the dependence of v' on inflation.

Past revenue losses are however ignored by the current government, so inflation is a more attractive revenue source for governments that cannot precommit than for those that can.

Since equation (5) is so similar to (10) the relationship between taxes and inflation cannot really be used to test for the presence of commitment. This does not imply that it is impossible to distinguish the commitment case from the no-commitment scenario, since the two may yield different predictions along other dimensions. For example, the two cases differ in their implications for the intertemporal behavior of tax rates. An optimizing government that is able to commit must be indifferent between the actual path of taxes and an alternative path which raises one additional dollar of revenue today and one less dollar (in present value terms) tomorrow. Barro (1979) has shown this implies that tax rates must follow a martingale:

$$h'(\theta_t) = \rho E_t R h'(\theta_{t+1}). \tag{12}$$

In the appendix, we derive the analogous relationship without commitment:

$$h'(\theta_t) = \rho E_t[R + (R - P_t/P_{t+1})(dm_t/d\theta_t)]h'(\theta_{t+1}). \tag{13}$$

Equation (13) shows that the expected tax rate change is related to expected inflation. The sign of this relationship, however, will depend upon the second derivatives of money demand with respect to inflation and taxes.

IV. The Empirical Relationship between Inflation and Taxes

This section evaluates the models of the previous sections in light of the relationship between taxes and inflation in several nations and over several time periods. We first consider the empirical counterpart of equation (5), which is valid with bond taxation regardless of whether the government can commit and without bond taxation provided the government can precommit.[11] Mankiw (1987) estimates an equation similar to this on post-war U.S. data. We also estimate the empirical counterpart of (7), the first order condition that holds with neither commitment nor bond taxation. Although inflation and the level of taxation have moved together during the last century in the United States, evidence from other nations yields very little support for the view of government behavior analyzed above.

To estimate the first order condition implied by government optimization, we must specify functional forms for h( ) and v( ), the deadweight losses due to taxation and inflation respectively. We assume constant elasticity functions so that our objective function is a generalization of the CES welfare function: $h(\theta_t) = z_1(\theta_t)^{\alpha+1}$ and $v(P_{t-1}/P_t) = z_2(P_{t-1}/P_t)^{1-\beta}$, for z_1, z_2, α and β positive constants. This implies that (5) can be written as

$$(14) \qquad \ln(P_t/P_{t-1}) = \gamma_0 + \gamma_1 \ln(\theta_t) + \gamma_2 \ln(m_{t-1}/y_t)$$

where $\gamma_1 = \alpha/\beta$ and $\gamma_2 = 1/\beta$. This specification relaxes Mankiw's (1987) assumption that the ratio of m_{t-1} to y_t is constant.

If the functions h( ) and v( ) were literally time invariant and correctly specified, equation (14) would hold without error. This literal version of our model is easy to reject. We are not, however, interested in testing the proposition that the theory can explain the exact relationship between taxes and inflation, but in exploring whether the theory can explain a substantial fraction

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[11] Under our assumption that the Fisher hypothesis holds, the empirical results do not depend on whether inflation or the nominal interest rate is used as the dependent variable. Mankiw (1987) found similar results in the United States time series using both dependent variables.

of the movements in these series. We therefore test the prediction that higher taxes tend to be associated with higher inflation by simply adding an error term, ϵ_t, to (14) and estimating the resulting equation for several countries.

Our estimation employs annual data for five countries: the United States, Britain, France, Germany, and Japan. Taxes and gross national product are flows during the calendar year. Our analysis is confined to taxes levied by the central government, since this is the level of government choosing monetary policy. Price indices, measured using consumer prices in each country, are annual average values. The stocks of money and debt are measured as mid-year values or yearly averages. Since both inflation and the tax rate are highly persistent, ordinary least squares estimation of (14) would recover the trends in the two series. We therefore add a time trend to (14) and estimate the resulting equation allowing for residual autocorrelation, or we difference (14) and estimate the resulting specification by ordinary least squares.

We begin by analyzing the time series evidence for the United States, using two measures of the tax rate θ_t. The first is the ratio of federal government tax receipts to GNP. If the government chooses its mix of tax instruments optimally, then the level of taxes divided by GNP is a summary statistic for the degree of tax distortion. It also avoids the problem of computing the marginal deadweight loss of particular tax instruments taking account of the interactions between tax instruments and of the other pre-existing distortions, and it is available for a long time period. The second measure of the tax burden is the weighted average marginal tax rate on labor income computed by Barro and Sahasakul (1986). Their tax measure, including both federal income and Social Security taxes, is available for the 1916-1985 period. Data limitations restricted our sample period to begin in 1890, even when we use T/GNP for our tax measure.[12]

The results of estimating equation (14) for a variety of different sample periods are shown Table 1. The tax rate is positively correlated with the inflation rate for all of the sample periods, but the strength of this correlation is strongest for the post-World War II period. For the entire 1891-1986 period, a ten percentage point increase in the share of taxes in GNP predicts a one half of one percentage point increase in the inflation rate. The tax rate and trend, however, explain less than six percent of the variation in inflation rates. The estimates in the AR(1) with trend and the differenced equations are similar, with slightly larger effects of the tax rate on inflation in the latter equations. For the period since 1919 but excluding World War II, the coefficient estimates are close to those for the full sample, although now the null hypothesis of no tax effect on inflation cannot be rejected at standard levels.

This conclusion is reversed when the sample is restricted to the post-war period. A ten percent of GNP increase in taxes now raises the inflation rate by approximately 3.4 percent, and the impact coefficient is estimated much more precisely than for the longer sample periods. When the Barro-Sahasakul marginal tax rate series is used in place of the tax-to-GNP ratio, the estimated inflation effect of a tax increase is smaller. A ten percentage point rise in the marginal tax rate raises the inflation rate by just under two percentage points.

The coefficient on $\log(m_{t-1}/y_t)$ in the full sample equations in Table 1 is

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[12] The Consumer Price Index for the United States is reported in Historical Statistics of the United States, and was updated using the Economic Report of the President. The money stock is the stock of high powered money, reported in Friedman and Schwartz (1982, Table 4.8). The interest rate is the nominal call money rate, again as reported in Friedman and Schwartz with updates by the authors. Government debt is measured as the publicly-held stock of government debt on July 1 of each year, as reported in Federal Reserve Board, Banking and Monetary Statistics.

Table 1: U.S. Time Series Evidence on Inflation and Tax Rates

Sample/Tax Rate	Level Specification: Constant	Tax Rate	M/Y	Trend	AR(1)	$\bar{R}^2$	Difference Specification: Constant	Tax Rate	M/Y	$\bar{R}^2$
1891-1985/TGNP	.093	.051	-.050	-.0011	.579	.052	-.001	.062	-.072	.03
	(.088)	(.024)	(.031)	(.0008)	(.084)		(.004)	(.032)	(.059)	
1919-40,1946-1985/TGNP	.039	.039	-.022	.0002	.411	.157	-.003	.063	-.078	-.00
	(.113)	(.034)	(.034)	(.0012)	(.118)		(.006)	(.057)	(.078)	
1919-40,1946-1985/MTR	.043	.030	-.017	-.0001	.409	.163	-.003	.059	-.082	.01
	(.105)	(.023)	(.030)	(.0012)	(.118)		(.006)	(.041)	(.078)	
1946-1986/TGNP	.572	.320	.205	.007	.543	.452	.009	.334	.294	.46
	(.145)	(.074)	(.056)	(.002)	(.148)		(.004)	(.069)	(.064)	
1946-1986/MTR	.382	.177	.170	.004	.542	.334	.0007	.184	.271	.09
	(.145)	(.059)	(.062)	(.002)	(.141)		(.0041)	(.059)	(.072)	

Estimates correspond to equation (14) in the text. Standard errors are reported in parentheses.

negative, although the null hypothesis that it is zero cannot be rejected at standard confidence levels. Since the coefficient on this variable is $1/\beta$, the negative estimate is inconsistent with the theory underlying equation (14). The negative parameter estimates are apparently due to the pre-war sample since the estimates for the post-World War II period suggest a positive effect of the money-to-income ratio on the inflation rate. The same coefficient pattern, negative in longer samples and positive for the postwar period, emerges in both the AR(1) and the differenced estimates.

Mankiw (1987) excludes the m_{t-1}/y_t variable. He justifies this exclusion by assuming both that the quantity equation holds, so that m_t/y_t is constant, and that observations are sufficiently close together (as they are in his continuous-time theoretical model) so that the difference between m_t and m_{t-1} can be ignored. To verify that our results are not due to our inclusion of $\log(m_{t-1}/y_t)$, we also estimated a modified version of (14) excluding this variable. Table 2 reports these equations for the same sample periods as Table 1. The estimated coefficients on the tax rate variable decline slightly, and the standard errors increase. The overall conclusions about the links between tax rates and inflation are not affected by this change in specification.

Our findings for the United States strengthen Mankiw's (1987) conclusions based on postwar period. To evaluate the robustness of the positive relationship between inflation and tax rates, however, we now consider data from four additional countries. For France, Germany, and Japan, we draw data from the International Monetary Fund International Financial Statistics for the postwar period to

Table 2: U.S. Time Series Evidence on Inflation and Tax Rates

Sample	Tax Rate Variable	Level Specification Constant	Tax Rate	Trend	AR(1)	R^2	Difference Specification Constant	Tax Rate	R^2
1890-1986	T/GNP	.130 (.084)	.033 (.021)	-.405 (.680)	.59 (.08)	.033	-.001 (.004)	.061 (.032)	.026
1919-40, 1946-86	T/GNP	.042 (.107)	.029 (.026)	.628 (.849)	.42 (.12)	.155	-.003 (.060)	.054 (.056)	-.001
1919-40, 1946-85	MTR	.043 (.104)	.024 (.020)	.423 (1.013)	.41 (.12)	.174	-.003 (.006)	.053 (.041)	.011
1946-86	T/GNP	.581 (.163)	.298 (.080)	-.518 (.863)	.69 (.11)	.263	.000 (.004)	.256 (.082)	.178
1946-85	MTR	.452 (.158)	.194 (.063)	-2.001 (1.154)	.64 (.12)	.210	- .000 (.005)	.133 (.066)	.072

Estimates correspond to equation (14) in the text, excluding the $\log(m_{t-1}/y_t)$ term. Standard errors are shown in parentheses.

construct tax-to-GNP ratios and inflation rates.[13] More extensive data are available for Britain. For the period 1872-1985, we constructed a tax-to-GNP ratio using data from British Historical Statistics and various issues of the Annual Abstract of Statistics. The annual price index was measured using the Retail Price Index (post-1948) and the Statist price index.[14]

Tables 3 and 4 report estimates of (14), with and without m_{t-1}/y_t, for these four countries. The positive association between inflation and taxes that appears in U.S. data does not generalize. The French and British data show a statistically significant and negative relationship between tax levels and the inflation rate. In Germany the relation is again negative although the standard error of the estimated coefficient is too large to reject the null hypothesis of no tax effect. Only the Japanese data confirm the U.S. finding of a positive relationship between inflation and taxes. A ten percent of GNP increase in the tax burden is estimated to increase the inflation rate by 3.1 percent in the AR(1) specification, and by 4.7 percent in the differenced equation. The estimated effects of $\log(m_{t-1}/y_t)$ on inflation are positive in each equation in Table 3, in contrast to the often negative coefficients for the United States.

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[13] Data on annual averages of consumer price indexes, as well as reserve money, government debt outstanding, gross domestic product, and call money interest rates, were drawn from the IFS. In some cases these series were spliced together using values from several different IFS publications and domestic statistical sources. The tax receipts of the central government are reported in the UN National Accounts.

[14] Interest rates and the stock of high powered money are drawn from Friedman and Schwartz (1983, Table 4.9). The stock of government debt is drawn from British Historical Statistics, Table Public Finance 3, updated using the Annual Abstract of Statistics. Implicit in our use of data from the gold standard is the notion that seigniorage is available even when dollars are measured in terms of a commodity. Seigniorage is possible as long as the gold stock held by the government doesn't bear any relation to government minted currency. Of course, the gold standard might be viewed as providing a commitment to prices so that inflation can indeed be optimally chosen as in the model of Section I.

Table 3: International Evidence on Inflation and Tax Rates

Sample/Tax Rate	Level Specification						Difference Specification			
	Constant	Tax Rate	M/Y	Trend	AR(1)	R^2	Constant	Tax Rate	M/Y	R
France/TGNP	-.332	-.681	.252	.013	.805	.647	.011	-.589	.302	.5
1948-1985	(.250)	(.132)	(.076)	(.003)	(.095)		(.008)	(.129)	(.075)	
Germany/TGNP	.175	-.041	.088	.0014	.595	.121	.0014	-.084	.076	.0
1954-1984	(.130)	(.107)	(.038)	(.0011)	(.159)		(.0022)	(.112)	(.039)	
Japan/TGNP	1.264	.313	.228	-.008	.796	.349	-.011	.472	.187	.4
1955-1984	(.337)	(.226)	(.103)	(.004)	(.121)		(.007)	(.230)	(.101)	
U.K./TGNP	.734	-.243	.778	.010	.957	.755	.011	-.236	.789	.7
1872-1984	(.235)	(.051)	(.044)	(.002)	(.026)		(.005)	(.050)	(.044)	

Estimates correspond to equation (14) in the text. Standard errors are shown in parentheses.

Table 4: International Evidence on Inflation and Tax Rates

Country/ Sample	Tax Rate Variable	Level Specification Constant	Tax Rate	Trend	AR(1)	$\bar{R}^2$	Difference Specification Constant	Tax Rate	$\bar{R}^2$
France 1947-85	T/GNP	-.654 (.103)	-.569 (.073)	.73 (.15)	.21 (.16)	.643	.003 (.010)	-.411 (.144)	.162
Germany 1952-84	T/GNP	.035 (.135)	.021 (.117)	.09 (.12)	.52 (.16)	.116	.001 (.003)	-.083 (.136)	-.021
Japan 1955-84	T/GNP	1.063 (.344)	.582 (.187)	-.008 (.004)	.89 (.08)	.207	-.009 (.006)	.644 (.183)	.288
U.K. 1871-1985	T/GNP	-.329 (.134)	-.095 (.042)	.003 (.001)	.34 (.09)	.089	.004 (.009)	-.296 (.098)	.068

Estimates correspond to equation (14) in the text, excluding $\log(m_{t-1}/y_t)$. Standard errors are shown in parentheses.

When the inflation-tax interaction is estimated using a specification excluding $\log(m_{t-1}/y_t)$, as in Table 4, France and Britain continue to show statistically significant negative coefficients on the tax variable. For Britain, the absolute size of the tax coefficient declines substantially in the AR(1) specification although not in the differenced specification. For Japan, the tax variable has an even stronger positive association with inflation when we exclude the money-to-income ratio. Finally, the coefficient on the tax share for Germany moves from negative in the equation with $\ln(m_{t-1}/y_t)$ to positive without this variable, but the coefficient is never statistically significant.

The failure of the estimates of equation (14) to reflect positive association between tax rates and inflation might be due to an incorrect specification. We have assumed that governments can either precommit, or that if they cannot, that they can tax outstanding government debt without resorting to inflation. If these assumptions are incorrect, the appropriate first-order condition linking taxes and inflation rates is equation (7), which includes the government's outstanding interest bearing debt. Under the same parametric assumptions used to derive (14) from (5), the version of (7) that we estimate is:

$$(15)\quad \ln(P_t/P_{t-1}) = \gamma_0 + \gamma_1 \ln(\theta_t) + \gamma_2 \ln[(b_{t-1}(1+i_{t-1}) + m_{t-1})/y_t] + \epsilon_t$$

Since the earlier results suggest that differencing and autoregressive corrections with time trends yield similar results, we present only the latter.

Table 5 reports estimates of (15) for all five countries in our sample. The inclusion of the broad government liabilities variable does not substantively alter our estimates of the association between taxes and inflation. In particular, the coefficient on the tax rate remains negative and statistically significant for Britain and France, positive and significant for Japan and the

Table 5: Inflation, Nominal Liabilities, and Tax Rates: International Evidence

Country/ Sample	Tax Rate Measure	Constant	Tax Rate	Government Liabilities	Trend	ρ	R^2
France 1948-85	T/GNP	-.778 (.180)	-.770 (.119)	.259 (.099)	.0185 (.0043)	.709 (.119)	.643
Germany 1954-84	T/GNP	-.0024 (.1410)	.037 (.108)	-.029 (.028)	.0012 (.0013)	.530 (.167)	.043
Japan 1957-83	T/GNP	1.178 (.346)	.841 (.222)	-.167 (.043)	-.063 (.003)	.477 (.185)	.352
U.K. 1872-1984	T/GNP	-1.335 (.317)	-.479 (.060)	.693 (.049)	.0085 (.0034)	.976 (.016)	.669
U.S. 1891-1985	T/GNP	.201 (.082)	.074 (.024)	-.055 (.019)	-.0001 (.0007)	.513 (.089)	.115
U.S. 1946-85	MTR	.311 (.186)	.184 (.062)	.063 (.043)	-.0003 (.0020)	.678 (.121)	.228
U.S. 1946-1985	T/GNP	.414 (.184)	.288 (.079)	.071 (.042)	.0022 (.0017)	.700 (.119)	.301

Estimates correspond to equation (15) in the text. Values in parentheses are standard errors.

United States, and statistically insignificant for Germany. The broad liability measure is less correlated with inflation than the $\log(m_{t-1}/y_t)$ variable that appeared in Table 3. This is reflected in lower R^2 values, as well as lower t-statistics. The point estimates for the liability variable are negative (i.e., incorrectly signed) for Germany and Japan, whereas the money-to-GNP ratio had the sign predicted by the foregoing theory.

The superiority of models including only the ratio of money to GNP, relative to models with total government liabilities as a share of GNP, can be demonstrated by estimating regression equations which include <u>both</u> variables. This is equivalent to the non-nested hypothesis test of the null hypothesis that one variable affects the inflation rate against the alternative that the other variable affects it. For the U.S., Germany, and Japan, including both variables yields a negative coefficient on the liability variable but a positive and usually statistically significant coefficient on the money variable. For France both variables have positive but statistically insignificant coefficients, while for Britain both are positive and statistically significant, but the coefficient on money is roughly three times as large as that on the broader liability measure. Overall, the results are more supportive of a specification including the ratio of lagged money to GNP than the total level of government liabilities.

The final empirical issue we address concerns the links between intertemporal changes in tax rates and other government choices, notably inflation. In the last section we showed that with commitment the tax rate should evolve as a martingale, while in the nc commitment case future tax rates should be partially predictable using lagged inflation rates. We explore this question by estimating simple regression models relating the change in the tax-to-GNP ratio between periods t-1 and t to the inflation rate in period t-1:

(16) $\theta_t - \theta_{t-1} = \delta_0 + \delta_1 \ln(P_{t-1}/P_{t-2}) + \nu_t.$

Table 6 presents estimates of equation (16). In four of the five nations, high inflation predicts an increase in the level of taxation. In the U.S. and France a one percent increase in the inflation rate predicts an increase of approximately one half of one percent in the tax-to-GNP ratio. The finding for France is statistically significant at conventional levels, while in the U.S. th null hypothesis that inflation cannot forecast tax changes would be rejected at the 10 percent level. In Britain and Germany each percentage point of inflation predicts higher taxes of approximately one quarter of one percent of GNP, with the British results rejecting the null hypothesis of no effects at high confidence levels. Finally, in Japan, there is a negative but imprecisely estimate relationship between the inflation rate and the change in tax burdens. These findings are potentially interesting because provide evidence against the martingale models of taxation developed by Barro (1979) and others,[15] and because they provide weak evidence against the assumption that governments can precommit to future actions.

V. Conclusions

The view that taxes and inflation are chosen by deadweight-loss minimizing governments, using both instruments to raise revenue, cannot explain our finding that higher taxes are just as often associated with lower as with higher inflation. Several explanations may be advanced to account for our results. One

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[15] Sahasakul (1987) presents other evidence for the U.S. contradicting the unpredictability of tax rate changes. He shows that tax rates respond to transitory increases in spending by more than can be justified by optimizing models with infinite-lived governments.

Table 6: Inflation as a Predictor of Tax Rate Changes

Country/ Sample	Tax Rate Measure	Constant	Lagged Inflation	ρ	R^2
France 1947-1984	T/GNP	-.022 (.108)	.587 (.082)	.135 (.170)	.593
Germany 1953-1984	T/GNP	.000 (.006)	.242 (.164)	-.029 (.181)	.068
Japan 1956-1984	T/GNP	.017 (.009)	-.015 (.133)	-.076 (.191)	.009
U.K. 1872-1985	T/GNP	.006 (.010)	.274 (.093)	.076 (.094)	.073
U.S. 1891-1986	T/GNP	.0051 (.0194)	.537 (.302)	.281 (.099)	.032

Estimates correspond to equation (16) in the text. Standard errors are reported in parentheses.

possibility, which begs the question of what objectives guide monetary policy, is that inflation is determined without regard to government revenue needs. Inflation might be chosen to stabilize GNP, for example. Even though traditional Keynesian presciptions for stabilization policy would call for coincident reductions in tax burdens and increases in the money stock, however, the observed correlation between taxes and inflation is likely to remain positive. Stabilization policy in large part responds to shocks. When exogenous factors cause a business slowdown, both inflation and the share of taxes in GNP are likely to decline.[16] If the government responds with a monetary expansion accompanied by a tax cut, the ratio of taxes to GNP will be unambiguously lower than without the shock and associated stabilization. Inflation will also be lower, unless the stabilization policy more than offsets the disturbance it was designed to correct.[17] The positive correlation implied by the deadweight-loss minimization above is therefore also characteristic of stabilization-induced variation.

A second potential explanation is that governments are unable to adjust the structure of taxes frequently enough to enforce the first order conditions implied by optimizing models. This view is implicit in the work of Feldstein (1983) and others who view the effects of inflation on tax burdens as largely accidental and unanticipated. Even when tax rules are costly to change, however, policy makers might be able to implement the links between taxes and inflation

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[16] Holloway (1984) suggests that the elasticity of federal tax receipts with respect to GNP is about 1.4. A decline in output will therefore lead to a decline in the tax-to-GNP ratio. Given the progressivity of the income tax it will also generally lower the average marginal tax rate.

[17] The negative correlation between T/GNP and inflation implied by stabilization policy could appear in the data if a substantial share of the policy variation was due to changing tastes on the part of government. Such variation is predicted, for example, by models of "political business cycles."

described above. An unindexed tax system which raises corporate tax burdens during inflationary periods because depreciation is based on historic cost, for example, generates a positive association between tax rates and inflation.

A final possibility is that the government's objective function which guides inflation and tax policy varies over time. This could explain our findings, regardless of whether inflation is chosen on the basis of revenue or stabilization considerations. The perceived costs of inflation and taxes may change with the political party in power, shifts in voter preferences, or changes in the transactions or tax-collecting technology.[18] Alesina and Sachs (1988) provide some support for the view that different political parties in the United States have different macroeconomic preferences, and Hibbs (1986) documents apparent variation through time in the inflation-unemployment preferences of the U.S. electorate. If governments that are willing to tolerate inflation also like expansionary policies in general, then total revenues will decline in periods of high inflation, reinforcing the negative inflation-tax correlation.[19]

The view that negative inflation-tax correlations are due to unstable government tastes is mildly supported by the fact that countries with more stable governments and less diverse political parties, such as postwar Japan and the United States, exhibit positive tax-inflation correlations. Countries with more political instability, such as Britain and France, tend to exhibit negative correlations. Further work could usefully explore how political institutions or

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[18] Barro's (1987) analysis allows preferences to shift in this way since the government's preferred interest rate changes over time.

[19] One situation that is reminiscent of changing tastes arises when governments must signal their type when there is an election but not otherwise. Rogoff and Sibert (1988) model such time-varying preferences, but in their model the correlation between inflation and taxation is ambiguous.

other aspects of social structure are related to the inflation-tax correlation.

The premise that governments raise revenue by equating the marginal deadweight losses on different tax instruments can also be tested in other contexts. Provided consumer tastes, production parameters, and the tax technology do not vary substantially over time, the marginal deadweight losses from different tax instruments should move together. An increase in one tax rate, due to increased spending, should raise the marginal deadweight burden from that tax and lead to commensurate increases in the efficiency costs of other tax instruments (and hence tax rates). In practice, tax rates on different goods do not change in tandem. The real excise tax rate on alcohol and cigarettes declined throughout the 1970s and early 1980s, for example, while marginal tax rates on labor income increased. Ballard, Shoven and Whalley (1985) document substantial disparities in the marginal efficiency costs of different excise taxes, and between excise and other taxes. Reconciling these patterns of tax burdens with optimizing models of government behavior is an important challenge to positive theories of fiscal policy.

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Appendix: Tax Dynamics Without Commitment or Direct Bond Taxation

In an equilibrium of the game between successive governments which cannot commit to the path of the money supply, the government must always be indifferent between maintaining the equilibrium level of taxes and changing taxes by a slight amount. Otherwise, given the differentiability of our problem, the current government would change taxes. By raising taxes slightly today, the government incurs a cost $h'(\theta_t)$. The reason such slight tax increases are not detrimental must be that, in equilibrium, such a tax increase would lead future governments to lower taxes. This expected fall in taxes at, say, time t+j raises welfare by $\rho^j h'(\theta_{t+j})$. This appendix derives a dynamic relationship for taxes by developing this indifference between current and future taxes.

We consider an equilibrium in which the contingent path for tax rates and inflation is $\{\theta_t, P_{t-1}/P_t\}$. For simplicity, we focus on the case in which income is always unity (therefore $\epsilon_\theta = 0$) and k'( ) is a constant. We start by analyzing what happens if the government at t raises its taxes slightly. Individuals and firms will rationally anticipate that taxes and inflation will be lower in the future. Current real money balances therefore rise while current nominal interest rates fall; if the Fisher effect holds, the real rate is unaffected. In the next period, there is an as yet unspecified equilibrium change in taxes $(d\theta^1_{t+1})$ and inflation (dP_t/P_{t+1}). These changes cause the end of period debt at t+1 to differ from the level which would have prevailed in the absence of the period t tax increase by:

(A1) $$db_{t+1} = -Rd\theta_t - [R - P_t/P_{t+1}](dm_t/d\theta_t) + m_t[d(P_t/P_{t+1})/d\theta_t] - d\theta^1_{t+1}.$$

The government at t+1 must also be indifferent with respect to small changes in tax rates. This means that the present discounted value of the welfare costs from period t+1 forward must be the same whether the government at t+1 levies taxes equal to $\theta_{t+1} + d\theta^1_{t+1}$ (as would actually happen if the government at t deviates in the prescribed manner) or equal to $\theta_{t+1} + d\theta_{t+1}$ where

(A2) $d\theta_{t+1}/d\theta_t = - R - [R - P_t/P_{t+1}](dm_t/d\theta_t) + m_t[d(P_t/P_{t+1})/d\theta_t]$.

The tax rate given by (A2) has the feature that real debt at the end of period t+1 is the same as it would have been had the government at t not deviated from the equilibrium path. If the government at t+1 imposed this tax, then governments after t+1 would abide by the original equilibrium path.

The indifference of the government at t+1 enables us to compute the welfare consequences of tax changes at t by pretending that taxes at t+1 will be used to offset the period t tax increase. This computation yields the total welfare effect of a tax increase at t:

(A3) $dW/d\theta_t = - E\rho h'(\theta_{t+1})\{R + [R - P_t/P_{t+1}](dm_t/d\theta_t) - m_t[d(P_t/P_{t+1})/d\theta_t]\}$
$- E\rho v'(P_t/P_{t+1})[d(P_t/P_{t+1})/d\theta_t] + h'(\theta_t)$.

The three terms in this expression represent the cost of the extra period t taxes, the cost of the extra t+1 taxes under the counterfactual assumption that taxes are given by (A2), and the cost of the increased inflation between t and t+1 respectively.

Using equation (10) and the requirement that government at t must be indifferent with respect to small changes in taxes (setting dW = 0 in (A3)) we obtain:

(A4) $h'(\theta_t) = \rho E[R + (R - P_t/P_{t+1})(dm_t/d\theta_t)]h'(\theta_{t+1})$.

This expression is similar to the random walk expression (12) which obtains with commitment, but differs by inclusion of the term $(R-P_t/P_{t+1})(dm_t/d\theta_t)$. This term is present because when the government at t raises taxes, agents expect lower inflation and real money balances rise. This increases government revenue, so taxes can fall tomorrow by more than R times the current tax increase. Since tax increases are associated with relatively large tax reduction tomorrow the deadweight burden of taxes tomorrow must be low relative to that given in (5); in other words $\rho Rh'(\theta_{t+1})$ must be below $h'(\theta_t)$. Still, for the special but not economically absurd case in which $(R - P_t/P_{t+1})(dm_t/d\theta_t)$ is independent of the rate of inflation (A4) implies that taxes follow a martingale.

Equation (A4) requires that the expected change in tax rates be associated with expected inflation. High rates of inflation tend to be inefficient so a low value for P_t/P_{t+1} means that the benefits from raising real money balances by reducing expected inflation are high. On the other hand, for plausible demand functions for money, the actual increase in real money balances from an increase in taxes is smaller with higher inflation.[20] Stated differently, whereas the first term of $(R - P_t/P_{t+1})(dm_t/d\theta_t)$ always rises with expected inflation, the second term may fall, making the effect of inflation on the difference between the left and right hand sides of (A4) ambiguous. Nonetheless it is worth studying whether the expected rate of change of taxes depends on the current expecetd rate of inflation, as we do in Table 6.

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[20]This is for instance the case if the demand for money is an exponential function of (P_t/P_{t+1}) while h() and v() are also exponential functions.