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Fiscal Policy Through Time-Varying Tax Rates: If and How

Martin D. Kaufman

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Fiscal Policy Through Time-Varying Tax Rates: If and How

Prepared by Martin D. Kaufman[1]

Authorized for distribution by Saul Lizondo

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Abstract

This paper investigates if there are circumstances where time-varying tax rates could improve welfare and whether such policy can effectively be implemented in practice. While, in principle, variable taxes could improve welfare in some cases, the paper highlights the very particular circumstances that need to prevail. With liquidity constraints, a consumption-tax break is in a better footing to boost consumption and welfare than an income-tax break. A hike in consumption taxes can also be used to restrain consumption and improve welfare under time-consistency problems induced by hyperbolic discounting. However, variable taxes are subject to serious implementation problems fettering their use.

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Author's E-Mail Address: Mkaufman@imf.org

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I. INTRODUCTION

Time-varying tax rates, defined as tax rates that hinge on the state of the business cycle, have been used sporadically in different countries and under different circumstances. In the late sixties, for example, the U.S. Government hiked temporarily income taxes to counter the effect of fast-growing economic activity on inflation.[2] On the other hand, countries such as Japan and Thailand have used in recent years temporary tax breaks to attempt to boost economic activity during times of recession. In the case of Chile, the issue of variable tax rates for counter-cyclical purposes has been in the academic and political arena for the last few years.[3] In contrast with the occasional use done by some countries in exceptional circumstances, like a deep and protracted slump in economic activity, in Chile the use of variable taxes has been envisaged more as a fine-tuning policy scheme in which tax rates are adjusted according to the state of the business cycle.

In this context, the aim of this paper is to investigate from an analytical viewpoint whether there are circumstances when fiscal policy through time-varying tax rates can improve welfare and whether this policy can be effectively implemented in practice. We select two cases that present at least the potential for time-varying taxes to improve welfare: one is the case of *under-consumption* resulting from negative transitory shocks to income and binding credit constraints; the other is the case of *over-consumption* resulting from time inconsistency in the allocation of consumption due to a change in preferences, i.e. time-decreasing discount rates.

This paper examines whether changes in tax rates could be used to boost or to restrain consumption in such a way as to increase welfare. Under binding liquidity constraints, a reduction in consumption taxes is more prone than a reduction in income taxes to boost consumption and improve welfare. In presence of time consistency problems in the allocation of consumption induced by hyperbolic discounting,[4] a hike in consumption taxes can be used

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[2] For a review of the U.S. experience in 1968 with the use of tax rates for counter-cyclical purposes see for example Okun (1971, 1975), Brandson (1973), and Springer (1977). For more recent empirical literature on the consumption effect of tax changes in the United States see Parker (1999).

[3] Budnevich and Le Fort (1997) have discussed the potential benefits and shortcoming of such policy for Chile.

[4] Hyperbolic discounting of consumers' utility, vis-à-vis the traditional exponential discounting, determines a time-decreasing discount rate as opposed to the traditional constant rate of discount. This implies that foregoing consumption for one period today is more costly in terms of utility than foregoing consumption for one period at any time in the future; thus the optimal plan will be changed period after period (a time consistency problem). This 'impatience' in consumption generates a front-loaded consumption path that is sub-optimal

(continued...)

to restrain consumption and improve welfare. However, the use of variable tax rates presents serious implementation problems.

While this paper shows that, in principle, variable taxes could improve welfare in some cases, it also highlights the very particular circumstances that need to prevail for such a result to follow. This places the burden of proof onto the proponents of variable taxes to demonstrate that these specific circumstances are actually present in the particular case considered.

More generally, the discussion of variable tax rates as a counter-cyclical policy invokes many questions related to counter-cyclical policies at large: Can the authorities act timely so as not to exacerbate cycles? Can the authorities correctly distinguish transitory from permanent shocks? These interrogations need to be reckoned carefully over and above the issues that this paper addresses in detail.

Moreover, many questions that we will not tackled here need to be dealt with before serious consideration is given to using tax rates for counter-cyclical policy. The first road-fork to be encountered is the question of why fiscal instruments instead of monetary instruments to pursue counter-cyclical policies. Then there is the question of why use tax rates for fiscal policy and not public expenditures. In fact, the use of tax rates would contradict the well-established tax-smoothing proposition when taxes are distortionary (Barro (1979)).

Finally, there are several strands of related literature that this paper will not deal with but that are worth bearing in mind for balance and perspective. First there is the optimal taxation issue from the standpoint of income versus consumption taxation or uniform versus differential taxation across consumption goods and sources of income (on this see for example Harberger (1974), Chari and Kehoe (1999) and Judd (1998a, b)),[5] the focus of this paper will be instead on optimal taxation from the point of view of tax-smoothing versus time-varying tax rates for a given type of tax and in specific circumstances. Secondly, there is a literature that deals with the issue of investment and investment stimuli under irreversibility (on this see for example Pennings (2000)), which addresses the effect of taxation on the timing of investment; the analysis in this paper will center on consumer decisions. Lastly, there is also a vast literature on the relationship of private and public savings that highlights the extent of private offset of changes in public savings (on this see for example Loayza, Schmidt-Hebbel and Serven (2000) and Lopez, Schmidt-Hebbel and Serven (2000)).

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and the consumer would be better off if it could make an irrevocable commitment on its consumption path.

[5] Also see Lucas and Stockey (1983) for optimality and time-consistency.

The paper is organized as follows: in the next two sections we identify in theory circumstances under which variable tax rates could potentially improve welfare. Thus, section II deals with the case of a temporary reduction in tax rates to boost private consumption in presence of a negative transitory shock and binding credit constraints, while section III considers the case where tax rates are transitorily increased to restrain private consumption under hyperbolic discounting (time-decreasing discount factor). Then, in section IV we address feasibility and implementation issues impinging on the use of variable tax rates. The last section concludes by summarizing the main findings.

II. THE USE OF VARIABLE TAXES TO BOOST CONSUMPTION UNDER CREDIT CONSTRAINTS: CAN TIME-VARYING TAXES INCREASE WELFARE?

To answer the question posed in the title of this section, we analyze separately the cases of income and consumption taxation.[6] The exercise performed is to compare the case of a constant tax rate (the optimal solution without credit constraints) with the case of tax rates that vary with the state of nature to investigate if, in presence of binding liquidity constraints, it is possible to improve welfare under the second alternative.

The results are derived from a theoretical framework comprising a representative agent that maximizes utility over its life-time horizon and a government that maximizes welfare using distortionary taxes. In this two-period model, the states of nature (productivity shock) are reveled at the beginning of times, and determine in each period the representative agent's real return on labor. In presence of a maximum-debt constraint, the state of nature in period 1 will determine whether the credit constraint is binding or not. The government levies taxes to finance a given stream of public expenditures (which we assume do not enter into the representative agent's utility function) and faces no credit constraint (which is needed to be able to pursue counter-cyclical fiscal policies). The economy has a constant return to scale production function, scaled by a productivity factor, with labor as the sole input.[7] The economy is small and internationally open, thus facing given good prices and the international interest rate.

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[6] It must be noted, at the start, that the use of fiscal policy to try to correct an imperfection in the financial market, such as the credit constraint, is not a first best solution. The first best response would be to tackle the problem at the source, i.e. to correct the informational or institutional problems that originate the imperfection in the financial sector. Only if the first best solution cannot immediately be applied does the search for second best remedies gain relevance. In this section we analyze one of those options, but no attempt is made to study it comparatively or produce a welfare-ranking vis-à-vis other alternatives.

[7] The lack of capital and income taxation on dividends in the model may bias some of the results obtained in the following section. Specifically, the preferred use of consumption taxation vis-à-vis income taxation may be less robust once taxes on dividends are introduced.

For the case of income taxes, when agents face binding liquidity constraints[8] and tax distortions are small, time-varying tax rates may improve welfare. In absence of credit constraints there is no role for government action to smooth private consumption and the welfare maximizing policy is to minimize distortions by fixing tax rates across time (Barro's (1979) tax smoothing hypotheses). With credit constraints, a policy of time-varying tax rates faces a welfare trade-off between labor distortions and private consumption smoothing.

For consumption taxation, the unconstrained optimal policy is again tax smoothing. But, with binding liquidity constraints, variable consumption taxes are in a better footing than income taxes to improve welfare since they do no distort labor decisions. The intuition of this result is as follows: with tax smoothing a binding liquidity constraint prompts agents, at some margin, to work harder in that period to close the gap between desired and constrained consumption. Lowering income tax rates in the period when the constraint is binding increases the disposable income and thus would tend to relieve the need to work harder but at the same time lower income tax rates create the incentive to work more, thus distorting the allocation that would have resulted from lump-sum tax breaks. Lower consumption taxes, in turn, will increase real income without distorting the inter-temporal allocation of labor, but will otherwise induce a consumption path tilted toward the current period. Inter-temporal lump-sum transfer would be the only nondistortive policy to relive cash-strapped agents, which we assume here non-feasible.

A. Income Tax Case

This section analyzes the case where the government levies income taxes to finance a given stream of government expenditures[9]. If credit constraints are non-binding, there is simply no role for government action to smooth private consumption and the welfare maximizing policy boils down to minimizing tax distortions (Barro's (1979) tax smoothing hypotheses), which is achieved by fixing tax rates across time. If credit constraints are binding time-varying income tax rates may improve welfare[10] in certain cases.

The starting point is to recognize that, under a negative transitory shock to income (and constant tax rates), individuals would like to borrow to smooth their consumption. However, under binding liquidity constraints they would not be able to do so, and the only way to achieve some smoothing of consumption would be to work harder in that period. This will

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[8] Note that liquidity constraints rule out Ricardian equivalence.

[9] The analysis presented in this section can readily be applied to transitory and fully-compensated changes in any income-related tax, such as mandatory pension contributions.

[10] Note that in this case time-varying taxes are also state-contingent taxes.

induce an intertemporal allocation of consumption tilted toward the future (because full smoothing will not be accomplished) and an allocation of labor tilted toward the present relative to the unconstrained allocations.

However, a policy that reduces tax rates in presence of negative transitory shocks can increase welfare when tax distortions are small and the liquidity constraint is strongly binding, i.e. the allocation of consumption is far-off from the optimal unconstrained allocation; this is because lower tax rates can achieve an allocation of consumption and labor closer to the unconstrained optimal one, and that such allocation can, under some conditions, improves welfare.

To show these results we will use the framework presented above where the representative agent's problem can be stated as follows:

$$\max_{c,l} \quad U = U(c_1, l_1) + \beta U(c_2, l_2); 0 < \beta < 1$$

with $U_c > 0$, $U_{cc} < 0$, $U_l < 0$, $U_{ll} < 0$

Subject to:

$$(\lambda)\ W \equiv \omega_1 l_1 (1-\tau_1) + \delta \omega_2 l_2 (1-\tau_2) = c_1 + \delta c_2; \quad \delta = \frac{1}{1+r}$$

$$(\mu)\ D_1 \le \overline{D}; D_1 = c_1 - \omega_1 l_1 (1-\tau_1)$$

Alternatively, (λ) can be expressed in a non-Ponzi game condition form:

$$D_2 = 0 = c_2 + (1+r) D_1 - \omega_2 l_2 (1-\tau_2)$$

Where c stands for consumption, l for labor, ω for labor income, W for wealth, τ for income tax rate, r for interest rate, D for debt, $\overline{D}$ for maximum debt constraint, λ is the intertemporal budget constraint multiplier, and μ is the liquidity constraint multiplier.

The first order conditions for this problem, which are sufficient conditions given the strict concavity of the utility function with respect to consumption and leisure, are:[11]

[11] We assume throughout the paper that the constraint $l_i \le l^{max}$ $\forall i$ is non-binding, i.e. we consider only interior solutions.

c) $U_{c_1} = \lambda + \mu$

$\beta U_{c_2} = \lambda\delta$

$$\left.\right\} \quad \frac{U_{c_1}}{U_{c_2}} = \frac{(\lambda+\mu)}{\lambda}\frac{\beta}{\delta} \qquad (\mathrm{I})$$

l) $U_{l_1} = -\lambda\omega_1(1-\tau_1) - \mu\omega_1(1-\tau_1)$

$\beta U_{l_2} = -\lambda\delta\omega_2(1-\tau_2)$

$$\left.\right\} \quad \frac{U_{l_1}}{U_{l_2}} = \frac{(\lambda+\mu)\omega_1(1-\tau_1)\beta}{\lambda\omega_2(1-\tau_2)\delta} \quad (\mathrm{II})$$

μ) $\overline{D} - D_1 \geq 0 \vee \mu \geq 0 \wedge \mu(\overline{D} - D_1) = 0$ (III) Kuhn-Tucker condition

In turn, the government's problem can be presented as:

$$\max_{\tau_1} \quad \mathbf{U} = U(c_1, l_1) + \beta U(c_2, l_2)$$

Subject to: (I), (II), (III); and

Non-Ponzi game condition $\quad B_2 = 0 = G_2 + (1+r)B_1 - \omega_2 l_2 \tau_2$

where $\quad B_1 = G_1 - \omega_1 l_1 \tau_1$

and given (G_1, G_2).

Note that the non-Ponzi game condition determines a general negative relationship between τ_1 and τ_2 given by:

$$\tau_2 = \frac{G_2 + (1+r)B_1}{\omega_2 l_2} = \frac{G_2 + (1+r)G_1 - (1+r)\omega_1 l_1 t_1}{\omega_2 l_2}$$

Plugging this condition into the wealth equation shows that the timing of taxes has no direct effect on wealth, as depicted below, but taxes do affect wealth through their effect on labor supply.

$$\begin{aligned} W &= \omega_1 l_1(1-\tau_1) + \delta\omega_2 l_2\left\{1 - \frac{[G_2 + (1+r)G_1 - (1+r)\omega_1 l_1 \tau_1]}{\omega_2 l_2}\right\} \\ &= \omega_1 l_1 + \delta\omega_2 l_2 - (G_1 + \delta G_2) \end{aligned}$$

We will use this framework to present two main results: (i) with a non-binding liquidity constraint the optimal policy is to set a constant across-time tax rate, and (ii) if the liquidity constraint is binding then, under certain conditions, a variable tax rate can be welfare improving.

Result 1: *If the credit constrain is non-binding, the optimal tax policy to maximize welfare is to minimize tax distortions which is achieved under* $\tau_1=\tau_2$.

This result derives from (I) and (II). If the credit constrain is not binding then $\mu=0$ and from (I) the allocation of consumption between period 1 and 2 will be independent of the timing of taxes. Moreover, from (II) if $\tau_1=\tau_2$ (tax smoothing) then the intertemporal allocation of labor would be undistorted (as in the case of lump-sum taxation).

Note however that if the credit constraint is binding then the tax smoothing policy will imply the following allocation of consumption and labor, where an asterisk denotes the unconstrained allocation of consumption and labor and an upper bar represents the constrained allocation, both under tax smoothing:

$$\bar{c}_1 < c_1^*$$
$$\frac{\bar{c}_1}{\bar{c}_2} < \frac{c_1^*}{c_2^*}$$
$$\bar{l}_1 > l_1^*$$
$$\bar{l}_2 < l_2^*$$

The first inequality, where consumption in period 1 is below the unconstrained consumption level, follows from (III). In words, if the credit constraint is binding, then consumption is restricted by whatever amount of financing is available (in this case $\bar{D}$).

The change in the consumption path can be derived from (I) where the binding liquidity constraint ($\mu>0$) creates a wedge between present and future marginal utility of consumption dislocating the unconstrained optimal smoothing. Since the relative marginal utility of consumption is higher in period 1 then the consumption path needs to be tilted toward the second period compared to the unconstrained allocation.

Moreover, consumption in period 2 will be above the unconstrained optimum if as a result of the binding liquidity constraint there is a positive wealth effect product of an increase in income from an expanded labor supply (in period 1 not fully compensated by a reduction in period 2; see below).

From (II) period 1 labor supply in the liquidity-constraint case is above the unconstrained optimum. Given that $\mu>0$, the only way that (II) will hold is for labor supply to be above the unconstrained optimum.[12] Also, from (II) it can be realized that labor supply in period 2 will be below the unconstrained optimum. This is because a higher l_1 will tend to reduce the wealth multiplier λ, and for this first order condition to hold l_2 will need to be below the unconstrained optimum (which in turn will tend to make the marginal utility of labor less negative and increase λ).

Result 2: *With credit constraints, variable income tax rates can, under certain conditions, be welfare improving. Specifically, a policy that reduces tax rates in presence of negative transitory shocks can increase welfare when tax distortions are small and the liquidity constraint is strongly binding.*

To see this result it suffices to show that there is a case, under $\mu>0$, where there exist a $\tau'_1<\tau_1=\tau_2$ such that $\mathbf{U}(\tau'_1)>\mathbf{U}(\tau_1)$. We proceed in two steps: first we show the conditions under which a reduction in period 1 taxes can achieve an allocation of consumption and labor closer to the unrestricted optimal one, and then we show under what conditions such allocation may improve welfare.

Consider first the following allocation of consumption and labor under $\tau'_1<\tau_1=\tau_2$ and $\mu>0$:

$$\bar{c}_1 \langle c_1^{\tau'} \langle c_1^*$$
$$c_2^* \langle c_2^{\tau'} \langle \bar{c}_2$$
$$l_1^* \langle l_1^{\tau'} \langle \bar{l}_1$$
$$\bar{l}_2 \langle l_2^{\tau'} \langle l_2^*$$

A lower first-period tax rate will induce higher consumption in period 1 compared to the constant tax rate case when, adjusted for the effect on wealth ($\partial\lambda/\partial\tau_1$), it reduces the credit constraint multiplier. This follows from (I):

$$\frac{\partial\lambda}{\partial\tau_1}+\frac{\partial\mu}{\partial\tau_1}\rangle 0$$

[12] To see this result suppose the opposite case that the labor supply were below the unconstrained optimum, then the marginal disutility of labor would be lower whereas the right hand side of (II) would be more negative (both because of the positive credit constraint multiplier and because a lower labor supply in period 1 would increase the wealth multiplier λ).

It is immediate to see that a reduction in the tax rate will reduce the credit constraint multiplier (μ) since a tax break increases the disposable income in period 1—allowing higher consumption of goods and leisure (lower labor supply) in that period, and thus it has the equivalent effect of an increase in the maximum debt $\overline{D}$ and a relaxation of the credit constraint.

Notice also that any wealth effect of a change in tax rates derives from the effect on the supply of labor:

$$\frac{\partial W}{\partial \tau_1} = (1-\tau_1)w_1 \frac{\partial l_1}{\partial \tau_1} + \delta(1-\tau_2)w_2 \frac{\partial l_2}{\partial \tau_1}$$

Moreover, from (I) consumption in the second period will be affected through a wealth effect ($\partial\lambda/\partial\tau_1$). Specifically, lower tax rates in period 1 will induce lower second period consumption if there is a negative wealth effect ($\partial\lambda/\partial\tau_1<0$). This requires that the labor supply in period 2 does not increases excessively as a result of labor reduction in period 1 (see below).

Turning to labor supply, a lower period 1 tax rate will determine a lower labor supply in period 1 when the credit constraint multiplier, controlling for the effect on wealth, is reduced; this is the result of a reduced need to over-work to compensate for the lack of financing to achieve the optimal consumption plan. But the required reduction of the multiplier is larger than the one for higher consumption in period 1 because here there is at play both an income and a substitution effect, while in the higher period 1 consumption condition there was only the income effect. Period 1 labor supply will be lower if the income effect (reduction in the credit constraint multiplier (μ) adjusted by the wealth effect (λ)) exceeds the substitution effect. The income effect, i.e. the higher disposable income brought about by a reduction in the tax rate (shown below by the second term inside the brackets), supports lower first period labor; the substitution effect, i.e. the higher return to labor in period 1 (shown by the term ($\lambda+\mu$) inside the brackets), induces higher labor in the first period. The presence of a substitution effect curbs the reduction in period 1 labor. From (II), this is displayed by:

$$\frac{\partial U_{l_1}}{\partial \tau_1} = w_1\left\{(\lambda+\mu)-(1-\tau_1)\left[\frac{\partial \lambda}{\partial \tau_1}+\frac{\partial \mu}{\partial \tau_1}\right]\right\} < 0 \quad \text{if} \quad \frac{\partial \lambda}{\partial \tau_1}+\frac{\partial \mu}{\partial \tau_1} > \frac{(\lambda+\mu)}{(1-\tau_1)}$$

Lastly, period 2 labor supply will be higher (toward the unconstrained optimal labor allocation) provided that it does not prevent a negative wealth effect, so that the effect of variable taxes on the overall labor supply does not imply a net increase in labor income and wealth. From (II), this is shown by:

$$\frac{\partial U_{l_2}}{\partial \tau_1} = -\frac{\delta}{\beta} w_2 \left[\frac{\partial \lambda}{\partial \tau_1}(1-\tau_2) - \lambda \frac{\partial \tau_2}{\partial \tau_1}\right] > 0 \quad \text{if} \quad \frac{\partial \lambda}{\partial \tau_1} < \frac{\lambda}{(1-\tau_2)} \frac{\partial \tau_2}{\partial \tau_1} < 0$$

Notice that the reduction in the first period tax rate (and the rise in period 2) has both a wealth effect (first term inside the brackets) and a substitution effect (second term). The latter will induce, other things equal, a lower labor supply in the second period; thus the increase in labor supply in period 2 will be lessened by the presence of the substitution effect.

Having shown the conditions that will lead to an intertemporal allocation of consumption and labor closer to the optimal unrestricted allocation under variable taxes, we turn now to the condition for higher welfare of the tax-varying allocation vis-à-vis the constant tax rate allocation.

Welfare will generally be higher with lower tax rates in period 1 (under a strictly positive liquidity constraint multiplier) when the welfare gains of moving consumption and labor in period 1 closer to the unconstrained optimal allocation outweighs the discounted welfare loss of moving consumption and labor in period 2 closer to the unconstrained optimum. This condition will be more likely to hold the farther apart the credit-constrained tax-smoothing allocation is from the optimal unrestricted one, i.e. how binding the liquidity constraint is. The more binding the credit constraint is the more likely that variable tax rates will lead to an allocation of consumption and labor with higher welfare than the tax-smoothing allocation. This follows from:

$$\frac{\partial U}{\partial \tau_1} = U_{c_1}\frac{\partial c_1}{\partial \tau_1} + U_{l_1}\frac{\partial l_1}{\partial \tau_1} + \beta\left[U_{c_2}\frac{\partial c_2}{\partial \tau_1} + U_{l_2}\frac{\partial l_2}{\partial \tau_1}\right]$$

and the fact that the allocation obtained above implies:

$$\frac{\partial c_1}{\partial \tau_1}\langle 0,\ \frac{\partial l_1}{\partial \tau_1}\rangle 0,\ \frac{\partial c_2}{\partial \tau_1}\rangle 0,\ \frac{\partial l_2}{\partial \tau_1}\langle 0$$

Thus, such allocation will have higher welfare than the tax-smoothing allocation with a binding liquidity constraint ($\mu>0$) when:

$$-\left[U_{c_1}\frac{\partial c_1}{\partial \tau_1} + U_{l_1}\frac{\partial l_1}{\partial \tau_1}\right]\rangle\, \beta\left[U_{c_2}\frac{\partial c_2}{\partial \tau_1} + U_{l_2}\frac{\partial l_2}{\partial \tau_1}\right]$$

The welfare gains of moving (c_1, l_1) closer to the unconstrained optimal allocation need to out-weigh the discounted welfare loss of moving (c_2, l_2) closer to the unconstrained optimum. This will prove to be the case the higher U_{c1} and $-U_{l1}$ are, which in turn depends on how far apart (c_1, l_1) and (c^*_1, l^*_1) are, i.e. how binding the liquidity constraint is in the tax smoothing case. The more binding the credit constraint is the more likely that variable tax rates could lead to an allocation of consumption and labor with higher welfare than the constant-tax allocation. Moreover, the welfare effect will depend also on the degree of distortion of

income taxes on the allocation of labor; the heightened incentive to work of an income tax break in period 1 (substitution effect) can make the labor allocation change only modestly and lessen the prospects for variable taxes to increase welfare.

Thus, when credit constraints are binding time-varying tax rates can improve welfare depending on how binding credit constraints are vis-à-vis the labor distortion of income taxes.

B. Consumption Tax Case

This section analyzes the effect of variable consumption tax rates on welfare under binding liquidity constraints. In the case of consumption taxation, even with non-binding credit constraints time varying tax-rates affect the allocation of consumption. This is because time-varying taxes affect the relative price of consumption today vis-à-vis tomorrow. As before, the optimal policy to maximize welfare without credit constraints is achieved under constant tax rates. This result follows from the fact that fixed tax rates across time will lead to the intertemporal allocation of consumption that would prevail in the case of lump-sum taxation. With binding liquidity constraints, a policy of variable consumption tax rates can be welfare improving vis-à-vis a policy of constant tax rates under some conditions. These conditions are less stringent than those discussed above for income taxation.

The use of consumption taxes requires a slight modification of the framework used in the previous section so that now the consumer's problem becomes:

$$\max_{c,l} \quad \mathbf{U} = U(c_1, l_1) + \beta U(c_2, l_2); \; 0 \langle \beta \langle 1$$

with $\quad U_c \rangle 0, \; U_{cc} \langle 0, \; U_l \langle 0, \; U_{ll} \langle 0$

Subject to:

$$(\lambda) \; W \equiv \omega_1 l_1 + \delta \omega_2 l_2 = c_1(1+\tau_1) + \delta c_2(1+\tau_2); \quad \delta = \frac{1}{1+r}$$

$$(\mu) \; D_1 \leq \overline{D}; D_1 = c_1(1+\tau_1) - \omega_1 l_1;$$

Again (λ) we can expressed in a non-Ponzi game condition form:

$$D_2 = 0 = c_2(1+\tau_2) + (1+r)D_1 - \omega_2 l_2$$

Where c stands for consumption, l for labor, ω for labor income, W for wealth, τ now denotes the consumption tax rate, r the interest rate, D the debt, $\overline{D}$ the maximum debt constraint, λ is the intertemporal budget constraint multiplier, and μ is the liquidity constraint multiplier.

In this case the first order conditions, which are again sufficient conditions given the strict concavity of the utility function with respect to consumption and leisure, are:

c) $U_{c_1} = (\lambda + \mu)(1+\tau_1)$

$$\left.\begin{array}{l} U_{c_1} = (\lambda+\mu)(1+\tau_1) \\ \beta U_{c_2} = \lambda\delta(1+\tau_2) \end{array}\right\} \qquad \frac{U_{c_1}}{U_{c_2}} = \frac{(\lambda+\mu)}{\lambda}\frac{(1+\tau_1)}{(1+\tau_2)}\frac{\beta}{\delta} \quad (\text{I}')$$

l) $U_{l_1} = -\lambda\omega_1 - \mu\omega_1$

$$\left.\begin{array}{l} U_{l_1} = -\lambda\omega_1 - \mu\omega_1 \\ \beta U_{l_2} = -\lambda\delta\omega_2 \end{array}\right\} \qquad \frac{U_{l_1}}{U_{l_2}} = \frac{(\lambda+\mu)\omega_1\beta}{\lambda\omega_2\delta} \quad (\text{II}')$$

μ) $\overline{D} - D_1 \geq 0 \vee \mu \geq 0 \wedge \mu(\overline{D} - D_1) = 0$ (III') Kuhn-Tucker condition

From the government's non-Ponzi game condition the negative relationship between τ_1 and τ_2 is now shown by:

$$\tau_2 = \frac{G_2 + (1+r)B_1}{c_2} = \frac{G_2 + (1+r)G_1 - (1+r)c_1\tau_1}{c_2}$$

Result 3: *Under consumption taxation, even with non-binding credit constraints, time varying tax-rates affect the path of consumption. The optimal policy to maximize welfare with μ=0 is achieved again under tax smoothing ($\tau_1 = \tau_2$).*

This result follows immediately from (I') and (II'); only when $\tau_1 = \tau_2$ the intertemporal allocation of consumption is undistorted as in the case of lump-sum taxation.

As in the case of income taxation, when the credit constraint is binding tax smoothing will determine the following allocation of consumption and labor, where an asterisk denotes the unconstrained allocation of consumption and labor and an upper bar represents the constrained allocation:

$$\bar{c}_1 < c_1^*$$
$$\frac{\bar{c}_1}{\bar{c}_2} < \frac{c_1^*}{c_2^*}$$
$$\bar{l}_1 > l_1^*$$
$$\bar{l}_2 < l_2^*$$

From (III') it follows that consumption in period 1 is below the unconstrained consumption level. The change in the consumption path can be derived from (I') where the binding liquidity constraint ($\mu>0$) creates a wedge between present and future marginal utility of consumption impeding the unconstrained optimal smoothing.

From (II') the labor supply in the liquidity-constrained case is above the unconstrained optimum. Given that $\mu>0$, the only way that (II') will hold is for labor supply to be above the unconstrained optimum. Also from (II'), it can be seen that labor supply in period 2 will be below the unconstrained optimum.

Result 4: *With binding liquidity constraints, a policy of variable consumption taxes (reducing rates in times of negative transitory shocks) can, under some conditions, be welfare improving vis-à-vis a policy of tax smoothing; the conditions to do so are less stringent than those for the income tax case.*

To establish this result we will proceed as we did in the case of income taxation. We proceed first by showing the conditions under which a reduction in period 1 taxes can achieve an allocation of consumption and labor closer to the unrestricted optimal allocation, to then show the conditions needed for such allocation to improve welfare.

Consider the following allocation of consumption and labor under $\tau'_1<\tau_1=\tau_2$ and $\mu>0$:

$$\bar{c}_1 < c_1^{\tau'} < c_1^*$$
$$c_2^* < c_2^{\tau'} < \bar{c}_2$$
$$l_1^* < l_1^{\tau'} < \bar{l}_1$$
$$\bar{l}_2 < l_2^{\tau'} < l_2^*$$

A lower first-period tax rate will induce higher consumption in period 1 compared to the constant tax rate case when, adjusted for the wealth effect ($\partial\lambda/\partial\tau_1$), the credit constraint multiplier is reduced. From (I'):

$$\frac{\partial\lambda}{\partial\tau_1}+\frac{\partial\mu}{\partial\tau_1} > -\frac{(\lambda+\mu)}{(1+\tau_1)}$$

This condition, compared to that of income taxation, supports now a broader set of wealth effects, i.e. larger negative wealth effects, and thus it is more likely to hold. This is because the reduction in period 1 tax rate induces, ceteris paribus, higher consumption in that period (substitution effect). As a result, consumption in period 1 will be higher even under a larger negative wealth effect relative to the income tax case.

Moreover, from (I') consumption in the second period will now also be affected by both a wealth effect ($\partial\lambda/\partial\tau_1$) and a substitution effect (increased cost of consumption in that period).

As a result, a lower tax rate in period 1 (and higher tax rate in period 2) will lead to lower second period consumption even under a limited positive wealth effect:

$$\frac{\partial U_{c_2}}{\partial \tau_1} \langle 0 \text{ if } \frac{\partial \lambda}{\partial \tau_1} \langle \frac{-\lambda}{(1+\tau_2)} \frac{\partial \tau_1}{\partial \tau_2}$$

This is because the higher consumption tax in period 2 will prompt by itself a reduction in consumption even if the effect of variable consumption taxes on the overall labor supply is somewhat positive, i.e. if the increase in period 2 labor supply outweighs the reduction in first period labor, and there is an increase in labor income and wealth.

Turning to labor allocation, a lower period 1 tax rate will determine a lower supply of labor in that period when the credit constraint multiplier (adjusting for the wealth effect) is reduced. But, as in the case of consumption, this condition is less restrictive relative to that of the income tax case because there is only the income effect (as opposed to the case of income taxation where there was also a substitution effect working in opposite direction). From (II'):

$$\frac{\partial U_{l_1}}{\partial \tau_1} = -w_1 [\frac{\partial \lambda}{\partial \tau_1} + \frac{\partial \mu}{\partial \tau_1}] \langle 0 \text{ if } \frac{\partial \lambda}{\partial \tau_1} + \frac{\partial \mu}{\partial \tau_1} \rangle 0$$

Once more, the labor supply in period 2 will be higher if the wealth effect is negative, and again this condition is looser relative to the income taxation case because of the lack of a substitution effect on labor, i.e. there are now no disincentives to work harder in period 2 as in the income tax case; hence a lesser negative wealth effect will prompt agents to increase labor in that period toward the unconstrained optimal labor allocation. From (II'):

$$\frac{\partial U_{l_2}}{\partial \tau_1} = -\frac{\delta}{\beta} w_2 \frac{\partial \lambda}{\partial \tau_1} \rangle 0 \text{ if } \frac{\partial \lambda}{\partial \tau_1} \langle 0$$

In sum, the set of conditions for variable consumption taxes to lead to an allocation of consumption and leisure closer to the optimal unrestricted allocation is broader than that of variable income taxes. Consumption taxation does not distort labor allocation as income taxation (with a substitution effect inducing a shift in labor allocation away from the optimal), and although consumption taxes distort the allocation of consumption (substitution effect) they do so toward the optimal allocation.

Given the conditions that would let variable taxes shift the consumption and labor allocations toward the optimal ones, we proceed to focus on the condition for higher welfare under the variable-tax allocation vis-à-vis that of constant tax rates.

As before the variable-tax allocation will have higher welfare than the tax-smoothing allocation with a binding liquidity constraint ($\mu>0$) when the welfare gains of moving (c_1, l_1)

closer to the unconstrained optimal allocation outweighs the discounted welfare loss of moving (c_2, l_2) closer to the unconstrained optimum:

$$-\left[U_{c_1}\frac{\partial c_1}{\partial \tau_1}+U_{l_1}\frac{\partial l_1}{\partial \tau_1}\right]\rangle\beta\left[U_{c_2}\frac{\partial c_2}{\partial \tau_1}+U_{l_2}\frac{\partial l_2}{\partial \tau_1}\right]$$

The variable tax allocation will have higher welfare than the constant-tax allocation the higher U_{c1} and $-U_{l1}$ (and lower U_{c2} and $-U_{l2}$) which depend on how far apart the tax-smoothing allocation is from the unrestricted optimal one, i.e. how binding the liquidity constraint is. In addition, since under variable consumption taxes the conditions for an allocation closer to the optimal is broader, then the condition for such allocation to have higher welfare will more likely be met.

III. THE USE OF VARIABLE TAXES TO RESTRAIN CONSUMPTION UNDER HYPERBOLIC DISCOUNTING

In this section we analyze the case where tax rates are used to restrain private consumption. But, are there situations when such policy could be optimal? Although, several potential reasons could be identified in the literature, such as moral hazard problems,[13] here we deal only with the particular case of hyperbolic discounting (for a comprehensive discussion on the latter see for example Laibson (1996, 1997)). This is because we want to focus on phenomena of a temporary nature, like a shock to preferences that can induce a burst of impatience and a path of consumption that is suboptimal due to time consistency problems.

Following Laibson (1996, 1997) we use quasi-hyperbolic discounting. We draw closely from the framework developed in the previous section, and assume that all information is revealed at the beginning (t=0). The exercise performed here is to compare the welfare effects of variable taxation relative to tax-smoothing in an economy subject to the change in preferences implied by hyperbolic discounting and without a commitment technology. The spirit of the exercise is to investigate if variable taxes can prevent time-consistency problems arising from a shock to intertemporal discount rates. Since income taxation without binding credit constraints has no affect on the intertemporal allocation of consumption, in this section we will only consider consumption taxes.

[13] To deal with moral hazard problems that induce excessive consumption forced pension schemes are used in practice. These schemes, in fact, serve to transfer early consumption to later years through forced savings. The effectiveness of such schemes rely on the presence of some degree of credit constrains so that agents cannot borrow against this source of future income and consumption is effectively restricted.

In absence of a commitment technology, hyperbolic discounting implies that consumers will re-optimize their plans in each period. This is because hyperbolic discounting entails a time-decreasing discount rate, as opposed to the traditional constant rate of discount, which determines that foregoing consumption for one period today is more costly in terms of utility than foregoing consumption for one period at any time in the future. Thus, the optimal plan will be changed period after period (a time consistency problem). This generates a front-loaded consumption path that is sub-optimal and consumers would be better off if they could make an irrevocable commitment on their consumption path.

Thus, we will show two results: (i) if consumers could commit at the beginning (t=0) to a consumption path, then it would be tilted to the future relative to the one that would result under no-commitment (while the allocation of labor will be tilted toward the present) and the optimal policy will be tax smoothing. In addition, (ii) without access to a commitment technology, time-varying tax rates on consumption, i.e. a higher tax rate in period 1 than in period 2, can improve welfare through an intertemporal allocation of consumption closer to the optimal one under commitment.
The representative agent's problem at t=0 can be described as follows:

$$\max_{c,l} \quad \mathbf{U} = \beta[\rho U(c_1,l_1) + \rho^2 U(c_2,l_2)] \; ; \; 0\langle\beta\langle 1 \; ; \; 0\langle\rho\langle 1$$

with $\quad U_c\rangle 0, \; U_{cc}\langle 0, \; U_l\langle 0, \; U_{ll}\langle 0$

Subject to: $\quad (\lambda) \quad W \equiv \delta\omega_1 l_1 + \delta^2\omega_2 l_2 = \delta c_1(1+\tau_1) + \delta^2 c_2(1+\tau_2) \; ; \; \delta = \dfrac{1}{1+r}$

Where c stands for consumption, l for labor, ω for income, W for wealth, τ denotes the consumption tax rate, r the interest rate, and λ is the intertemporal budget constraint multiplier.

In this case the first order conditions, which are sufficient given the strict concavity of the utility function with respect to consumption and leisure, are:

$$\left.\begin{array}{l} c)\ \beta\rho U_{c_1} = \lambda\delta(1+\tau_1) \\ \\ \beta\rho^2 U_{c_2} = \lambda\delta^2(1+\tau_2) \end{array}\right\} \quad \frac{U_{c_1}}{U_{c_2}} = \frac{(1+\tau_1)}{(1+\tau_2)}\frac{\rho}{\delta} \quad (\mathrm{I}'')$$

$$\left.\begin{array}{l} l)\ \beta\rho U_{l_1} = -\lambda\delta\omega_1 \\ \\ \beta\rho^2 U_{l_2} = -\lambda\delta^2\omega_2 \end{array}\right\} \quad \frac{U_{l_1}}{U_{l_2}} = \frac{\omega_1\rho}{\omega_2\delta} \quad (\mathrm{II}'')$$

Conditions (I'') and (II'') determine the allocation of consumption and labor under commitment.

In absence of a commitment technology, hyperbolic discounting implies that consumers will re-optimize their plans in t=1, facing the following problem:

$$\max_{c,l} \quad \mathbf{U} = U(c_1, l_1) + \beta\rho U(c_2, l_2) \; ; \; 0\langle\beta\langle 1 \; ; \; 0\langle\rho\langle 1$$

with $\quad U_c\rangle 0, \; U_{cc}\langle 0, \; U_l\langle 0, \; U_{ll}\langle 0$

Subject to: $\quad (\lambda) \quad W \equiv \omega_1 l_1 + \delta\omega_2 l_2 = c_1(1+\tau_1) + \delta c_2(1+\tau_2); \; \delta = \frac{1}{1+r}$

The first order conditions then become:

$$\left.\begin{aligned} &c)\; U_{c_1} = \lambda(1+\tau_1) \\ &\beta\rho U_{c_2} = \lambda\delta(1+\tau_2) \end{aligned}\right\} \quad \frac{U_{c_1}}{U_{c_2}} = \frac{(1+\tau_1)}{(1+\tau_2)}\frac{\beta\rho}{\delta} \quad (\text{I}''')$$

$$\left.\begin{aligned} &l)\; U_{l_1} = -\lambda\omega_1 \\ &\beta\rho U_{l_2} = -\lambda\delta\omega_2 \end{aligned}\right\} \quad \frac{U_{l_1}}{U_{l_2}} = \frac{\omega_1\beta\rho}{\omega_2\delta} \quad (\text{II}''')$$

Result 5: *With hyperbolic discounting, if consumers could commit at t=0 to a consumption path it would be tilted to the future relative to the one that would result under no-commitment. Moreover, the optimal policy under commitment is tax smoothing ($\tau_1 = \tau_2$).*

The first result follows from (I'') and (I''') where the consumption path under discretion will be front-loaded compared to the commitment case. Similarly, from (II'') and (II''') the allocation of labor under discretion will be tilted towards the second period. The optimal policy result follows from (I'') and the fact $\tau_1 = \tau_2$ will achieve the undistorted allocation as with lump-sum taxation.

The question that follows is then: Can time-varying tax rates serve as a commitment technology for consumers?

Result 6: *With hyperbolic discounting and no commitment technology, higher present tax rates on consumption relative to future rates can improve welfare (compared to tax smoothing) by shifting the consumption path toward the optimal one under commitment.*

To show this result note that there is a $\tau_1>\tau_2$ (specifically $(1+\tau_1)= (1+\tau_2)/\beta$) such that condition (I''') equals (I'') under tax smoothing; in words, without a commitment technology there is a path of tax rates that can replicate the ratio of marginal conditions in consumption under commitment and tax-smoothing by changing the relative price of present and future consumption.

The game is as follows: Given that there is no commitment technology, consumers will re-optimize their plans at t=1. Thus, the government can maximize welfare (as the consumer would have done with a commitment technology at t=0) by setting time-specific consumption taxes, subject to the constraints of consumers' re-optimization at t=1 on consumption (I''') and labor (II'''), to replicate the marginal rate of substitution that would prevail under commitment and tax-smoothing. This means that the government will adjust tax rates to equate (I''') to (I'') under tax-smoothing (the optimal solution with commitment) which implies that, with no commitment technology, period 1 consumption with variable taxes will be lower than consumption under tax-smoothing. Since consumption taxes do not affect labor decisions, then from (II'') and (II''') the allocation of labor would still remain tilted towards the future ($l_1< l_1^{commit}$ and $l_2>l_2^{commit}$).

IV. Can Variable Tax Rates be Effectively Used?

Several implementation issues can impinge on the effective use of variable tax rates, even when favorable theoretical cases can be identified. This section discusses operational issues and identifies potential shortcomings.

At the outset, there are general implementation issues that in practice need to be paid serious attention. The timing of information and the lagged effect of policy changes need to be analyzed in light of the potential to exacerbate cyclical movements; for instance, the use of variables taxes may end up increasing rather than reducing cyclical fluctuation given that there are lags from the time when economic activity is affected by a shock, to when the authorities are able to identify the situation, when taxes are actually changed, and when changed taxes have an impact on consumption behavior. In this regard, the characteristics of the country's shocks and cyclical patterns must be carefully taken into account. In addition, the ability to correctly distinguish transitory from permanent shocks is of central importance to guide smoothing policies since only the former would merit such a policy.

In Section II and III we found some particular theoretical cases that could lend support to the use of variable taxes. We also shed light on the specific conditions that need to be present for such policy to be warranted. Thus, in Section II we considered the case when tax rates are

used to stimulate consumption in presence of liquidity constraints,[14] when tax breaks are used to relieve cash-strapped consumers, welfare would increase depending on tax distortions vis-à-vis how binding the credit constraint is. Then, the country's tax system will need to be carefully analyzed to investigate its potential distortionary effects under variable taxation.

In Section III, we studied the case when taxes are used to restrain consumption under time-consistency problems in the allocation of consumption induced by hyperbolic discounting. The story portrayed there can be generally interpreted to represent cases in which there are shocks to consumers' discount rates. The case for using consumption taxes to solve the time-consistency problem faced by this type of consumer is highly tentative; the case of hyperbolic discounting can be observational equivalent to the exponential discounting case (Laibson (1996)), where there is no time consistency problem and no need to use variable taxes, and thus its practical relevance is seriously hampered.

There are other key implementation issues that relate to how tax administration would be affected by the new regime. This requires careful investigation of the additional administrative costs and the potential for increased evasion. Some immediate candidates to look at, for example, are the potential for setbacks arising from VAT credits on inventories (and the incentives to alter the timing of recording of transactions) and from the link of income tax payments to past performance (which would diminish the effectiveness of the tax break). Moreover, as Budnevich and Le Fort (1997) point out, the inflationary impact of changes in consumption taxes need to be reckoned, specially in countries with inflation targeting frameworks.

Political economy questions are also of great importance; any temporary change in tax rates will have the desired effect as long as it is truly perceived as such. This highlights the importance of the institutional framework under which this policy is pursued. A rules-based approach will address time-consistency problems but may prove to be too rigid for the judgment calls that this policy may require; more discretional arrangements may lessen the effectiveness of a variable tax policy on credibility grounds. Therefor, this trade-off would need to be considered carefully before deciding on the institutional changes to be introduced to make such a scheme operational.[15]

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[14] In line with the caveats expressed above, it must be emphasized that the results derived in that section were in a setting where the timing, type and duration of the shock was perfectly known; nevertheless, the use of tax rates was not a first-best policy.

[15] In the case of the United States in 1968, Congress authorized the government for a given period of time to change income tax rates at discretion within a pre-established range. In Japan in late 1997 and 1998 the government's stimulus package included temporary income tax rebates; this was done through congress simultaneously with a revised budget. In Thailand, VAT rates were reduced through an administrative measure for a period of two years (from 10 to 7 percent) following the economic fallout of the Asian crisis

Finally, by assuming that only private agents face credit constraints the case portrayed in Section II where the government can effectively play a role in smoothing consumption may be overestimated. The relaxation of this assumption will compromise the ability to play that role. In this context, the government's unrestricted access to financing may not be so immediate in practice (because, for example, Ponzi games cannot be credibly ruled out) which will lessen its ability to pursue countercyclical policies.

V. Conclusion and Policy Implications

This paper has sought to answer two questions concerning fiscal policy through time-varying tax rates: whether the use of variable taxes can increase welfare in some circumstances, and whether these can be effectively implemented in practice.

Are there circumstances in theory when variable taxes can improve welfare?

We identified two cases where variable taxes, under certain conditions, can improve welfare: that of binding credit constraints and of hyperbolic discounting. The first case is characterized by under-consumption and a temporary reduction in tax rates can be used to boost consumption and improve welfare if tax distortions relative to the burden of the credit constraint are small. Nevertheless, the use of tax rates is not a first-best policy and no comparison has been done with other alternatives. In the second case, hyperbolic discounting generates a time-consistency problem for the allocation of consumption and a transitory increase in tax rates to restrain consumption is considered. The story portrayed in that section is one of a shock to preferences, more specifically to the rate of discount, that induces a front-loaded path of consumption that is sub-optimal. Time-varying tax rates can increase welfare by shifting the inter-temporal allocation of consumption toward the one that would prevail without the time-consistency problem.

Can variable taxation be effectively implemented in practice?

Even when some specific theoretical cases can be identified, several implementation issues can interfere with the effective use of variable taxes.

General questions such as whether the government can accurately distinguish permanent from transitory shocks or whether it can act in a timely manner to avoid exacerbating the effect of shocks need to be addressed to evaluate these policies.

Moreover, since variable taxes may boost consumption and welfare under binding credit constraints depending on tax distortions, the suitability of this policy will depend on the country's tax system. In the case where tax rates are used to restrain consumption under hyperbolic discounting, the practical hurdle rests on the difficulty to identify such cases. This is because the case of hyperbolic discounting can be observational equivalent to the exponential discounting case.

Other key implementation issues relate to the effect of variable taxes on tax administration (higher administrative costs and the potential for increased evasion), political economy and time consistency problems, the government's own credit constraints and thus its ability to play a role in smoothing consumption, and the institutional changes that would need to be introduced.

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