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A NOTE ON INTERPRETING CONSUMPTION TAX INCIDENCE IN OLG MODELS

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A Note on Interpreting Consumption Tax Incidence in OLG Models

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Abstract

This note discusses the generational incidence of consumption taxes in an OLG framework. The objective is to highlight the channels through which an increase in, e.g., a VAT redistributes income across generations. It turns out that with labor supply exogenous VAT incidence is very similar to the impact of a PAYG pension system or government debt.

1 Introduction

The objective of this paper is to provide a comprehensive interpretation of the generational incidence of consumption taxes. First, I employ in section 2 a version of Diamond's (1965) two-period overlapping generations model to identify the impact of consumption taxes on the generational distribution of economic welfare. Next, I relate the inter-cohort redistribution effects to the macro-economic impact using a general equilibrium, simulation model embodying the Blanchard-Yaari-Weil OLG structure. This is done in section 3, while section 4 summarizes the findings.

2 Consumption taxes in the Diamond-model

Below I identify the generational impact of consumption taxes. For expositional ease, I employ the simplest possible model: The two-period, exogenous labor Diamond-model with the VAT and age-specific, non-distortive income transfers as the only instruments available to the fiscal authority. In the standard notation of the Diamond-model, consider the lifetime budget constraint of the young

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in period t,

$$(1+\tau)c_t^1 + (1+\tau)\frac{1}{1+r}c_{t+1}^2 = y_t^1 + T_t^1 + \frac{1}{1+r}\left(y_{t+1}^2 + T_{t+1}^2\right) \tag{1}$$

which states that the present value of consumption expenditures in the two periods, c_t^1 and c_{t+1}^2, inclusive of the consumption tax levied at rate τ, and discounted at the market rate of interest r, must equal the present value of income accruing to the household. Income in turn consists of labor income y and lump sum transfers from the government, T. Throughout, I use superscript "1" to denote the young while "2" indicates the old generation. Equation (1) may also be written as

$$c_t^1 + \frac{1}{1+r}c_{t+1}^2 = y_t^1 + \frac{1}{1+r}y_{t+1}^2 - \left\{\mu_t^1 + \frac{1}{1+r}\mu_{t+1}^2\right\} \tag{2}$$

where μ_t^1 and μ_{t+1}^2 represent net taxes due in each period of the life cycle, or

$$\mu_t^1 \equiv \tau c_t^1 - T_t^1 \quad \text{and} \quad \mu_{t+1}^2 \equiv \tau c_{t+1}^2 - T_{t+1}^2 \tag{3}$$

Thus, the household is constrained to spend, in present value, no more than its discounted labor income minus the present value of net taxes. This way of viewing the intertemporal budget constraint turns out to be useful below. In what follows, I will assume that the rate of interest is constant; hence, we may interpret the aggregate consumer sector as forming part of a small, open economy to which the rate of return is given from the world capital market[1], or we may think of the analysis that follows as tracing out the partial equilibrium response of consumers in a closed economy. With a given rate of interest, the optimal time path of consumption is described by the Euler-equation

$$c_{t+1}^2 = (1+\gamma)c_t^1 \tag{4}$$

where γ, the growth rate of optimal consumption, depends on the rates of return and time preference, as well as the elasticity of intertemporal substitution in the utility function. Inserting this in (1) yields period t consumption demand of the young,

$$c_t^1 = \frac{(1+r)}{(2+r+\gamma)}\left[\frac{y_t^1 + T_t^1 + \frac{1}{1+r}\left(y_{t+1}^2 + T_{t+1}^2\right)}{1+\tau}\right] \tag{5}$$

Period t savings by the young, s_t, are accordingly

$$s_t \equiv y_t^1 + T_t^1 - (1+\tau)c_t^1 = \frac{(1+\gamma)}{(2+r+\gamma)}\left(y_t^1 + T_t^1\right) - \frac{1}{(2+r+\gamma)}\left(y_{t+1}^2 + T_{t+1}^2\right) \tag{6}$$

Finally, period $t+1$ consumption expenditures may then be found as

$$c_{t+1}^2 = (1+r)s_t + y_{t+1}^2 + T_{t+1}^2 = \frac{(1+r)(1+\gamma)}{(2+r+\gamma)}\left[\frac{y_t^1 + T_t^1 + \frac{1}{1+r}\left(y_{t+1}^2 + T_{t+1}^2\right)}{1+\tau}\right] \tag{7}$$

[1]See Persson (1985) for an analysis of government debt policies and generational distribution in open economy versions of the Diamond model.

Equations (5) and (7) immediately reveal the incidence of the consumption tax: It is a proportional tax on lifetime resources. Occasionally, the VAT is described as being regressive, because those who consume a large fraction of their income pay a relatively large part of it in taxes.[2] While this is obviously true in an annual accounting sense, from a lifetime incidence perspective, which is the appropriate one in an intertemporal setting, the VAT is a proportional tax. The point is that those who save will eventually pay consumption taxes on their savings (plus return) once they liquidate their wealth. The *net* incidence of the consumption tax then depends on the incidence of the tax instrument used to rebate consumption tax revenue *relative* to a proportional tax on lifetime income. Before turning to this problem, it is useful to highlight the key factors affecting individual savings by rewriting (6) using

$$y_{t+1}^2 = (1 + g_{t+1})y_t^1 \quad \text{and} \quad y_t^1 + \frac{1}{1+r}y_{t+1}^2 = \bar{y} \tag{8}$$

That is, $\bar{y}$ represents the present value of labor income accruing to the young at time t, while g_{t+1} is its growth rate. Defining similarly

$$T_{t+1}^2 = (1 + \lambda_{t+1})T_t^1 \quad \text{and} \quad T_t^1 + \frac{1}{1+r}T_{t+1}^2 = \bar{T} \tag{9}$$

yields upon substitution in (6)

$$s_t = \frac{1+r}{(2+r+\gamma)(2+r+g_{t+1})}(\gamma - g_{t+1})\bar{y} + \frac{1+r}{(2+r+\gamma)(2+r+\lambda_{t+1})}(\gamma - \lambda_{t+1})\bar{T} \tag{10}$$

Accordingly, savings in period t depend on the present value of lifetime resources of the young generation - i.e. $\bar{y}$ and $\bar{T}$ - as well as the distribution of income flows across the two periods of life. Given the slope parameters, g_{t+1} and λ_{t+1}, increasing the wealth of the young induces them to save more, provided savings are initially positive. Increasing the growth of income over the lifecycle, keeping the present values unchanged, leads to lower savings as the household receives less income in the first period of life and more in the last. To sustain the desired intertemporal consumption profile, which is given by (5), savings are reduced.

I now piece together the model of the consumer sector by collecting the equations characterizing the behavior of the period t young and old, respectively, and adding the government budget constraint linking lump sum transfers to consumption tax revenue. Consumption of the young is

$$(1+\tau)c_t^1 = \frac{(1+r)}{(2+r+\gamma)}\left[y_t^1 + T_t^1 + \frac{1}{1+r}\left(y_{t+1}^2 + T_{t+1}^2\right)\right] \tag{11}$$

while the members of the old generation consume their savings, inclusive of the accrued return, plus total labor income in period t, that is

$$(1 + \tau)c_t^2 = (1 + r)s_{t-1} + y_t^2 + T_t^2 \tag{12}$$

[2] See, e.g., Ministry of Finance (1996), page 285.

I assume that the fiscal authority operates a balanced budget in each period. Accordingly, revenue from the consumption tax is rebated as lump sum transfers. Hence

$$T_t^1 + T_t^2 = \tau \left[c_t^1 + c_t^2 \right] \tag{13}$$

In the following it is useful to introduce a policy parameter that captures the way the government divides tax revenue into transfers to the young and old, respectively. Thus λ denotes the amount by which transfers to the old generation exceed those to the young, per unit of transfers to the young, i.e. $T_t^2 = (1+\lambda)T_t^1$. Totally differentiating (11)-(13) while keeping labor income fixed yields

$$(1+\tau)dc_t^1 + c_t^1 d\tau = \frac{(1+r)}{(2+r+\gamma)}\left[dT_t^1 + \frac{1}{1+r} dT_{t+1}^2 \right] \tag{14}$$

$$(1+\tau)dc_t^2 + c_t^2 d\tau = dT_t^2 \tag{15}$$

$$dT_t^1 + dT_t^2 = \tau \left[dc_t^1 + dc_t^2 \right] + \left[c_t^1 + c_t^2 \right] d\tau \quad \text{and} \quad dT_t^2 = (1+\lambda)dT_t^1 \tag{16}$$

For simplicity, I assume that initially $\tau = T_t^1 = T_t^2 = 0$. Solving out for dc_t^1 and dc_t^2 produces

$$dc_t^1 = \left[\frac{r(\gamma - \lambda)}{(2+\lambda)(2+r+\gamma)} \right] c_t^1 d\tau \tag{17}$$

while

$$dc_t^2 = \left[\frac{\lambda - \gamma}{2+\lambda} \right] c_t^1 d\tau \tag{18}$$

where I have utilized that, because the representative members of each generation are identical, (4) implies $c_t^2 = (1+\gamma)c_t^1$ while $T_{t+1}^2 = (1+\lambda)T_t^1$. Notice that, because the intertemporal price structure is unchanged, we may use equations (17)-(18) to assess the welfare impact of fiscal policy changes. Also, since the situation in which each future generation finds itself is exactly identical to that of the period t young, equation (17) also identifies the economic plight of these future consumers.

Consider first the case where the government raises the VAT and spends the revenue on age independent transfers, that is $\lambda = 0$. In this experiment, consumption and welfare of the old is reduced, while all future generations gain. The intuition for this outcome is straightforward. Note that the loss incurred by the elderly is proportional to γ, the individual consumption growth rate. That is, the steeper is the optimal path of individual consumption, the larger is the loss incurred by the old at time t. This is so because the old generation's share of the tax base, which is equal to their share in aggregate consumption, is larger than their one-half share of revenue rebated. Accordingly, under the assumption $\lambda = 0$, the old lose. How does the gain to future generations materialize? To

understand this, totally differentiate (2) and insert from (14)-(16) to obtain

$$dc_t^1 + \frac{1}{1+r}dc_{t+1}^2 = -d\mu_t^1 - \frac{1}{1+r}d\mu_{t+1}^2$$

$$= \left\{\frac{\gamma-\lambda}{2+\lambda}\right\}c_t^1 d\tau - \left\{\frac{1}{1+r}\frac{\gamma-\lambda}{2+\lambda}\right\}c_t^1 d\tau = \left(\frac{r}{1+r}\right)\left(\frac{\gamma-\lambda}{2+\lambda}\right)c_t^1 d\tau \qquad (19)$$

Hence, when $\gamma > \lambda$, the lifetime budget constraint of the representative young household shifts out. Notice how this comes about through lower net tax payments during the first period of life, i.e. the first curly bracket term in (19), while net taxes increase in old age as indicated by the second term in curly brackets. The present value, however, of the change in net tax payments is negative as long as $\gamma > \lambda$. Therefore, the young benefit because their net tax payments are shifted forward in time; the time path of lifetime after-tax income becomes less steeply sloped.

Consider next the case of $\gamma = \lambda$, i.e. the share of the old in the tax rebate scheme equals their share of the consumption tax base. Under that assumption, there is no generational redistribution, as the old receive additional lump sum transfers exactly offsetting the increase in their consumption tax payments. Accordingly, the lifetime budget constraints are unaffected by the VAT increase, and the fiscal policy change has no impact on the economy.[3]

Finally, consider the case where $\lambda \to \infty$. This implies that the entire revenue from the consumption tax accrues to the old. Taking limits in (17) and (18) above yields

$$dc_t^1 = -\frac{r}{(2+r+\gamma)}c_t^1 d\tau \qquad (20)$$

and

$$dc_t^2 = c_t^1 d\tau \qquad (21)$$

The net gain of the old generation now equals the tax burden imposed on the young, which in turn equals their consumption demand times the change in the consumption tax rate. Each future generation loses an amount equal to the annuity value of the transfer to the period t old. This experiment is equivalent to a VAT financed increase in pay-as-you-go pension benefits. As is well known, this amounts to a transfer from future generations to the current old. From the viewpoint of the young, their net tax payments increase early in life, while they also benefit from the increased old age transfer. The net present value is negative, however, mirroring the windfall recorded by the old at time t.

The incidence of consumption taxes may accordingly be thought of as operating through two channels. First, there is a loss to the elderly depending in their share of rebated revenue. Second, the slope of the lifetime income profile faced by the current young and all future generations is

[3]It would of course be very different if labor supply was endogenous, as the VAT would then distort the labor-leisure choice. In the next section, I consider this aspect using a numerical model.

altered. The crucial determinants of generational incidence is thus, on the one hand, the slope of the individual intertemporal consumption profile and, on the other hand, the design of the revenue recycling scheme. This is an important point, because it illustrates that in an OLG framework differential incidence is "not just differential incidence". It is precisely the impact on the slope of the intertemporal net income profile of the young households that enables the government to rather remarkably affect redistribution from the old to *each and every* future generation. Thus, e.g., the loss incurred by the old when $\lambda = 0$ results not from the VAT always bearing more heavily on the old because they have higher consumption propensities. As noted above, the VAT is a proportional tax on lifetime income. The incidence also reflects the assumption that revenue is disposed of through age independent income transfers. That is, the old have a higher share of the tax burden than of the tax rebate scheme.

Notice also the equivalence between, e.g., the VAT increase in the case of $\lambda < \gamma$ and a host of other policies. A cut in PAYG pension benefits, financing larger age independent lump sum transfers, would similarly inflict a loss on the old and benefit future generations. Also, a reduction in government debt through temporarily lower lump sum transfers results in the same generational incidence as the VAT; the old are adversely affected while future generations benefit as lower public indebtedness allows for lower net taxes. That is, a number of policies that might seem very different in terms of the deployment of fiscal instruments, are in fact equivalent in terms of their impact on generational welfare.[4] The key insight is that these policies all affect the lifetime budget constraints of young households in similar fashion as the time path of net tax liabilities becomes more steeply sloped, which in turn implies a net gain in present value, lifetime resources.

Before turning to the results from the simulation model, it is useful to consider briefly the impact of the consumption tax on the savings of young households. Differentiating (6) yields

$$ds_t = \frac{(\gamma - \lambda)(2 + \gamma)}{(2 + r + \gamma)(2 + \lambda)} c_t^1 d\tau \tag{22}$$

Thus, if the consumption tax experiment redistributes in favor of the young, that is if $\gamma > \lambda$, savings increase. This outcome reflects both effects identified in the discussion of equation (10) above. As the lifetime resources of the young are augmented in present value, they choose higher savings in order to consume more in both periods. Simultaneously, the time path of labor income also changes as net taxes are moved forward in time. This further stimulates asset demand, as consumers face larger tax burdens late in life and consequently set more resources aside to finance consumption in old age.

[4]For more examples along these lines, see Auerbach and Kotlikoff (1987), chapter 7.

3 Consumption tax incidence: Illustrative simulations

In the model used in the previous section, consumption taxes lead to purely redistributive effects as there are no distortions in the model. In this section, I seek to quantify the dynamic impact of consumption taxes using a simulation model featuring endogenous labor supply and a wide range of tax instruments. These features imply that a change in the rate of VAT will interact with the other taxes deployed by the government. To illustrate the sensitivity of the outcome with respect to revenue recycling, I will consider two alternative ways of securing intertemporal budget balance. In the first case, I assume that budget balance is obtained period by period through the adjustment of age independent lump sum transfers. In the second scenario, the lump sum income subsidy is changed only once, while public debt absorbs the intertemporal variations in tax revenue. I also contrast endogenous versus fixed labor supply in order to more accurately identify the impact of incentive effects.

The simulation model features standard building blocks joined together in a small, open economy framework. The consumer side embodies the Blanchard-Yaari-Weil OLG structure, and the individual household chooses labor supply, consumption and savings so as to maximize expected lifetime utility. Firms are competitive and employ capital services and labor in order to produce a domestic good, which is perfectly substitutable with foreign production. Finally, I assume perfect mobility of financial assets between the home and foreign economies, while physical capital mobility is hampered by installation costs in the short run.

In each of the experiments reported below, the VAT rate is raised by 5 percentage points and the proceeds are used to increase non-distortionary income transfers to households.

Endogenous labor supply. A summary of the macro impact is shown i figure **1** below. The broken curve indicates the period by period budget balance scenario, where lump sum transfers are calculated so as to keep government debt unchanged relative to the baseline. The solid curve represents the policy of using public debt to smooth transfers.

'Further details on the simulations are provided in the tables in the appendix.

Figure 1: *Macroeconomic effects of the VAT increase. Endogenous labor.*

Fig. 1a: Consumption

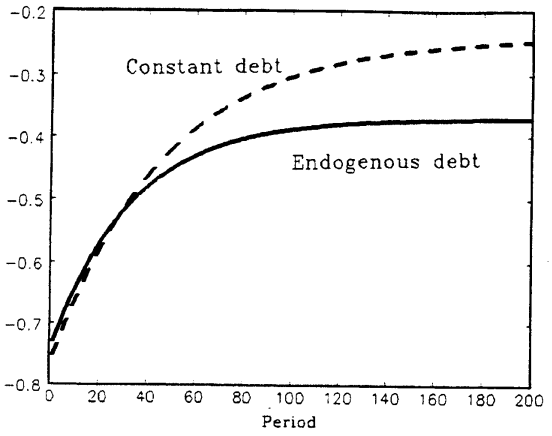


Fig. 1b: Labor supply

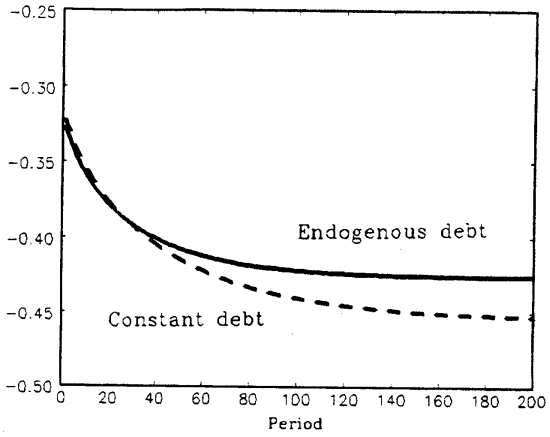


Fig. 1c: Govt. debt

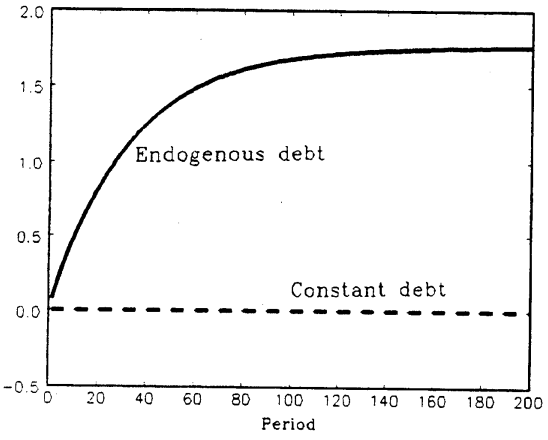


Fig. 1d: Foreign assets

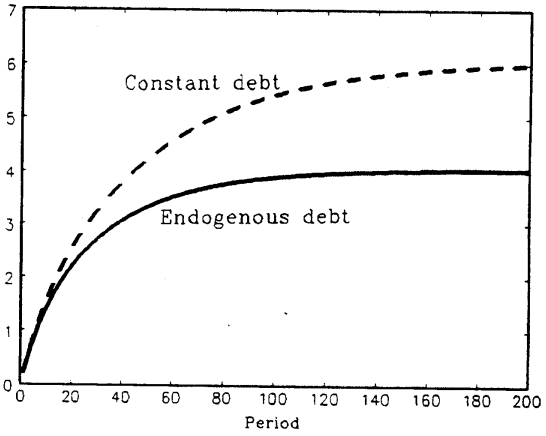


Fig. 1e: Lump sum transfers

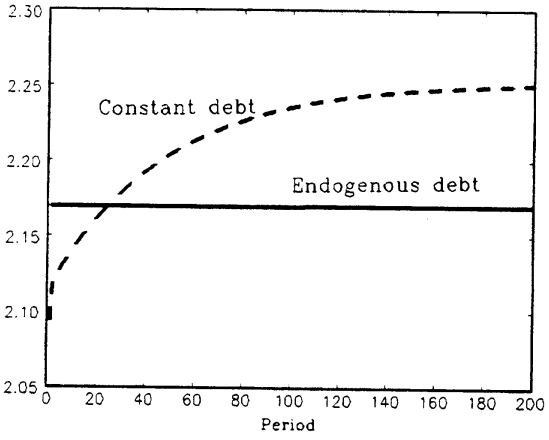
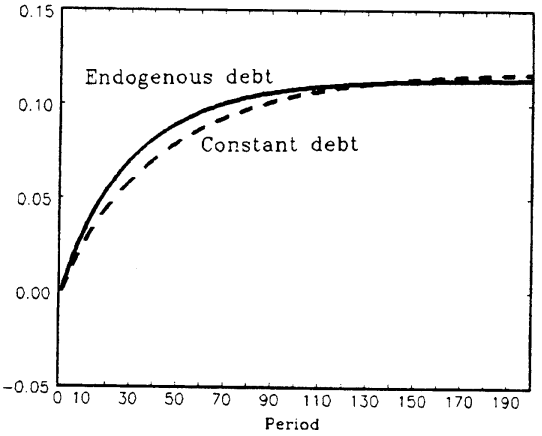


Fig. 1f: Savings tax revenue



Note: Labor supply and consumption are shown in percentage change relative to the baseline simulation. The changes in the remaining variables are shown in per cent of baseline GDP at market prices.

As figure 1e shows, the increase in the VAT rate raises an amount of revenue equal to approximately 2.2 per cent of GDP in average, annual terms. According to the results in the previous section, this implies redistribution from the elderly, who have relatively large asset holdings, to future generations. This shows up in the upward sloping time paths of goods and leisure consumption - that is, consumption of goods increases during the transition, while labor supply drops reflecting the wealth effect on hours of work supplied by future generations. However, relative to the baseline, consumption is lower throughout the transition as households react to the lower after-tax wage rate by cutting labor supply.

Figure 1d portrays the dynamic evolution of net foreign assets. As resources are shifted from the current old towards future generations, the latter react by saving more. Also, the new generations face lighter tax burdens early in their lives, as their optimal consumption path is upward sloping and they consequently pay relatively little in consumption taxes, while they benefit from increased transfers. Thus the VAT and the revenue recycling policy interact to rearrange intertemporally the net tax burdens faced by the young; accordingly, they save more initially in order to pay higher taxes later. In a small, open economy setting this shows up as an increase in net foreign assets, as the supply of domestic securities is unresponsive to demand. Hence, a half-century into the transition foreign debt has been reduced by 3 to 4 per cent of base GDP.

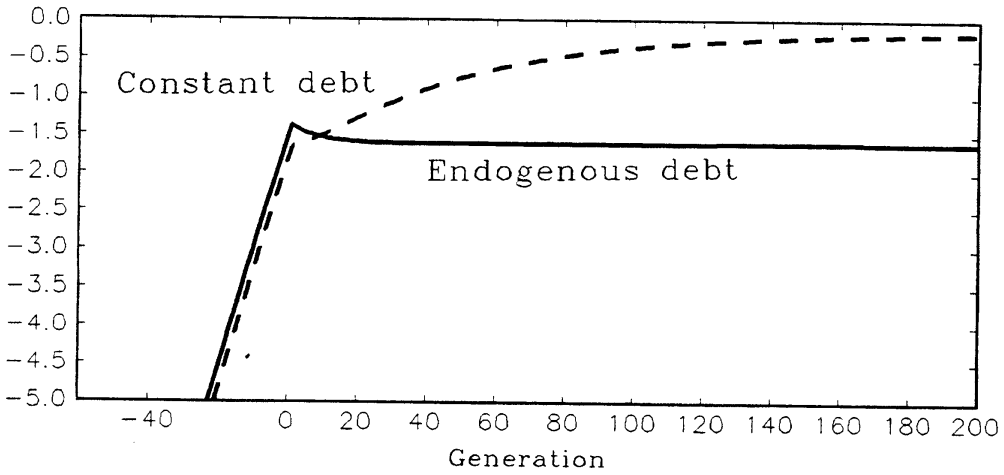
Under the unchanged debt policy, i.e. the broken curves in figure 1, the time path of non-distortive transfers directly reflects the time path of tax revenue. As figures 1e and 1f shows, tax revenue increases over time, as the higher stock of foreign assets generates additional revenue from the taxation of interest income. Hence, the long run impact on consumption, labor supply and asset demand are all reinforced by this policy. In contrast, when the fiscal authority employs debt policy to smooth transfers over time, this acts to shift resources back towards survivors from the initial equilibrium, as these generations now get to share in the long run increase in savings tax revenue. Notice how savings tax revenue in the constant debt scenario transitionally drops below the level in the endogenous debt case. This precisely mirrors the upward sloping time path of transfers. Households thus rationally foresee larger, future income subsidies, and hence choose to accumulate fewer financial claims. In the long run, however, as this policy is more effective in stimulating long run asset demand, savings tax revenue is higher.

Notice how the response of consumption and labor supply differs very little between the two experiments, whereas the outcomes in the longer term deviate more. This is so for two reasons. First, during the initial phase of the transition, winners and losers under the VAT policy co-exist, and switching to either of the two budget balance rules benefits one category at the expense of the other; hence, the differences in macro effects are barely discernible. Second, discounting the resources of future generations at the market rate of interest implies that, when income is shifted

towards current consumers, they benefit relatively little; i.e. flattening the time path of transfers also flattens the consumption response, but by surprisingly little initially.

Figure 2 portrays the impact on generational welfare as expressed by the equivalent variation.

Figure 2: *Generational incidence of the VAT policy.*



Note: The horizontal axis shows the date of birth of each cohort: Positive numbers indicate future generations, while negative ones represent survivors from the initial steady-state. The vertical axis shows the equivalent variation expressed in per cent of baseline per capita GDP.

The curves confirm the intuition from the previous section, as the old lose while future generations gain in lifetime utility. Older survivors from the initial steady-state incur relatively large losses. This simply reflects the capital levy component of the VAT; asset holdings increase with age in the BYW model, and hence the old suffer relatively more under the VAT increase.[6] Strikingly, the net utility losses of generations born far into the transition are almost zero. This reflects the fact that the relatively generous transfers afforded those individuals compensate for the efficiency losses due to the distortion of labor supply incentives. These distortionary cost are in turn shifted to those alive initially. Looking at the welfare impacts of the two different budget balance strategies, one may be tempted to conclude that the period by period adjustment of lump sum transfers is superior in aggregate efficiency terms. However, as tables 1b and 2b show, the aggregate efficiency losses, as measured by the sum of EV's, are exactly identical. This is, of course, not surprising as the difference between the two policies reflects lump sum redistribution. That is, when discounting is allowed for, the areas between the curves and the horizontal axis are equal and identical to the aggregate efficiency measures in tables 1b and 2b. This highlights the difficulties involved in assessing the desirability of policy changes in an OLG model by merely looking at the distribution of generational welfare. There is a further point. The net efficiency cost equals an annual decline

[6]Note, that in the BYW model the propensity to consume out of total wealth, that financial plus human capital, is *constant*. That is, one cannot identify the losers from the VAT experiment by observing their consumption propensities; they are equal. As pointed out above, the VAT is a proportional tax on lifetime wealth, and the equivalent variation of the old shows large losses simply because these households are relatively rich.

of 0.55 per cent in private consumption, or roughly 0.35 per cent of GDP. Comparing this to the welfare effects portrayed in figure 2, it is evident that the purely redistributive elements in the VAT change are fairly large relative to the efficiency effect. This is a quite common finding in OLG model simulations of tax policies.

Exogenous labor supply. To focus on the purely redistributive elements of consumption taxation, figure 3 shows the macro impact under the assumption of exogenous labor supply.

Figure 3: *Macroeconomic effects of the VAT increase. Exogenous labor.*

Fig. 3a: Consumption

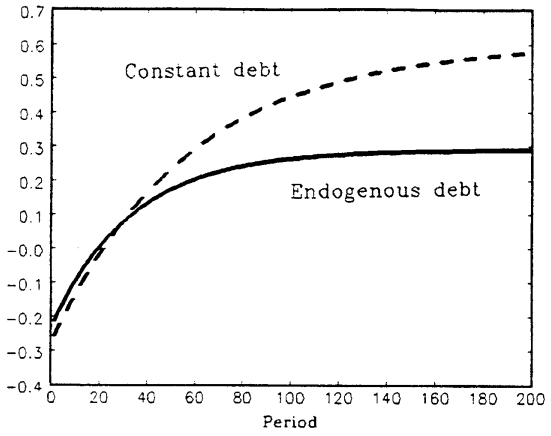


Fig. 3b: Labor supply

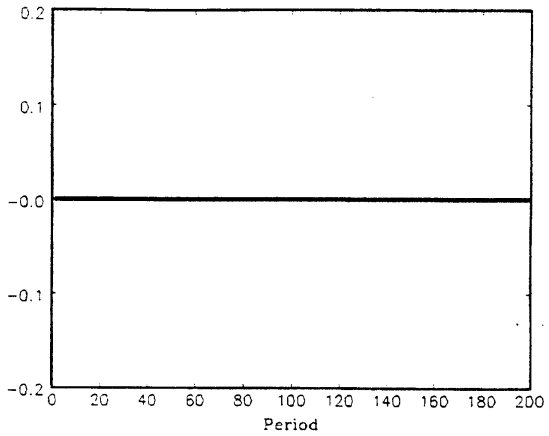


Fig. 3c: Govt. debt

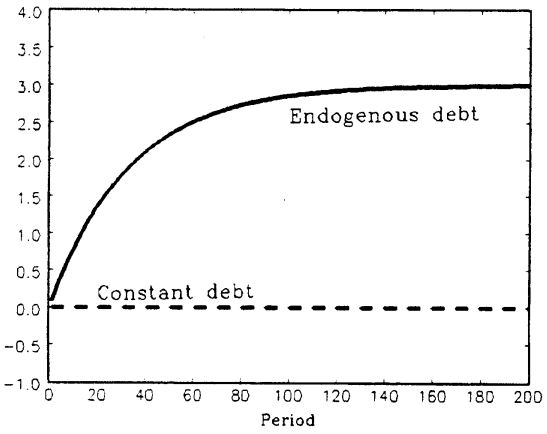


Fig. 3d: Foreign assets

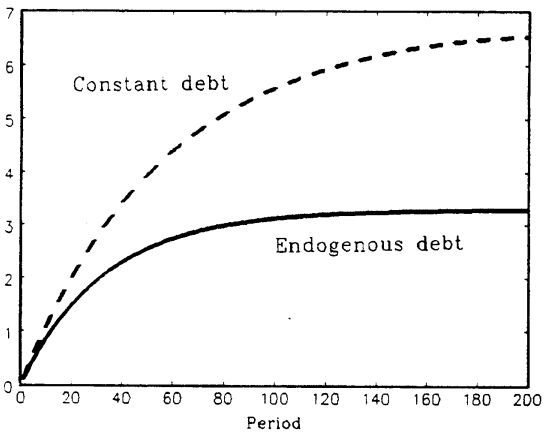


Fig. 3e: Lump sum transfers

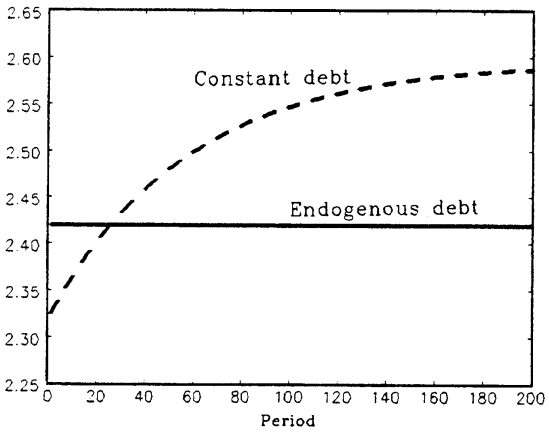
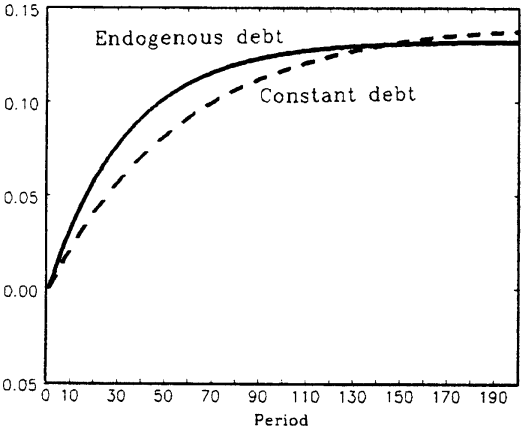


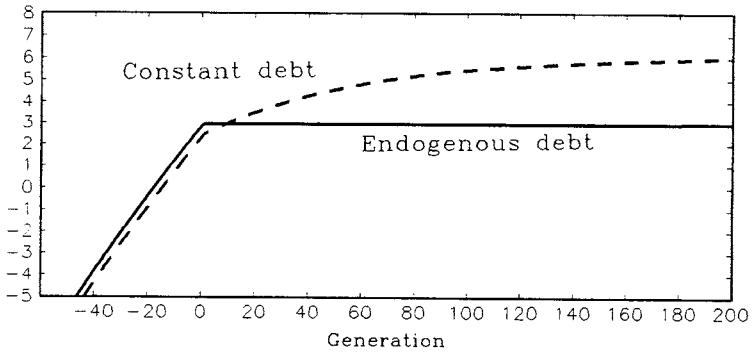
Fig. 3f: Savings tax revenue



Note: Labor supply and consumption are shown in percentage change relative to the baseline simulation. The changes in the remaining variables are shown in per cent of baseline GDP at market prices.

The qualitative picture is very similar to that emerging under endogenous work effort. However, consumption now increases above the base level in the long run, and the increase in asset demand is more powerful. Of course, this reflects the absence of excess burden; the experiment amounts to substituting one lump sum tax for another. The macro impact reflects precisely this redistributive character of the policy change.

Figure 4: *Generational incidence of the VAT policy.*



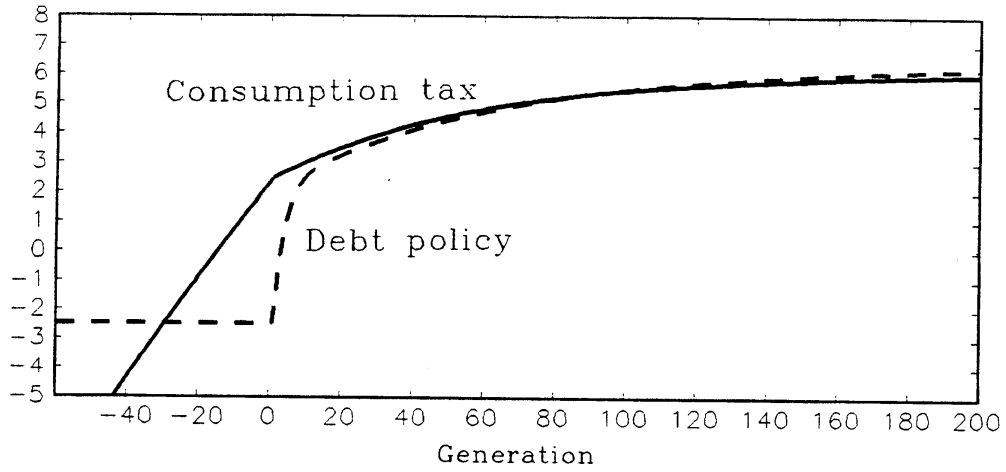
Note: The horizontal axis shows the date of birth of each cohort: Positive numbers indicate future generations, while negative ones represent survivors from the initial steady-state. The vertical axis shows the equivalent variation expressed in per cent of baseline per capita GDP.

The generational welfare effects are also similar to the variable hours case, but notice that, as tables 3b and 4b indicate, the areas between the EV curves and the horizontal axis are now zero when discounting is allowed for. Also, the figure reveals a fairly large redistributive impact of consumption taxation.

Consider finally the welfare impact on distant future generations. Under fixed hours, they always gain, as lifetime income is redistributed in their favor. This outcome hinges only on the upward sloping time path of individual consumption, as pointed out in section 2. Therefore, the losses recorded by future generations in the variable hours version reflects the fact that their share in the excess burden overwhelms their gain from generational redistribution. As the lifetime net worth of a future generation equals its human wealth, this is the same thing as saying that, in purchasing power terms, the wealth of distant future generations goes down in the endogenous labor case. Notice also, that the relevant consumer price index is measured inclusive of the price of leisure; i.e. it does not increase quite as much as the price index of consumer goods, as the after-tax wage rate is unchanged.

Consumption taxes versus debt policies. A basic idea advanced in section 2 is the similarity, in terms of the generational welfare consequences, between a VAT increase and a reduction in government debt, financed by lower age independent income transfers. This similarity is illustrated in figure 5 below.

Figure 5: *Generational incidence of VAT versus debt policy.*



Note: The horizontal axis shows the date of birth of each cohort: Positive numbers indicate future generations, while negative ones represent survivors from the initial steady-state. The vertical axis shows the equivalent variation expressed in per cent of baseline per capita GDP.

Figure 6 shows the dynamic evolution of the primary budget deficit and public debt, respectively, under the debt policy. This scenario features a short run lump sum tax increase equal to 1.5 per cent of base GDP and a rapid decumulation of public debt. Primary budget surpluses persist for approximately one decade. As the net worth of the government is improved, transfers are gradually increased until budget balance is restored. By normal standards, this experiment represents fairly "activist" fiscal policy. However, as figure 5 shows, the impact on generational welfare is pretty much equivalent to a more "prudent" policy of raising the VAT, while balancing the budget each period through lump sum transfers.[7]

[7]Obviously, the impact on survivors from the initial steady-state cannot be precisely replicated under the debt policy as discrimination between age groups is ruled out by the age independence of transfers.

Figure 6: *The debt policy.*

Fig. 6a: Primary deficit

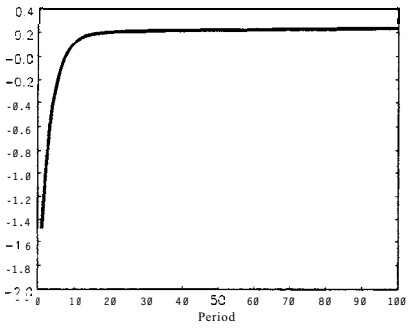
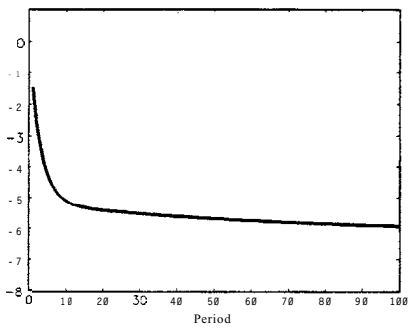


Fig. 6b: Govt. debt



Note: The numbers are expressed in per cent of baseline GDP.

4 Concluding remarks

This paper has analyzed the generational impact of consumption taxes, and illustrated its quantitative importance in an OLG simulation model.

It turned out that consumption taxation redistribute resources across generations by imposing a one time capital levy on the assets of existing generations *and* rearranging the time path of net taxes faced by future generations. In this way, a permanent increase in the rate of VAT may shift resources away from the current old towards all future generations. This is, however, as much a result of the way revenue is disbursed as it reflects the incidence of the VAT. The VAT is a proportional tax on lifetime income, and hence net benefits will accrue to future generations only if they share disproportionately in the revenue rebating scheme, relative to their share in the consumption tax base. This underscores the importance of being specific about the differential incidence assumptions employed in dynamic tax analysis.

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Table 1a: VAT + 5 percentage points, c.b.c., tau equalization

dbg=1 dtw=1 dtc=1 dty=1 di=1 dinstc=1

Period (s)	GDP at const. market prices (fGDPM)	Priv. cons. (fCP)	Govt. cons. (fCG)	Priv. inv. (I)	Current account (CA**)	Labor supply (L)	Net savings rate (level)
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	-0.32	-0.73	0.00	-0.73	0.19	-0.33	0.26
2	-0.33	-0.72	0.00	-0.70	0.17	-0.33	0.25
3	-0.35	-0.71	0.00	-0.68	0.16	-0.34	0.24
4	-0.36	-0.70	0.00	-0.67	0.15	-0.34	0.23
5	-0.36	-0.69	0.00	-0.65	0.14	-0.34	0.21
6	-0.37	-0.68	0.00	-0.64	0.13	-0.35	0.21
7	-0.38	-0.67	0.00	-0.63	0.12	-0.35	0.20
8	-0.39	-0.66	0.00	-0.62	0.11	-0.35	0.19
9	-0.39	-0.65	0.00	-0.61	0.11	-0.36	0.18
10	-0.40	-0.64	0.00	-0.61	0.10	-0.36	0.17
20	-0.42	-0.57	0.00	-0.58	0.06	-0.38	0.12
50	-0.44	-0.45	0.00	-0.59	0.02	-0.41	0.05
100	-0.45	-0.39	0.00	-0.60	0.00	-0.42	0.01
295	-0.45	-0.37	0.00	-0.61	0.00	-0.43	0.00

	------Private financial wealth------				Human	After-tax	Lump-sum
Period (s)	Total (A*)	Equity (V*)	Govt. debt (Bg*)	Foreign (F*)	wealth (H*)	wage rate (atw)	transfers (TAU*)
0	-0.21	-0.23	0.00	0.00	40.32	0.00	0.000
1	-0.02	-0.24	0.08	0.19	40.29	-3.79	2.170
2	0.16	-0.25	0.13	0.37	40.25	-3.80	2.170
3	0.33	-0.26	0.18	0.53	40.23	-3.82	2.170
4	0.49	-0.26	0.22	0.68	40.20	-3.83	2.170
5	0.65	-0.27	0.27	0.82	40.18	-3.84	2.170
6	0.80	-0.28	0.31	0.96	40.16	-3.85	2.170
7	0.94	-0.28	0.36	1.08	40.15	-3.86	2.170
8	1.07	-0.28	0.40	1.20	40.13	-3.87	2.170
9	1.20	-0.29	0.44	1.31	40.12	-3.88	2.170
10	1.33	-0.29	0.48	1.41	40.11	-3.88	2.170
20	2.35	-0.31	0.81	2.19	40.05	-3.91	2.170
50	3.98	-0.32	1.39	3.32	40.03	-3.92	2.169
100	4.82	-0.33	1.68	3.89	40.03	-3.93	2.170
295	5.06	-0.33	1.79	4.03	40.01	-3.93	2.169

	-----Private sector----			-GDP factor prices-		-----Consumption------		
Period (s)	Output (Y)	Energy (Ei)	Capital (K)	Total (fGDPF)	Private (fGDPFP)	Total (fCP)	Energy (fEc)	Other (fC)
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	-0.33	-0.13	-0.06	-0.26	-0.34	-0.73	-0.73	-0.73
2	-0.36	-0.18	-0.12	-0.28	-0.36	-0.72	-0.72	-0.72
3	-0.38	-0.22	-0.17	-0.29	-0.38	-0.71	-0.71	-0.71
4	-0.40	-0.25	-0.21	-0.31	-0.40	-0.70	-0.70	-0.70
5	-0.41	-0.29	-0.25	-0.32	-0.42	-0.69	-0.69	-0.69
6	-0.43	-0.32	-0.28	-0.33	-0.43	-0.68	-0.68	-0.68
7	-0.44	-0.34	-0.31	-0.34	-0.44	-0.67	-0.67	-0.67
8	-0.45	-0.37	-0.34	-0.35	-0.45	-0.66	-0.66	-0.66
9	-0.46	-0.39	-0.36	-0.35	-0.46	-0.65	-0.65	-0.65
10	-0.47	-0.40	-0.39	-0.36	-0.47	-0.64	-0.64	-0.64
20	-0.53	-0.51	-0.50	-0.40	-0.53	-0.57	-0.57	-0.57
50	-0.58	-0.58	-0.58	-0.44	-0.58	-0.45	-0.45	-0.45
100	-0.60	-0.60	-0.60	-0.46	-0.60	-0.39	-0.39	-0.39
295	-0.61	-0.61	-0.61	-0.46	-0.61	-0.37	-0.37	-0.37

All variables except (*) and (**) are pct. change over base case.
(*) indicates change in level in pct. of base line GDP at mkt. prices.
(**) - do. - current - do. -

Table 1b: VAT + 5 percentage points, c.b.c., tau equalization

Government financial balance, annuity equiv., pct. of base case GDP		
Taxes	: Wage income taxes	-0.1364
	Interest income taxes	0.0515
	Dividend and capital gains taxes	-0.0057
	Corporate income taxes	-0.0086
	Consumption taxes	2.2885
	Energy taxes	-0.0121
Total tax revenue		2.1772
Expenditures	: Wages	0.0075
	Purchases of goods	0.0000
	Income transfers	2.1696
Total expenditures		2.1772

Change in energy cons., annuity equivalent, pct. of initial cons.	
Households	-0.576
Firms	-0.450
Total	-0.505

Efficiency index (zeta):	EV-based	CV-based
Level, pct. of initial GDP at market prices	-8.219	8.521
Annuity equivalent, pct. of initial private cons.	-0.547	0.567

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Table 2a: VAT + 5 percentage points, c.b.c., Bg constant

dbg=1 dtw=1 dtc=1 dty=1 di=1 dinstc=1

Period (s)	GDP at const. market prices (fGDPM)	Priv. cons. (fCP)	Govt. cons. (fCG)	Priv. inv. (I)	Current account (CA**)	Labor supply (L)	Net savings rate (level)
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	-0.32	-0.75	0.00	-0.72	0.20	-0.32	0.18
2	-0.33	-0.74	0.00	-0.69	0.19	-0.33	0.20
3	-0.34	-0.73	0.00	-0.68	0.17	-0.33	0.19
4	-0.35	-0.72	0.00	-0.66	0.16	-0.33	0.18
5	-0.36	-0.71	0.00	-0.65	0.15	-0.34	0.17
6	-0.37	-0.70	0.00	-0.63	0.15	-0.34	0.17
7	-0.38	-0.69	0.00	-0.62	0.14	-0.35	0.16
8	-0.38	-0.68	0.00	-0.62	0.13	-0.35	0.15
9	-0.39	-0.67	0.00	-0.61	0.12	-0.35	0.15
10	-0.39	-0.66	0.00	-0.60	0.12	-0.35	0.14
20	-0.42	-0.58	0.00	-0.58	0.08	-0.38	0.11
50	-0.45	-0.42	0.00	-0.60	0.04	-0.41	0.05
100	-0.46	-0.30	0.00	-0.63	0.01	-0.44	0.02
295	-0.46	-0.24	0.00	-0.65	0.00	-0.45	0.00

Period	------Private financial wealth------ Total	Equity	Govt. debt	Foreign	Human wealth	After-tax wage rate	Lump-sum transfers
(s)	(A*)	(V*)	(Bg*)	(F*)	(H*)	(atw)	(TAU*)
0	-0.21	-0.23	0.00	0.00	40.01	0.00	0.000
1	-0.08	-0.24	0.00	0.20	40.04	-3.79	2.093
2	0.06	-0.25	0.00	0.39	40.04	-3.81	2.119
3	0.20	-0.26	0.00	0.57	40.05	-3.82	2.122
4	0.33	-0.26	0.00	0.74	40.07	-3.83	2.125
5	0.45	-0.27	0.00	0.89	40.08	-3.84	2.128
6	0.57	-0.27	0.00	1.04	40.10	-3.85	2.130
7	0.69	-0.28	0.00	1.18	40.11	-3.86	2.133
8	0.80	-0.28	0.00	1.32	40.13	-3.87	2.136
9	0.90	-0.28	0.00	1.44	40.15	-3.88	2.138
10	1.01	-0.29	0.00	1.56	40.17	-3.88	2.140
20	1.87	-0.31	0.00	2.53	40.39	-3.91	2.161
50	3.48	-0.33	0.00	4.22	40.92	-3.92	2.204
100	4.64	-0.35	0.00	5.43	41.33	-3.93	2.236
295	5.25	-0.36	0.00	6.07	41.55	-3.93	2.253

Period	-----Private sector---- output	Energy	Capital	-GDP factor prices- Total	Private	-----Consumption------ Total	Energy	Other
(s)	(Y)	(Ei)	(K)	(fGDPF)	(fGDPFP)	(fCP)	(fEc)	(fC)
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	-0.33	-0.13	-0.06	-0.26	-0.34	-0.75	-0.75	-0.75
2	-0.35	-0.17	-0.12	-0.27	-0.36	-0.74	-0.74	-0.74
3	-0.37	-0.21	-0.17	-0.29	-0.38	-0.73	-0.73	-0.73
4	-0.39	-0.25	-0.21	-0.30	-0.40	-0.72	-0.72	-0.72
5	-0.41	-0.28	-0.25	-0.31	-0.41	-0.71	-0.71	-0.71
6	-0.42	-0.31	-0.28	-0.32	-0.42	-0.70	-0.70	-0.70
7	-0.43	-0.34	-0.31	-0.33	-0.44	-0.69	-0.69	-0.69
8	-0.44	-0.36	-0.34	-0.34	-0.45	-0.68	-0.68	-0.68
9	-0.46	-0.38	-0.36	-0.35	-0.46	-0.67	-0.67	-0.67
10	-0.46	-0.40	-0.38	-0.36	-0.47	-0.66	-0.66	-0.66
20	-0.53	-0.51	-0.50	-0.40	-0.53	-0.58	-0.58	-0.58
50	-0.59	-0.59	-0.59	-0.45	-0.59	-0.42	-0.42	-0.42
100	-0.63	-0.63	-0.63	-0.48	-0.63	-0.30	-0.30	-0.30
295	-0.65	-0.65	-0.65	-0.49	-0.65	-0.24	-0.24	-0.24

All variables except (*) and (**) are pct. change over base case.
(*) indicates change in level in pct. of base line GDP at mkt. prices.
(**) - do. - current - do. -

Table 2b: VAT + 5 percentage points, c.b.c., Bg constant

Government financial balance, annuity equiv., pct. of base case GDP

Taxes	: Wage income taxes	-0.1366
	Interest income taxes	0.0442
	Dividend and capital gains taxes	-0.0056
	Corporate income taxes	-0.0085
	Consumption taxes	2.2885
	Energy taxes	-0.0121
Total tax revenue		2.1697
Expenditures	: Wages	0.0074
	Purchases of goods	0.0000
	Income transfers	2.1623
Total expenditures		2.1697

Change in energy cons., annuity equivalent, pct. of initial cons.

Households	-0.576
Firms	-0.451
Total	-0.506

Efficiency index (zeta):	EV-based	CV-based
Level, pct. of initial GDP at market prices	-8.219	8.522
Annuity equivalent, pct. of initial private cons.	-0.547	0.567

→

Table 3a: VAT + 5 percentage points, exog. L, tau equalization

dbg=1 dtw=1 dtc=1 dty=1 di=1 dinstc=1

Period (s)	GDP at const. market prices (fGDPM)	Priv. cons. (fCP)	Govt. cons. (fCG)	Priv. inv. (I)	Current account (CA**)	Labor supply (L)	Net savings rate (level)
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	-0.03	-0.21	0.00	-0.00	0.09	-0.00	0.26
2	-0.03	-0.20	0.00	-0.00	0.09	-0.00	0.25
3	-0.02	-0.19	0.00	-0.00	0.09	-0.00	0.24
4	-0.02	-0.17	0.00	-0.00	0.09	-0.00	0.23
5	-0.02	-0.16	0.00	-0.00	0.08	-0.00	0.23
6	-0.02	-0.14	0.00	-0.00	0.08	-0.00	0.22
7	-0.02	-0.13	0.00	-0.00	0.08	-0.00	0.21
a	-0.02	-0.12	0.00	-0.00	0.08	-0.00	0.21
9	-0.01	-0.11	0.00	-0.00	0.07	-0.00	0.20
10	-0.01	-0.10	0.00	-0.00	0.07	-0.00	0.20
20	0.00	0.00	0.00	-0.00	0.05	-0.00	0.14
50	0.02	0.17	0.00	-0.00	0.02	-0.00	0.06
100	0.03	0.27	0.00	-0.00	0.00	-0.00	0.01
295	0.04	0.30	0.00	-0.00	0.00	-0.00	0.00

Period	------Private financial wealth------ Total (A*)	Equity (V*)	Govt. debt (Bg*)	Foreign (F*)	Human wealth (H*)	After-tax wage rate (atw)	Lump-sum transfers (TAU*)
(s)							
0	-0.00	-0.00	0.00	0.00	44.63	0.00	0.000
1	0.19	-0.00	0.09	0.10	44.63	-3.93	2.419
2	0.37	-0.00	0.17	0.19	44.63	-3.93	2.419
3	0.54	-0.00	0.26	0.28	44.63	-3.93	2.419
4	0.71	-0.00	0.34	0.37	44.63	-3.93	2.419
5	0.87	-0.00	0.42	0.46	44.63	-3.93	2.419
6	1.03	-0.00	0.49	0.54	44.63	-3.93	2.419
	1.19	-0.00	0.57	0.62	44.63	-3.93	2.419
a	1.34	-0.00	0.64	0.70	44.63	-3.93	2.419
9	1.48	-0.00	0.71	0.78	44.63	-3.93	2.419
10	1.63	-0.00	0.78	0.85	44.63	-3.93	2.419
20	2.83	-0.00	1.35	1.48	44.63	-3.93	2.419
50	4.88	-0.00	2.33	2.55	44.63	-3.93	2.419
100	5.98	-0.00	2.85	3.12	44.63	-3.93	2.419
295	6.30	-0.00	2.97	3.33	44.67	-3.93	2.422

Period	-----Private sector---- Output (Y)	Energy (Ei)	Capital (K)	-GDP factor prices- Total (fGDPF)	Private (fGDPFP)	-----Consumption------ Total (fCP)	Energy (fEc)	Other (fC)
(s)								
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	-0.00	-0.00	-0.00	-0.00	-0.00	-0.21	-0.21	-0.21
2	-0.00	-0.00	-0.00	-0.00	-0.00	-0.20	-0.20	-0.20
3	-0.00	-0.00	-0.00	-0.00	-0.00	-0.19	-0.19	-0.19
4	-0.00	-0.00	-0.00	-0.00	-0.00	-0.17	-0.17	-0.17
5	-0.00	-0.00	-0.00	-0.00	-0.00	-0.16	-0.16	-0.16
6	-0.00	-0.00	-0.00	-0.00	-0.00	-0.14	-0.14	-0.14
7	-0.00	-0.00	-0.00	-0.00	-0.00	-0.13	-0.13	-0.13
a	-0.00	-0.00	-0.00	-0.00	-0.00	-0.12	-0.12	-0.12
9	-0.00	-0.00	-0.00	-0.00	-0.00	-0.11	-0.11	-0.11
10	-0.00	-0.00	-0.00	-0.00	-0.00	-0.10	-0.10	-0.10
20	-0.00	-0.00	-0.00	-0.00	-0.00	0.00	0.00	0.00
50	-0.00	-0.00	-0.00	-0.00	-0.00	0.17	0.17	0.17
100	-0.00	-0.00	-0.00	-0.00	-0.00	0.27	0.27	0.27
295	-0.00	-0.00	-0.00	-0.00	-0.00	0.30	0.30	0.30

All variables except (*) and (**) are pct. change over base case.
(*) indicates change in level in pct. of base line GDP at mkt. prices.
(**) - do. - current - do. -

Table 3b: VAT + 5 percentage points, exog. L, tau equalization

Government financial balance, annuity equiv., pct. of base case GDP		
Taxes	: Wage income taxes	-0.0000
	Interest income taxes	0.0562
	Dividend and capital gains taxes	-0.0000
	Corporate income taxes	-0.0000
	Consumption taxes	2.3632
	Energy taxes	-0.0000
Total tax revenue		2.4194
Expenditures	: Wages	0.0000
	Purchases of goods	0.0000
	Income transfers	2.4194
Total expenditures		2.4194

Change in energy cons., annuity equivalent, pct. of initial cons.	
Households	-0.000
Firms	-0.000
Total	-0.000

Efficiency index (zeta):	EV-based	CV-based
Level, pct. of initial GDP at market prices	-0.000	0.000
Annuity equivalent, pct. of initial private cons.	-0.000	0.000

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Table 4a: VAT + 5 percentage points, exog. L, Bg constant

dbg=1 dtw=1 dtc=1 dty=1 di=1 dinstc=1

Period (s)	GDP at const. market prices (fGDPM)	Priv. cons. (fCP)	Govt. cons. (fCG)	Priv. inv. (I)	Current account (CA**)	Labor supply (L)	Net savings rate (level)
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	-0.03	-0.26	0.00	-0.00	0.11	-0.00	0.16
2	-0.03	-0.24	0.00	-0.00	0.11	-0.00	0.16
3	-0.03	-0.23	0.00	-0.00	0.11	-0.00	0.16
4	-0.03	-0.22	0.00	-0.00	0.11	-0.00	0.15
5	-0.03	-0.20	0.00	-0.00	0.11	-0.00	0.15
6	-0.02	-0.19	0.00	-0.00	0.10	-0.00	0.15
7	-0.02	-0.17	0.00	-0.00	0.10	-0.00	0.15
8	-0.02	-0.16	0.00	-0.00	0.10	-0.00	0.14
9	-0.02	-0.15	0.00	-0.00	0.10	-0.00	0.14
10	-0.02	-0.13	0.00	-0.00	0.10	-0.00	0.14
20	-0.00	-0.02	0.00	-0.00	0.08	-0.00	0.12
50	0.03	0.23	0.00	-0.00	0.05	-0.00	0.07
100	0.06	0.45	0.00	-0.00	0.02	-0.00	0.03
295	0.08	0.60	0.00	-0.00	0.00	-0.00	0.00

Period (s)	------Private financial wealth------ Total (A*)	Equity (V*)	Govt. debt (Bg*)	Foreign (F*)	Human wealth (H*)	After-tax wage rate (atw)	Lump-sum transfers (TAU*)
0	-0.00	-0.00	0.00	0.00	44.09	0.00	0.000
1	0.12	-0.00	0.00	0.12	44.16	-3.93	2.324
2	0.23	-0.00	0.00	0.23	44.22	-3.93	2.329
3	0.35	-0.00	0.00	0.35	44.28	-3.93	2.333
4	0.46	-0.00	0.00	0.46	44.34	-3.93	2.338
5	0.57	-0.00	0.00	0.57	44.41	-3.93	2.342
6	0.67	-0.00	0.00	0.67	44.47	-3.93	2.347
7	0.78	-0.00	0.00	0.78	44.52	-3.93	2.351
8	0.88	-0.00	0.00	0.88	44.58	-3.93	2.355
9	0.98	-0.00	0.00	0.98	44.64	-3.93	2.360
10	1.08	-0.00	0.00	1.08	44.69	-3.93	2.364
20	2.00	-0.00	0.00	2.00	45.20	-3.93	2.401
50	3.94	-0.00	0.00	3.94	46.30	-3.93	2.480
100	5.57	-0.00	0.00	5.57	47.22	-3.93	2.547
295	6.75	-0.00	0.00	6.75	47.88	-3.93	2.595

Period (s)	-----Private sector---- Output (Y)	Energy (Ei)	Capital (K)	-GDP factor prices- Total (fGDPF)	Private (fGDPFP)	-----Consumption------ Total (fCP)	Energy (fEc)	Other (fC)
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	-0.00	-0.00	-0.00	-0.00	-0.00	-0.26	-0.26	-0.26
2	-0.00	-0.00	-0.00	-0.00	-0.00	-0.24	-0.24	-0.24
3	-0.00	-0.00	-0.00	-0.00	-0.00	-0.23	-0.23	-0.23
4	-0.00	-0.00	-0.00	-0.00	-0.00	-0.22	-0.22	-0.22
5	-0.00	-0.00	-0.00	-0.00	-0.00	-0.20	-0.20	-0.20
6	-0.00	-0.00	-0.00	-0.00	-0.00	-0.19	-0.19	-0.19
7	-0.00	-0.00	-0.00	-0.00	-0.00	-0.17	-0.17	-0.17
8	-0.00	-0.00	-0.00	-0.00	-0.00	-0.16	-0.16	-0.16
9	-0.00	-0.00	-0.00	-0.00	-0.00	-0.15	-0.15	-0.15
10	-0.00	-0.00	-0.00	-0.00	-0.00	-0.13	-0.13	-0.13
20	-0.00	-0.00	-0.00	-0.00	-0.00	-0.02	-0.02	-0.02
50	-0.00	-0.00	-0.00	-0.00	-0.00	0.23	0.23	0.23
100	-0.00	-0.00	-0.00	-0.00	-0.00	0.45	0.45	0.45
295	-0.00	-0.00	-0.00	-0.00	-0.00	0.60	0.60	0.60

All variables except (*) and (**) are pct. change over base case.
(*) indicates change in level in pct. of base line GDP at mkt. prices.
(**) - do. - current - do. -

Table 4b: VAT + 5 percentage points, exog. L, Bg constant

Government financial balance, annuity equiv., pct. of base case GDP

Taxes	: Wage income taxes	-0.0000
	Interest income taxes	0.0430
	Dividend and capital gains taxes	-0.0000
	Corporate income taxes	-0.0000
	Consumption taxes	2.3632
	Energy taxes	-0.0000
Total tax revenue		2.4062
Expenditures	: Wages	0.0000
	Purchases of goods	0.0000
	Income transfers	2.4062
Total expenditures		2.4062

Change in energy cons., annuity equivalent, pct. of initial cons.

Households	-0.000
Firms	-0.000
Total	-0.000

Efficiency index (zeta):	EV-based	CV-based
Level, pct. of initial GDP at market prices	0.004	-0.004
Annuity equivalent, pct. of initial private cons.	0.000	-0.000

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