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Public-Debt/Output Guidelines:

The Case of Israel

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Public-Debt/Output Guidelines: the Case of Israel

Zvi Hercowitz and Michel Strawczynski*

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Abstract

This paper analyzes the implications of adding to a tax-smoothing framework the cost of deviating upwards from a public-debt/output guideline. The implications for the dynamic paths of the tax rate, the debt/output ratio and the government spending/output ratio are derived. A simulation of the model with Israeli data suggests that Israeli fiscal behavior is consistent with the (implicit) existence of such a guideline. Some international perspective, with countries having explicit guidelines in the context of the Maastricht Treaty, is also presented.

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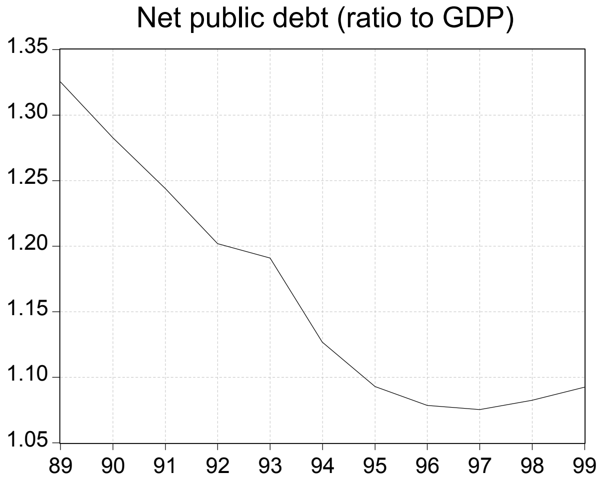

Figure 1:

1 Introduction

As shown in Figure 1, the debt/output ratio in Israel has declined sharply since the late 1980s. This pattern started earlier on, following the stabilization plan of 1985.

What is the reason for this decline? One contributing factor may be high output growth till the middle 1990s, following the immigration influx from the former Soviet Union, which reduced the debt/output ratio for given fiscal policy. Another contributing factor may be the existence of an implicit public-debt/output guideline, which may have generated active fiscal behavior to reduce the debt. Unlike the Maastricht Treaty countries, there is no explicit debt/output guideline in Israel. However, government budget publications ("Ykarei Hataksiv") since 1990, state the goal of reducing the debt/output ratio. The Maastricht guideline of a public-debt/output ratio of 60% is mentioned in the budget publications for the years 1997-2000 as important to achieve, and policy makers often refer to the Maastricht guideline as a model to imitate. This may reflect an expectation that the Maastricht guideline may become widespread in the future and that outlier countries could suffer a reputation loss, which may have real consequences for the economy.

This paper focuses on the implications of such a guideline on the dynamics of fiscal policy—tax rates, government spending and deficits—using a model where the policy maker faces both tax-smoothing considerations and the cost of deviating upwards from a debt/output guideline. This specification is consistent with existing empirical results, as in Kremers (1989), who finds mean reversion of the public debt in the US. Recently, the Maastricht Treaty drew attention to the existence of guidelines as the force driving reversion of the public-debt/output ratio—albeit asymmetrically—only when the ratio is high.

According to these considerations, the severity of the guideline depends on two factors: the cost of deviating from the norm, and the (perceived) closeness of the critical date of guideline implementation. These two factors are captured in the present framework by two key parameters, on which the analysis focuses.

The paper is organized as follows. Section 2 presents the model, an example characterizing different degrees of guideline severity, and the cases of endogenous government spending and output. Section 3 reports a simulation applied to Israeli data, aimed at evaluating the existence and importance of an implicit public-debt/output guideline. Section 4 presents some international perspective and Section 5 concludes.

2 The model

The model is a simple framework based on Barro (1979). The policymaker faces exogenous flows of spending and determines the dynamic path of the tax rate, given the existence of deadweight losses from taxation and a public-debt/output guideline.

The deadweight loss from taxation, associated with tax rate τ_t and output Y_t, is denoted by $z(\tau_t)Y_t$, with $z' > 0, z'' > 0$. The functional form adopted is $z(\tau_t) = \frac{1}{2}(\tau_t)^2$. In addition, there is a (reputation) cost associated with a high ratio of public debt to output, $b_t \equiv B_t/Y_t$, where B_t is the outstanding public debt at the end of period t. This cost applies, starting from some future date $\bar{t}$, if b_t is higher than the guideline $\bar{b}$ (taken later on as the Maastricht guideline of 60%). If $b_t \leq \bar{b}$, there is no loss nor benefit. This cost is then specified as

$$w(b_t)I_tY_t, \qquad w' > 0, w'' > 0,$$

where I_t is the indicator function

$$I_t = 1, \text{ if } b_t > \overline{b} \text{ and } t \geq \overline{t},$$

and

$$I_t = 0, \text{ otherwise.}$$

The inclusion of a cost in the policy maker's objective function may reflect either an explicit rule, deviation from which involves a fine as in the Maastricht Treaty, or an implicit guideline, subject to a reputation loss. The functional form adopted is $w(b_t) = \frac{\lambda}{2}(b_t - \overline{b})^2$, $\lambda > 0$.

The objective function of the government, acting in a small open economy environment, is

$$Min \sum_{t=1}^{\infty} \left(\frac{1}{1+r}\right)^{t-1} [z(\tau_t) + w(b_t)I_t] \, Y_t,$$

or

$$Min \sum_{t=1}^{\infty} \left(\frac{1}{1+r}\right)^{t-1} \frac{1}{2} \left[(\tau_t)^2 + \lambda(b_t - \overline{b})^2 I_t\right] Y_t, \tag{1}$$

where r is the real interest rate.

The marginal deadweight loss of taxation equals $\tau_t Y_t$, while the marginal reputation loss from public debt equals $\lambda(b_t - \overline{b})Y_t$—if $b_t > \overline{b}$ and $t \geq \overline{t}$. Hence, for $t \geq \overline{t}$, the parameter λ determines the loss associated with the public debt, relative to the deadweight loss from taxation.

The periodical budget constraints are

$$\tau_t = \frac{1}{Y_t} \left[(1+r)B_{t-1} + G_t - B_t\right], \qquad t = 1, 2, ...\infty, \tag{2}$$

where G_t is real expenditure net of interest payments. The intertemporal budget constraint associated with (2) is

$$\sum_{t=1}^{\infty} \left(\frac{1}{1+r}\right)^{t-1} (G_t - \tau_t Y_t) + (1+r)B_0 = 0. \tag{3}$$

The exogenous variables are output growth, $\{\mu_t\}_{t=1}^{\infty}$, and the spending/output ratio, $\{g_t\}_{t=1}^{\infty}$ ($\mu_t \equiv Y_t/Y_{t-1} - 1$, $g_t \equiv G_t/Y_t$), known with perfect foresight. The starting public debt, B_0, is predetermined.[1]

[1] The deterministic nature of the model and the constant real interest rate precludes state-contingent taxation and state-contingent return on the debt as in Chari, Christiano and Kehoe (1994). The absence of assets in the model, as money in Lucas and Stokey (1983), avoids time-inconsistency in taxation.

Substituting the expressions for the tax rate in (2) into (1), the first-order conditions with respect to B_t are

$$-\tau_t + \tau_{t+1} + \lambda(b_t - \overline{b})I_t = 0, \qquad t = 1, 2 \ldots \infty. \tag{4}$$

Equation (4), (2) and (3), characterize the solution.

Let us consider two possible cases for the initial debt: (a) $b_0 \leq \overline{b}$ and (b) $b_0 > \overline{b}$. The case $b_0 \leq \overline{b}$ yields the standard tax-smoothing solution for the entire planning horizon, where the smoothened tax rate is set at the only level which satisfies the intertemporal budget constraint. Then, the debt/output ratio remains at the initial level b_0, implying that $I_t = 0$ for all t's.

The interesting case in the present context arises when $b_0 > \overline{b}$. Prior to $\overline{t}$, given that $I_t = 0$, it follows from (4) that $\tau_t = \tau_{t+1}$—i.e., there is tax smoothing. The pattern of the tax rate from $\overline{t}$ onwards depends on $(b_{\overline{t}} - \overline{b})$. Hence, the question here is whether b reaches the value $\overline{b}$ at $\overline{t}$. The answer is no; $b_{\overline{t}} > \overline{b}$ holds. The reason is the following. If τ is set high enough prior to $\overline{t}$ so as to get $b_{\overline{t}} \leq \overline{b}$, then $I_{\overline{t}} = 0$, implying from (4) that $\tau_{\overline{t}} = \tau_{\overline{t}-1}$. Iterating this reasoning forward implies that τ stays constant forever at the rate high enough to reduce the debt/output ratio. Hence, b continues to decline without bound. This is inconsistent with the intertemporal budget constraint: surpluses which reduce b are never reversed.

The conclusion is, therefore, that the optimal debt/output ratio at $\overline{t}$ should satisfy $b_{\overline{t}} > \overline{b}$, which triggers $I_{\overline{t}} = 1$. Then, $\tau_{\overline{t}+1} < \tau_{\overline{t}}$ follows from (4). Accordingly, the tax rate is reduced from $\overline{t}$ onwards, while b declines towards $\overline{b}$. As $b \rightarrow \overline{b}$, the tax rate converges to a lower smoothened level.[2] The interpretation of this behavior is the following. Prior to $\overline{t}$, the government takes into account the future reputation loss, and therefore it keeps the tax rate high so as to reduce the debt/output ratio towards the critical date $\overline{t}$. At $\overline{t}$, the tax rate starts to decline, converging to a new smoothened level. The degree to which $b_{\overline{t}}$ is close to $\overline{b}$ at the critical date $\overline{t}$ depends on the value of λ. The higher λ, the larger is the reputation cost, and hence the higher should be the tax rate prior to $\overline{t}$ and the closer should $b_{\overline{t}}$ be to $\overline{b}$.

[2] As b declines, it will not go below $\overline{b}$, because if it does, then $(b_t - \overline{b}) < 0$ in (4) implies that $\tau_{t+1} > \tau_t$. Hence, as soon as b declines below $\overline{b}$ the tax rate changes direction and begins to increase, reducing b even further, and so on. This violates the intertemporal budget constraint.

2.1 An example

The solution of the model, and in particular the dependency of the time profiles of τ and b on the parameter λ, is illustrated by the following example: $b_0 = 1$, $\overline{b} = 0.6$, $\{\mu_t = 0,\ g_t = 0.4\}_{t=1}^{\infty}$, $r = 0.05$ and $\overline{t} = 10$.

Three alternative cases are considered:

Case 1: $\lambda = 0$ ("no guideline"),

Case 2: $0 < \lambda < \infty$ ("guideline of moderate severity"),

Case 3: $\lambda \to \infty$ ("guideline of extreme severity").

Figures 4 and 5 plot the simulated τ and b time profiles, respectively, for the three cases.[3] Case 1 yields tax smoothing at the rate 45% for the entire planning horizon, while the debt/output ratio remains at the starting value of 1. Case 3 corresponds to an extremely high value of λ. In this case, the tax rate until period $\overline{t}$ is higher, 48.2%, which generates a fast decline of the debt/output ratio, to reach 0.6 at $\overline{t}$. At this point, the tax rate jumps to the smoothened lower level 43%.

Case 2 is an intermediate one, with a small value of λ (0.005). Given that the fine for $b_0 > \overline{b}$ is small relative to that in Case 3, the tax rate till date $\overline{t}$ is lower here, 46.2%, implying that the debt/output ratio declines slower. At date $\overline{t}$ the tax rate begins to decline, reaching asymptotically the level of 43%, as b approaches $\overline{b}$.

2.1.1 Equivalent parameterizations of guideline severity

It should be stressed that guideline severity, as judged by its effect on government behavior, depends on *both* λ and $\overline{t}$. The same tax and debt behavior in the periods following the planning period can be obtained with different

[3] To express the system in a convenient form for the simulation, equation (4) is expressed as

$$\tau_t = \frac{1+r}{1+\mu_t} b_{t-1} + g_t - b_t, \qquad t = 1, 2, ...\infty. \tag{5}$$

Substituting (5) into (4) yields

$$-\left(\frac{1+r}{1+\mu_t} b_{t-1} + g_t - b_t\right) + \frac{1+r}{1+\mu_{t+1}} b_t + g_{t+1} - b_{t+1} + \lambda(b_t - \overline{b}) I_t = 0,$$

$t = 1, 2, ...\infty$, which is a second-order linear equation in b_t—given the exogenous variables, g_t and μ_t, and the indicator function I_t. The equation is solved given the initial debt b_0 and the terminal condition (3). In the actual simulations, a finite debt/output ratio is postulated with a long enough horizon.

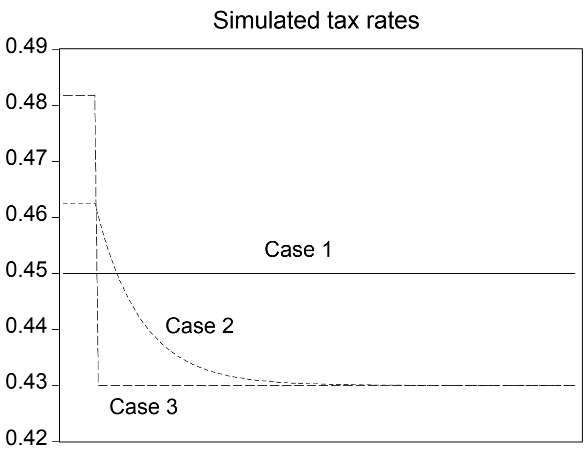

Figure 2:

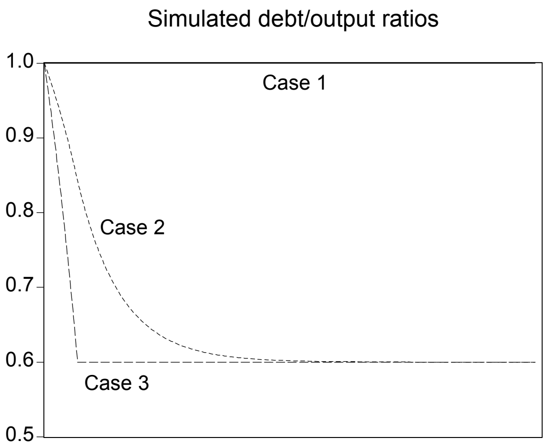

Figure 3:

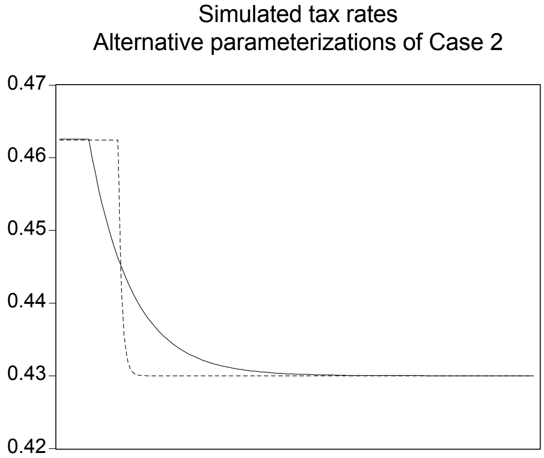

Figure 4:

combinations of λ and $\bar{t}$. The effect of a stiffer fine (higher λ) on initial behavior may be nil if at the same time the timing of this fine is delayed enough (higher $\bar{t}$). Case 2 above was simulated using $\lambda = 0.005$ and $\bar{t} = 10$, which yields the tax rate 46.2% for the initial 10 periods, while b declines during this period of time as shown in Figure 3. The same tax rate (and thus debt path) during the first 10 periods can be obtained with $\lambda = 1$ and $\bar{t} = 19$, for example. This is shown in Figure 4, where the full line describes the tax rate for Case 2 from Figure 2, and the dashed line corresponds to the alternative parameter values. It can be seen that τ is the same for the first part of the simulation (10 periods).[4]

2.2 Endogenous government spending

The analysis above was based on exogenous flows of government spending. This subsection considers endogenous determination of g_t.

Assume that the utility to the public or to the policymaker from providing real expenditure G_t, when the output level is Y_t, is given by $u(g_t) = -\frac{\gamma}{2}(g - g_t)^2 Y_t$, $\gamma > 0$. Given that $u'(g_t) = \gamma(g - g_t)$, the exogenous parame-

[4] Given that here $\bar{t} = 19$, the tax rate remains unchanged for longer, with a sharper decline at period 19.

ter g determines the level of g_t beyond which government spending provides negative marginal benefit.[5] The objective function is now

$$Min\sum_{t=1}^{\infty}\left(\frac{1}{1+r}\right)^{t-1}\frac{1}{2}\left[(\tau_t)^2+\gamma(g-g_t)^2+\lambda(b_t-\overline{b})^2I_t\right]Y_t, \qquad (6)$$

while the constraints remain the same. The additional first-order condition is

$$\tau_t-\gamma(g-g_t)=0, \qquad t=1,2...\infty, \qquad (7)$$

or

$$g_t=g-\frac{\tau_t}{\gamma}.^6 \qquad (8)$$

Condition (4) for the tax rates applies here as well. Equations (4) and (8) together imply that while τ_t is smooth until $\overline{t}$ at a high level, g_t is smoothened at a low level. Starting from $\overline{t}+1$, as τ_t declines approaching its permanent lower level, g_t *increases* to a new permanent level.[7] Hence, the main implication of endogenizing g_t is that the lower burden of interest payments following from approaching the target is now divided between lower taxes and higher spending.

The example above in Section 2.1 can be modified to illustrate the present case. The exogenous value 0.4 for g_t is replaced by the parameters $g=0.85$ and $\gamma=1$, which yield $g_t=0.4$ endogenously when $\lambda=0$. Figure 5 shows the paths for g_t and τ_t when $\lambda=0.005$. The two variables have mirror-image behavior, as implied by (8). The tax rate follows the same type of pattern as in the previous example, but declines less since g_t increases, thereby allowing for a smaller tax reduction.

The implication of imposing a debt/output guideline with endogenous government expenditures is also illustrated in Figure 5 by comparing the $\lambda>0$ case with the $\lambda=0$ case: the long-run level g_t is higher when $\lambda>0$.

How reasonable is it to combine a debt/output guideline with endogenous spending, which leads to a larger government? The goals of fiscal policy in Israel during the 1990s, as stated in the government budgets ("Ykarei Hataksiv"), include the gradual reduction of government expenditure, along with

[5] Expanding regulating agencies beyond a certain level may be an example of such a negative effect.

[6] The case of exogenous government spending at level g is represented by $\gamma\to\infty$.

[7] This feature follows from the additive nature of the utility from g_t.

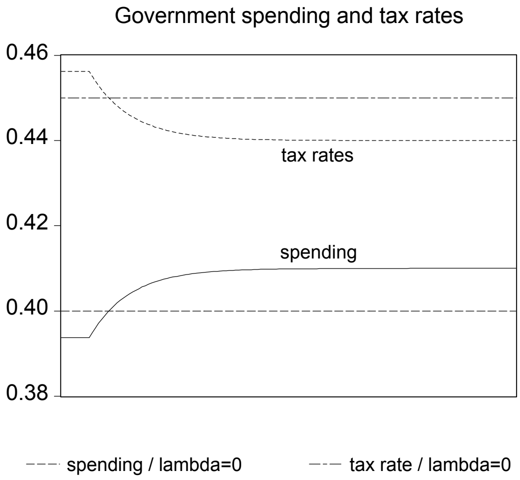

Figure 5:

the decline in the public-debt/output ratio. This is consistent with viewing the debt/output guideline as facilitating a lower tax burden in the future, and not with facilitating the expansion of government expenditure. Given this argument, we proceed under the assumption of an exogenous pattern for g_t—reflecting the goal of controlling the size of government. However, we address the implications of considering spending as endogenous for the interpretation of the results.

2.3 Endogenous output

So far, output was assumed to be exogenous. A relevant question is whether the optimal pattern of tax and debt policy remain the same when taxation has a negative effect on output. In other words, the question is whether the tax rate remains high at a constant level until the critical date $\bar{t}$, while the debt/output ratio declines towards the guideline $\bar{b}$, and only then starts to decline.

It is shown in the appendix that endogenous output does not alter the form of the optimal policy pattern, under the assumption that lower taxes cannot reduce the debt/output ratio via the induced increase in output.

3 Simulation applied to the Israeli case

This section addresses first the no-guideline case ($\lambda = 0$) in Subsection 3.1, focusing on the degree to which output growth during the immigration period can explain the debt/output decline.[8] Then, the guideline ($\lambda > 0$) is introduced in Subsection 3.2. The procedure adopted is to combine the model with actual data on output and government spending for the period 1990-1999, and forecasts for the years beyond the sample, in order to simulate the paths for the tax rate and the debt/output ratio. In the no-guideline case, there is no constraint on the simulated evolution of the debt, and in the guideline case the parameters of the guideline are set so that the simulated debt mimics the actual decline.[9]

The starting year for the simulation (period 1 in the model) is taken as 1990. This year is a convenient choice for two reasons. First, as shown in Figure 6, the tax rate stabilizes around 1989.[10] According to the model, the tax rate should be smooth following the starting year of planning. Second, the year 1990 was chosen, rather than 1989, because the large-scale immigration from the former Soviet Union started unexpectedly at the end of 1989, while the model incorporates perfect foresight of future output growth.

The path for output growth, μ, is matched to the actual growth rate of GDP from 1990 to 1999, a forecast of 0.039 for 2000, and 0.04 thereafter.[11] The empirical counterpart of g is total public expenditure, net of interest

[8] For consistency between the debt and the other fiscal variables, the debt/output ratio was computed using deficits and output growth data (starting from the Bank of Israel's estimate for 1989).

[9] An alternative mechanism to mimic the actual decline in the debt/output ratio is by setting the discount rate of the policymaker lower than the interest rate. This implies a declining tax rate, while the observed tax rate during the sample is trendless. Hence, the quantitative decline in the tax rate resulting from calibrating the discount rate differential to get the actual debt/output decline represents a test of this alternative mechanism. It turns out that the implied negative trend in the tax rate is very small. Thus, one may conclude that this may be indeed an alternative explanation of the debt/output decline. The unappealing aspect of this explanation is that it contradicts the usual assumption that policymakers tend to have *high* discount rates.

[10] The tax rate includes the health tax in the entire sample.

[11] The choice of constant 4% growth beyond 2000 is probably low for a decade or so, and somewhat high for the period beyond. This approximation seems satisfactory given that the simulation results depend on the present values as of 1990. In any event, in terms of the long-run values, what matters primarily for the results is the difference $r - \mu$, which equals 1%. Therefore, the results are very similar with, say, $r = 0.045$ and $\mu = 0.035$.

Figure 6:

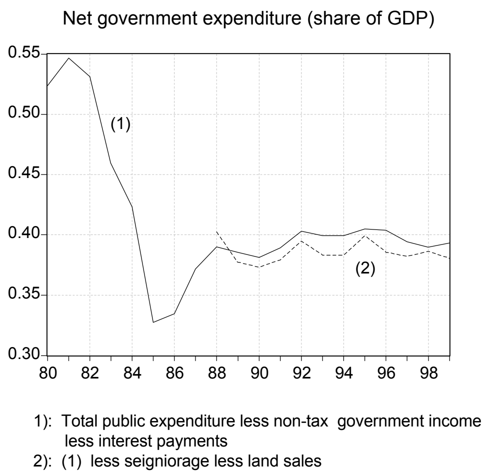

Figure 7:

payments and non-tax income, less income from seigniorage and state-owned land sale, as a fraction of GDP. The series is plotted in Figure 7.[12] The path for g is the actual one from 1990 to 1999. For the years beyond 1999, two scenarios are considered. In the main scenario, g declines gradually over 10 years a total of 1 percentage points of GDP.[13] The alternative scenario is that g does not decline, but stays constant at the same level as in the 1990-1999 period.

3.1 Simulation with no guideline

When $\lambda = 0$, the only consideration governing the pattern of the tax rate is tax-smoothing. As shown in Figure 6, the tax rate appears to be relatively stable from 1990 onwards, which is consistent with tax smoothing without major surprises during the period. The large immigration influx, which started at the end of 1989, in conjunction with tax smoothing, can, in principle, contribute to the explanation of the decline in the debt/output ratio.

Figure 8 displays output growth during the 1990-1999 period. The years of mass immigration (1990-1995) are characterized by high growth rates, while after 1996, the growth rates decline sharply.

The simulated debt/output ratio is shown in Figure 9, along with the actual data. It is clear that although high output growth during the 1990-1995 period can explain a decline in the debt, the reduction in the simulated debt during this period is slower than in the actual one. Moreover, since 1996, slow GDP growth has caused a reversal of the simulated debt/output ratio, which returns at the end of the period to the initial level.

We conclude here that the framework with no guideline fails to mimic the

[12] Government spending includes health expenditure financed by the health tax for the whole period.

[13] The 1 percentage-point reduction in the spending/output ratio is based on the assumption that the factors reducing g are somewhat stronger than the factors increasing it. The main factors reducing g are the following. (1) as mentioned in footnote 11, output growth during the next decade is expected to be relatively high. Hence, the share of public goods in GDP should decline accordingly. (2) The ongoing peace process gives room for some further reduction on the share of defense in GDP. The main factor increasing g is the decline in the share of unilateral transfers from abroad.

Regarding transfers to the public, its share is likely to remain largely unchanged given two opposing forces. On one hand the ratio of persons aged 65 or more to population is expected to decline in the 1998-2010 period. On the other, inequality is likely to increase.

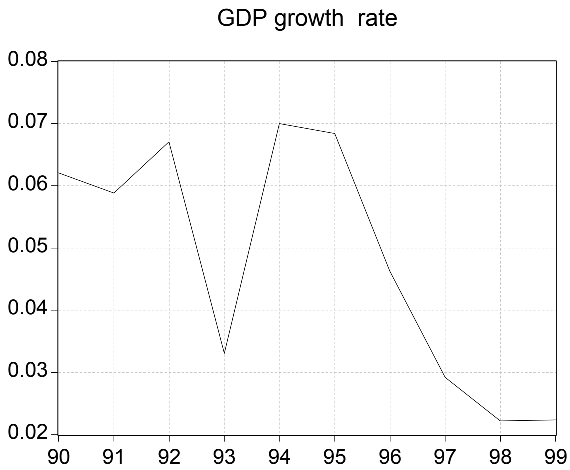

Figure 8:

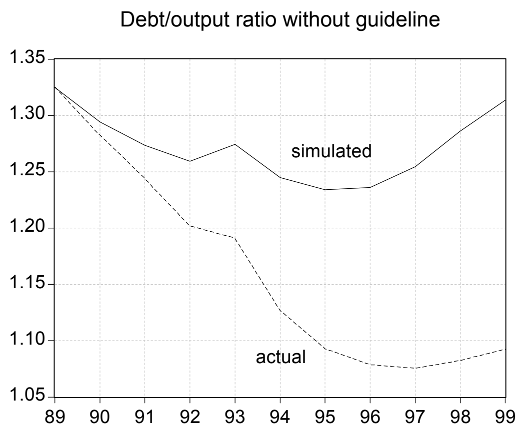

Figure 9:

actual reduction in the debt/output ratio. The next subsection introduces into the simulation such a guideline, whose severity is calibrated to explain the actual decline in the debt.

3.2 Simulation with a debt/output guideline

The purpose of this subsection is to evaluate the severity of a debt/output guideline. The procedure adopted consists in using the same data on output growth and government spending as above (for $\lambda = 0$), but the parameters of guideline severity (λ or $\bar{t}$) are now calibrated by fitting the simulated path of the public debt/output ratio to the observed decline in the actual data.

The first step is to choose the critical date $\bar{t}$. According to the model, the tax rate is smooth until $\bar{t}$, and then it starts to decline. Hence, if during the available sample the actual tax rate is stable, $\bar{t}$ should be beyond the sample, i.e., after 1998. Furthermore, given that the budget for the year 2000 does not include a tax reduction, the first plausible year to be taken for $\bar{t}$ is 2001—or $\bar{t} = 12$. We then use $\bar{t} \geq 12$.

The initial debt/output ratio, b_0, corresponding to the end of 1989, is 1.32. Taking the Maastricht guideline of 0.6 as the empirical counterpart of $\bar{b}$ implies that $b_0 > \bar{b}$, which corresponds to the interesting case in terms of Section 2. The interest rate, r, is set at the annual rate 0.05.

The resulting λ is 0.003, and the corresponding path of the tax rate is plotted in Figure 10. It can be observed that the resulting tax rate until 2001 is flat at 40.9% (somewhat higher than the average actual rate 40.4%). From 2001 onwards, the simulated tax rate starts to decline, asymptotically reaching 38.0%.

The basic results are based on choosing 2001 as the critical year for the reputation loss, but any year beyond 2001 is also consistent with the available data. Based on the discussion at the end of Section 2, there are higher values for both $\bar{t}$ and λ which leave the simulated path of b for 1990-1999 unchanged, i.e., as in actual data. One particular alternative is to let $\lambda \to \infty$, calibrating $\bar{t}$ so that b fits the data. In practice, $\lambda = 1000$ is chosen, resulting in $\bar{t} = 31$ (i.e., 2020). Figure 10 also plots the path for τ in this case. The tax rate remains at the 40.9% level until 2020, and then it declines immediately to the long-run level of 38.0%. The message that emerges from the alternative parameterization is that both a gradual or a sudden tax reduction are consistent with the observed fiscal policy.

Given the different alternative procedures for calibrating the model, one

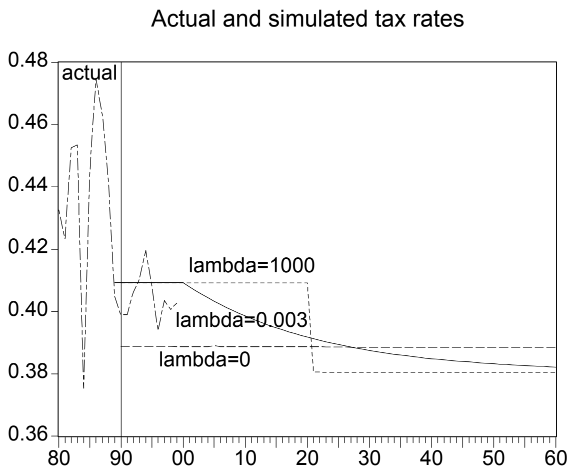

Figure 10:

cannot tell the degree of guideline severity by looking at λ only. A convenient way to evaluate the severity of the guideline is to compare the tax rate with $\lambda = 0$, 38.9% with the tax rate with $\lambda = 0.003$, 40.9%. The difference of 2.0 percentage points is interpreted as resulting from the guideline in the policymaker's objective function.

The alternative scenario for government spending is that after 1999, g does not decline by 1 percentage point of GDP, but stays constant at the average value over the 1990-1999 period. The resulting value of λ is 0.0012, and the tax rate for the $\lambda = 0$ case is 39.7%. Hence, the additional tax attributable to the guideline is reduced to 1.2 percentage points. The range for the extra tax generated by the two scenarios is, hence, 1.2-2.0 percentage points. Note that this range is biased downwards if one takes into account the possibility that taxes affect output negatively, as mentioned in Section 2.3 and analyzed in the appendix. In this case, when $\lambda = 0$, the lower τ, relative to the corresponding tax rate for $\lambda > 0$, is accompanied by higher output flows. Hence, τ can be reduced further and still satisfy the intertemporal budget constraint. Hence, the tax differential should be larger than in the computations above, where output is exogenous.

Note that if government spending is endogenous, as in Section 2.2, g is expected to *increase* after $\overline{t}$. Hence, the tax differential between the no-guideline and the guideline cases will be even smaller than in the second scenario above, where g remains exogenously constant, because the current tax rate takes into account the future higher level of spending. The tax rate differential in the endogenous g case, however, does not represent guideline severity anymore, because the effort to achieve the guideline is reflected in both higher τ and lower g—until date $\bar{t}$.

4 International perspective

An interesting reference for the present analysis is the group of countries which joined the Maastricht Treaty.[14] In this treaty a specific time-table was set, including fines on countries violating the public-debt guideline stipulated in the treaty. Indeed, in most of the countries in the group the debt/output ratio declined, at least in the last few years.[15] However, there are different patterns of debt reduction: a mild decline in Greece and Spain, and a dramatic decline in Ireland—where debt was reduced by more than 30 percent of GDP in the last five years. In this section we look at two countries in the Maastricht group: Italy and Belgium, which share with Israel the feature of a high historical debt. Similarly as for Israel, this section is devoted to evaluating guideline severity as reflected in the data for these two countries.

Given that the draft of the treaty was signed in February 1992, this year is appropriate as the starting period (period 1), and b_0 corresponds to the debt/output ratio at the end of 1991. A natural candidate for the critical date $\bar{t}$ is 1999, since fines on violators were stipulated to be enforced starting on January 1st, 1999.[16] The obvious choice for $\bar{b}$ is 60%, as specified in the treaty.

Figures 13 and 16 display the public-debt/output ratios for the two countries, using the reported gross debt levels until 1991 and—similarly as with the Israeli data—a calculation using general government expenditure, revenue and output growth, since then. Given that for both countries $b_0 > \bar{b}$, one could expect b to decline monotonically from 1991 to 1998. However, the

[14]The countries joining the treaty are (in parenthesis we quote the date of referendum approval): Belgium (5.11.92), France (23.9.92), Italy (29.10.92), Luxembourg (2.7.92), Holland (15.12.92), Ireland (18.6.92), Greece (31.7.92), Portugal (10.12.92), Spain (25.11.92), Denmark (18.5.93), United Kingdom (23.7.93), Germany (12.10.93), Austria (12.6.94), Finland (16.10.94) and Sweden (13.11.94). Source: Kessing's Records of World Events.

[15]Source of the data: European Economy (1998).

[16]International Currency Review (1991/92).

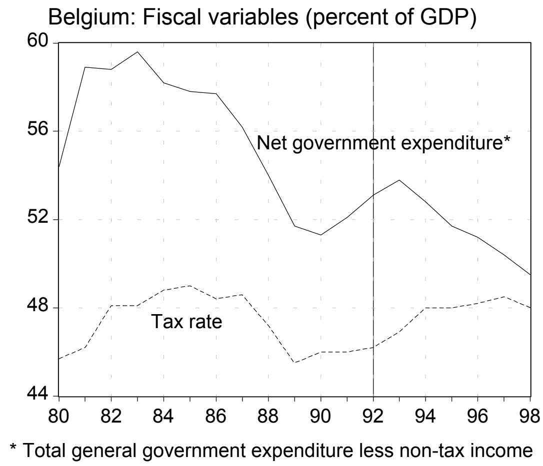

Figure 11:

debt/output ratio *increases* around the 1992-1994 period in both countries. This evidence does not necessarily contradict the relevance of a guideline, given that in those years there was low output growth (as shown in Figures 12 and 15), which motivate large deficits for tax-smoothing purposes.

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4.1 Simulation procedure

Actual data for output growth, μ, and public-spending/output ratios, g, are available in our sample until 1998. Values beyond the sample are chosen as follows. Output growth is set at the average level in the 1980-1998 sample: 1.9 % for both Italy and Belgium. In order to choose the expenditure/output ratios beyond 1998, we look at their behavior during the 1980-1998 sample in the two countries, as depicted in Figures 11 and 14. Public expenditure has a declining pattern since 1993. In particular, the expenditure/output ratio in 1998, the last year in the sample, is lower than the sample average. Assuming that this "correction" is permanent, g levels beyond 1998 are set at the 1998 value.[17] Finally, the real interest rate is set at 5%.

[17] See below for the implications of assuming the alternative assumption that this correction of g was not completed until 1998.

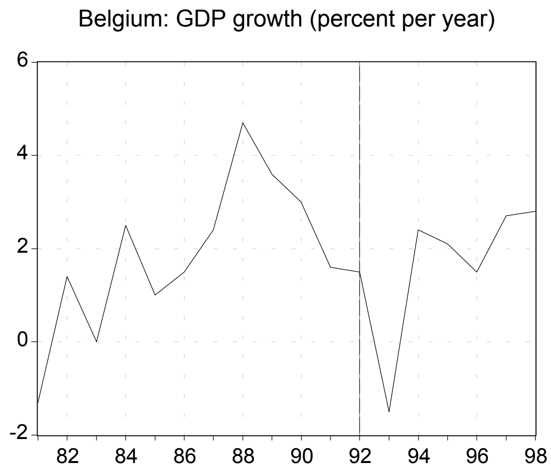

Figure 12:

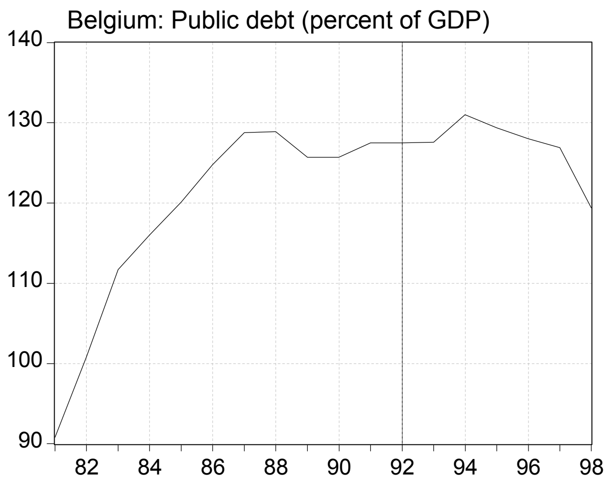

Figure 13:

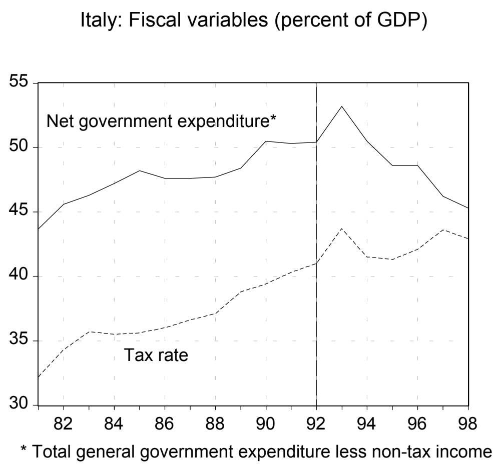

Figure 14:

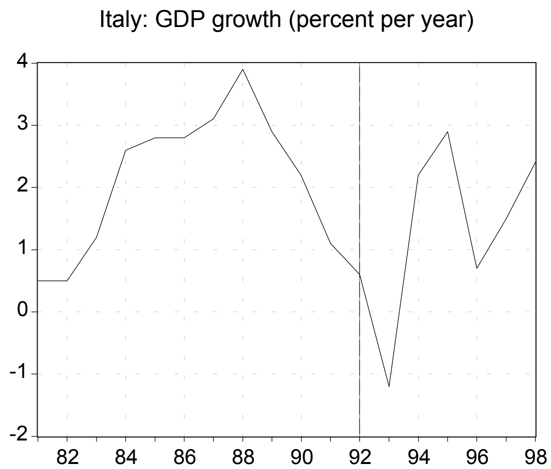

Figure 15:

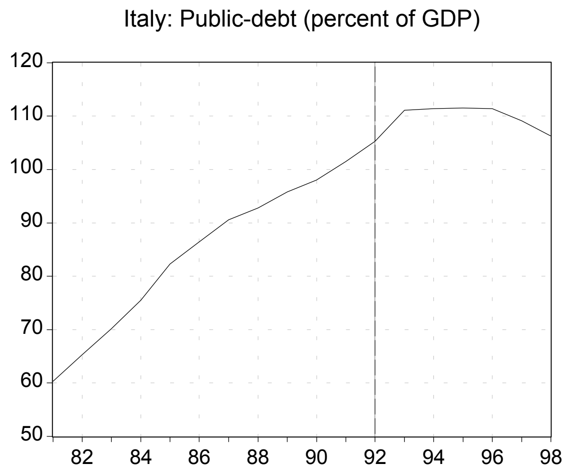

Figure 16:

Given the choice of $\bar{t}$ as 1999, the model predicts that the tax rate should be smoothened from 1992 to 1998. For Italy, the tax rate is close to being stable, but for Belgium it increases from 1992 to 1994, and only then does it stabilize. In what follows we ignore this, and consider the average tax rate over the 1992-1998 period.

Similarly to the simulation performed for Israel, λ is calibrated so that the simulated debt/output ratio for 1998 is equal to the actual figure.[18]

4.2 Results

The results are shown in the following table:

Country	λ	Additional tax relative to tax smoothing
Italy	0.0011	0.9 percent of GDP
Belgium	0.0027	2.0 percent of GDP

[18] In the case of Belgium it turns out that the actual tax rate is lower than the simulated one by 0.3 percent of GDP, while for Italy the actual tax rate is higher than the simulated rate by 0.7 percent of GDP. Part of this difference can be explained by real interest payments: while in Belgium the actual real interest rate during the 1992-1998 period matches very closely the assumption of 5 percent, in Italy it was 5.5 percent, which implies that the simulated tax payments are low.

The results indicate that the λ values for Italy and Belgium are lower than in the main scenario computed for Israel. These results, however, do not necessarily imply that the evaluated guideline severity is lower for Italy and Belgium than for Israel, given that $\bar{t}$ is much closer in the two Maastricht countries. In terms of the additional tax rate (relatively to tax smoothing), the figures for Italy and Belgium are 0.9 and 2 percentage points respectively, while for Israel the parallel figures in the two scenarios are 2.0 and 1.2 percentage points.

Clearly, the results shown in the table are sensitive to the assumption that the level of government expenditure, as a percent of GDP, remains beyond 1998 at the 1998 level. The resulting values of λ would be higher if it is assumed that the "correction" of the expenditure level—as observed since 1993—did not come to an end, and that the trend of reducing the relative size of government spending will continue.

5 Concluding remarks

This paper considers a public-debt/output guideline in a model of an optimizing policy maker. This guideline may reflect a reputation loss and/or a fine—as stipulated in the Maastricht Treaty.[19] The reduced form of the model implies that the government takes into account both the buffer role of deficits—which allow for tax smoothing—and the desire to avoid a high public-debt/output ratio.[20]

This framework provides a rationale for the observed behavior of the tax rate in Israel, which was kept constant since 1989 in spite of the drastic decline in the public debt.[21] According to the model, it is optimal to begin to reduce the tax rate only after reaching the critical date of guideline implementation. This result also holds when the negative effect of taxation on output is taken into account.

[19] Alternative mechanisms for generating the reduction of the public debt are the desire to reduce the debt burden on future generations, or the possibility of an unfeasible debt path, as analyzed by Drazen and Helpman (1990).

[20] These two elements are emphazised by Corsetti and Roubini (1993) in their analysis on optimal fiscal rules.

[21] As shown in Figure 2, the tax rate was reduced in 1989 and has been kept constant since then. The 1989 reduction of the tax rate was performed only after the deficit was reduced, following the stabilization plan in 1985 (for a detailed description of this point see Strawczynski and Zeira, 1999).

If government spending is considered endogenous, the model predicts that the paths of expenditure and the tax rate have mirror images: spending is low while the tax rate is high. Accordingly, expenditure begins to increase after the critical date of guideline implementation, leading to a long-run expenditure/output ratio which is higher than one with no guideline.

An international comparison shows that the Israeli debt reduction path may reflect a similar degree of guideline severity to that computed for two of the high-debt countries in the Maastricht Treaty.

Appendix - Endogenous output

This appendix explores the implications of output being a negative function of the tax rate. The model in Section 2 is modified in one respect: the exogenous Y is replaced by

$$Y = Y(\tau), \qquad Y'(\tau) < 0, \qquad Y''(\tau) < 0. \tag{9}$$

This specification is seen as a reduced form, reflecting negative effects of taxation on the motivation to produce.

The deadweight loss from taxation is now defined as the loss of output due to taxation:

$$v(\tau) \equiv Y(0) - Y(\tau), \qquad v'(\tau) > 0, \qquad v''(\tau) > 0, \tag{10}$$

where the signs of the derivatives follow from (9).

The revenue from taxation is given by the function

$$\begin{aligned} R(\tau_t) &\equiv \tau_t Y(\tau_t), \\ R'(\tau_t) &= \tau_t Y'(\tau_t) + Y(\tau_t), \\ R''(\tau_t) &= 2Y'(\tau_t) + \tau_t Y''(\tau_t) < 0, \qquad \text{(from (9))}. \end{aligned} \tag{11}$$

The solution of the planning problem in this, more general, case is based on the following assumption:

$$\frac{d}{d\tau_t}\left[\frac{B_t}{Y(\tau_t)}\right] < 0. \tag{12}$$

In words, increasing the tax rate today, given current spending and interest payments, reduces the debt/output ratio at the end of the period. A more detailed form of assumption (12) is obtained using the periodical budget constraint

$$B_t = (1+r)B_{t-1} - G_t - R(\tau_t),$$

which implies that

$$\frac{dB_t}{d\tau_t} = -R'(\tau_t). \tag{13}$$

Then,

$$\frac{d}{d\tau_t}\left[\frac{B_t}{Y(\tau_t)}\right] = \frac{-R'(\tau_t) - Y'(\tau_t)\frac{B_t}{Y(\tau_t)}}{Y(\tau_t)}.$$

Hence, (12) requires that

$$R'(\tau_t) + Y'(\tau_t)\frac{B_t}{Y(\tau_t)} > 0. \tag{14}$$

This condition has two parts. One is $R'(\tau_t) > 0$, i.e., τ_t has to be in the upward sloping range of the Laffer curve. Hence, a higher τ_t should make it possible to reduce B_t, the numerator in $B_t/Y(\tau_t)$ ratio. However, this is not enough for complying with (12). The reduction in B_t should not be offset by the decline in output, represented by the negative term $Y'(\tau_t)B_t/Y(\tau_t)$.

The current version of the planning problem is

$$Min\sum_{t=1}^{\infty}\left(\frac{1}{1+r}\right)^{t-1}\left[v(\tau_t) + \frac{\lambda}{2}(\frac{B_t}{Y(\tau_t)} - \bar{b})^2 I_t Y(\tau_t)\right], \tag{15}$$

subject to the periodical budget constraints, which are written here as

$$F(\tau_t, B_t, G_t, B_{t-1}) \equiv B_t - (1+r)B_{t-1} + G_t - R(\tau_t) = 0, \qquad t = 1, 2, ...\infty, \tag{16}$$

and the intertemporal budget constraint.

In Section 2, the optimality conditions were obtained by substituting the expression for τ_t from the periodical budget constraints into the objective function, leaving B_t as the decision variable. In (16) τ_t is an *implicit* function of B_t. The relevant partial derivatives of this implicit function are

$$\frac{d\tau_t}{dB_t} = -\frac{F_B}{F_\tau} = -\frac{1}{R'(\tau_t)} < 0,$$

$$\frac{d\tau_t}{dB_{t-1}} = \frac{1+r}{R'(\tau_t)} > 0,$$

where the signs follow from (14). The current counterparts of the first-order conditions in Section 2 are

$$-\frac{v'(\tau_t)}{R'(\tau_t)} + \frac{v'(\tau_{t+1})}{R'(\tau_{t+1})} + \lambda(\frac{B_t}{Y(\tau_t)} - \bar{b})I_t\left[\frac{Y(\tau_t) + \frac{Y'(\tau_t)}{R'(\tau_t)}B_t}{Y(\tau_t)}\right] - \frac{Y'(\tau_t)}{R'(\tau_t)}\frac{\lambda}{2}(\frac{B_t}{Y(\tau_t)} - \bar{b})^2 Y(\tau_t)I_t = 0, \tag{17}$$

$t = 1, 2...\infty$.

Note that when $\lambda = 0$, these conditions become:

$$-\frac{v'(\tau_t)}{R'(\tau_t)} + \frac{v'(\tau_{t+1})}{R'(\tau_{t+1})} = 0.$$

Since $\frac{v'(\tau)}{R'(\tau)}$ is a monotonic and increasing function of τ (from (14) and (11)), the solution is $\tau_t = \tau_{t+1}$, i.e., tax smoothing.

If $\lambda > 0$, the interesting case is when $b_0 > \overline{b}$. As in equation (4), $I_t = 0$ holds until period $\overline{t}$, and thus the tax rate is smooth till then. The main question is whether the tax rate follows the same type of pattern from period $\overline{t}$ onwards, as in Section 2.

Following a similar reasoning as Section 2, $B_{\overline{t}}/Y(\tau_{\overline{t}}) - \overline{b} > 0$ holds. The terms in square brackets in (17), which can be written as $\frac{1}{R'(\tau_t)}\left[R'(\tau_t) + Y'(\tau_t)\frac{B_t}{Y(\tau_t)}\right]$ is also positive from (14). Hence, $\frac{v'(\tau_{\overline{t}})}{R'(\tau_{\overline{t}})} > \frac{v'(\tau_{\overline{t}+1})}{R'(\tau_{\overline{t}+1})}$ holds, which implies $\tau_{\overline{t}+1} < \tau_{\overline{t}}$, i.e., the tax rate declines at time $\overline{t}$. So long as $B_t/Y(\tau_t)\ -\overline{b} > 0$ As $(b-\overline{b}) \rightarrow 0$, the tax rate converges again to a smoothened rate, at a lower level.

We conclude that output being a negative function of the tax rate should not alter the main conclusion in the text, i.e., tax rates are reduced only after the debt is substantially reduced towards the level implied by the implicit debt/output guideline.

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