

TAXATION WHEN BORROWING IS COSTLY

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Abstract

The implications for taxation theory of a life-cycle model of consumption incorporating financial transactions costs are derived. The equity case for progressive taxation is shown to correspond, in a life-cycle setting, to an efficiency case. Individuals prefer a progressive tax system to a proportional one because the tax burden is lower when they are young and face high transactions costs of borrowing. Similarly, an income tax is preferred to a consumption tax. Unlike earlier models based on liquidity constraints, the model presented here involves a financial sector consuming real resources. This permits analysis of the tax treatment of financial services in a consumption tax system. Exemption of financial services will generally be desirable.

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TAXATION WHEN BORROWING IS COSTLY

I Introduction

The choice between consumption and income taxes has generally been seen as one between efficiency and equity. Although income taxes, and particularly progressive income taxes, are more equitable, it is generally assumed that they involve efficiency costs which are not incurred when consumption is the base for taxation. This result is typically derived from life-cycle consumption models, as in the work of Summers (1981). The purpose of this paper is to argue for a position directly at odds with this conventional wisdom. I claim that consumption taxes are inefficient precisely because they are inequitable.

The argument is developed in the context of a life-cycle model. In order to focus attention on the efficiency issues, differences between individuals are disregarded. All individuals are assumed to have the same lifetime path of income and consumption, and differ only in age. The model addresses the question - if an individual is faced with a fixed lifetime tax liability (in present value terms), what time-path of tax payments will impose the least welfare loss ?

Although standard life-cycle models rely on capital markets to allocate the flow of consumption over time, they do not normally contain a financial sector which uses real resources to achieve this end. Indeed, the notion of a 'perfect capital market' is precisely one which involves no transaction costs and consumes no resources. It is rather as if a 'perfect agricultural sector' was one which required no inputs of labor, land or fertiliser.

In Quiggin (1991), a life-cycle model with an explicit, costly, financial sector is developed. Individuals face higher interest rates when they are net debtors than when they are savers. The margin between borrowing and lending rates of interest represents the costs of financial intermediation. Unlike the usual perfect capital market case, it is shown that

individuals are not indifferent between income streams with the same present value (evaluated at the rate of return to savings). Rather, they prefer flatter income streams which involve lower levels of indebtedness and less costly borrowing.

This result has important implications for taxation policy. The central element of the efficiency case against the use of income as a tax base has been that, by driving a wedge between the post-tax return to saving and the real rate of return to capital, the taxation of interest income distorts the intertemporal allocation of consumption and, in particular, reduces net saving below its optimal level. This analysis depends critically on the assumption of costless capital markets. If intertemporal transfers are a free good, it is natural that they should be consumed up to the point of satiation. This point occurs where the marginal rate of substitution between consumption in different time periods is equal to the real rate of interest which in turn is equal to the marginal productivity of capital. Any policy which reduces the volume of intertemporal transfers below this level is distortionary.

A further implications individuals are indifferent as to the distribution of the tax burden over their lifetime provided its present value, discounted at the market rate of interest, remains constant. A number of other equivalences, for example between a consumption tax and a tax on wage income, follow from this fact.

The conclusions of the standard analysis are called into question when it is recognised that borrowing and lending are costly. Taxes, such as consumption taxes, that bear most heavily on people when they are young and relatively poor impose a higher burden than taxes which bear most heavily on people at peak income levels. It follows that individuals are not, and society should not be, unconcerned about the lifetime distribution of the tax burden. Any (revenue neutral) tax change which increases the tax burden in periods when individuals have low income and negative assets reduces taxpayer welfare and increases the demand for socially costly borrowing transactions.

The analysis presented here may be interpreted more generally as the basis of an efficiency case for progressive taxation. It is shown that the lifetime stream of post-tax income under a progressive system is strictly preferred to that obtained under a proportional or regressive system yielding the same revenue (in present value terms).

II Model

The model used here is presented in detail by Quiggin (1991). Identical individuals have a known lifetime $[0, T]$. The population is constant and age is uniformly distributed across $[0, T]$ at all times. Individuals receive a known flow of lifetime wage income, given by a function $W: [0, T] \rightarrow \mathfrak{R}$. Wage income at time t is denoted W_t .

The economy is open to flows of capital and is small relative to the world market. Hence, the real rate of return to capital equals r and this rate is determined exogenously in the world market. The individual's time-path of assets is denoted by V and total assets at time t will be denoted by V_t . The time path of consumption is denoted by C . Individuals may save, receiving returns at the internationally determined rate r , or borrow at a rate ρ . The margin $m = \rho - r$ represents transaction costs incurred by the financial sector in assessing the credit-worthiness of borrowers and enforcing contracts. There are no economic profits in the financial sector, which is perfectly competitive.

In the general case, examined in Quiggin (1991), m may depend on the level of outstanding debt. In this paper, attention is confined to the case of a fixed margin.

The object of capital market transactions is to maximise the expected utility of lifetime consumption

$$Z = \max \int_0^T U(C_t) e^{-\alpha t} dt \quad (1)$$

subject to the endpoint constraints

$$V_0 = 0 = V_T \quad (2)$$

and the accounting conditions

$$\partial V / \partial t = W_t - C_t + \rho V_t \quad V_t < 0 \quad (3a)$$

$$\partial V / \partial t = W_t - C_t + r V_t \quad V_t \geq 0 \quad (3b)$$

where

W denotes wage income

C denotes consumption

V denotes total assets

δ is the pure rate of time preference

and

U is a utility function of the constant relative risk aversion (CRRA) form

$$U(C) = \frac{\sigma}{\sigma - 1} C^{1-1/\sigma} \quad \sigma \neq 1 \quad (4)$$

$$= \log(C) \quad \sigma = 1$$

where σ is the intertemporal elasticity of substitution.

The main case of interest is where wage income rises until some retirement date TR , then falls to zero. The individual will initially consume in excess of her income, building up a debt. A period of saving will then commence, with the debt being repaid at time t^* , which will be referred to as the ‘crossover year’. Saving will continue in order to build up assets for the retirement period. When the retirement period commences, there is a switch from saving to dissaving, with assets being exhausted at T . In Quiggin (1991), it is shown that, for an interior solution, the optimal time-path of consumption takes the form

$$C_t = C_{t^*} e^{-\eta(t^* - t)} \quad 0 \leq t \leq t^* \quad (5)$$

$$C_t = C_{t^*} e^{\gamma(t - t^*)} \quad t^* \leq t \leq T$$

where

$$\gamma = \sigma(r - \delta)$$

$$\eta = \sigma(\rho - \delta)$$

and t^* and C_{t^*} are chosen to satisfy the requirements that $V_0 = V_{t^*} = V_T$, or

$$\int_0^{t^*} (C_{t^*} e^{-\eta(t^* - t)} - W_t) e^{-\rho t} dt = 0 \quad (6)$$

$$\int_{t^*}^T (C_{t^*} e^{\gamma(t - t^*)} - W_t) e^{-rt} dt = 0$$

The time-path of consumption is simplest in the case where $r = \delta$. In this case, consumption rises exponentially until t^* and is constant thereafter.

If the transaction costs of borrowing are sufficiently high relative to the rate of growth of wages, a corner solution involving no borrowing is derived. The individual initially consumes her income, commences saving at t^* , then accumulates net assets until income declines below the annualised present value of income, at which point dissaving begins. This is the pattern of behavior proposed in 'liquidity-constrained' models. The conditions under which this corner solution arises may be stated most simply for the case when wage income grows at a constant percentage rate k over the period $[0, t^*]$. The interior solution will be feasible if and only if $\eta = \sigma(\rho - \delta) < k$. If $\eta \geq k$, liquidity constrained behavior will apply.

The properties of the interior solution may be illustrated by a range of simulations. In Table 1, the model presented above is solved for a range of values of the transaction cost parameter m . Individuals are assumed to work for 40 years and to be retired for 10 years. The initial wage is normalised to unity and wages are assumed to rise at a rate of 3 per cent per annum throughout the individual's working life. The real rate of return on capital and the rate of time preference are set at 5 per cent. The intertemporal substitution parameter σ is set equal to 0.5. The transaction cost parameter m ranges from 0 to 6 per cent. For higher values of m , the corner solution applies.

On the basis of the data presented by the Australian Bankers Association (1991) and Milbourne and Cumberworth (1992), margins in retail banking have typically been in the range 3-5 per cent. Since this may include some bundling of services not covered by fees and charges, attention will be focused on the case when m is set to 3 per cent.

The first row of the table indicates the initial consumption level as a proportion of the initial wage level. The second row indicates the final consumption level. The third row is the crossover year t^* . The fourth row indicates the welfare loss relative to the case of costless transactions. This is computed by solving for the uniform percentage increase in income that would be required to achieve the same utility as that obtained in the absence of transactions costs. For the given parameters, consumption in the absence of transactions costs is constant. Since, under constant relative risk aversion, a uniform increase in income generates a similar

uniform increase in consumption, it is necessary to solve for Δ in

$$\int_0^T U(C_0^*) e^{-\delta t} dt = \int_0^{t^*} U((1+\Delta)C_{t^*} e^{-\eta(t^*-t)}) e^{-\delta t} dt + \int_{t^*}^T U((1+\Delta)C_{t^*} e^{\lambda(t^*-t)}) e^{-\delta t} dt$$

where C_0^* is the constant level of consumption in the absence of transactions costs and C_{t^*} is as derived in (6).

The fifth row represents the proportion of social resources consumed in transaction costs related to borrowing. As shown in Quiggin (1991), this is equal to the difference between the present value of wages and the present value of consumption, both evaluated at the rate r . For values of m greater than or equal to 6 per cent, the solution involves zero borrowing and no consumption of resources in the financial sector.

TABLE 1

OPTIMAL CONSUMPTION PATHS WITH $\sigma = 0.5$

Transaction cost m (%)	0	1	2	3	4	5	6
Initial Consumption ^a	1.50	1.37	1.29	1.17	1.10	1.05	1
Final Consumption ^a	1.50	1.61	1.76	1.81	1.89	1.93	1.94
Crossover year t^*	33.3	32.2	30.8	29.0	26.9	24.5	22.1
Welfare Loss ^b (%)	0	2.0	3.6	4.6	5.3	5.6	5.6
Resource Use ^b (%)	0	1.7	2.4	2.3	1.7	0.8	0

a: As proportion of initial wage

b: As proportion of present value of wage income

A series of empirical studies, surveyed in Pencavel (1986) have reported estimated values of σ less than 0.5, and in some cases not significantly different from zero. A lower value of σ implies greater aversion to variations in consumption and hence a greater social loss associated with the fact that financial transactions are costly. In the simulations reported in Table 2, the inter-temporal substitution parameter σ has been reduced from 0.5 to 0.33.

TABLE 2

OPTIMAL CONSUMPTION PATHS WITH $\sigma = 0.33$

Transaction cost m (%)	0	1	2	3	4	6	9
Initial Consumption ^a	1.50	1.40	1.32	1.25	1.19	1.09	1
Final Consumption ^a	1.50	1.56	1.63	1.70	1.77	1.88	1.94
Crossover year t^{*b}	33.3	32.7	32.0	31.0	30.0	27.1	22.1
Welfare Loss ^b (%)	0	4.3	8.0	11.0	13.4	16.5	17.8
Resource Use ^b (%)	0	1.9	3.1	3.6	3.6	2.5	0

a: As proportion of initial wage

b: As proportion of present value of wage income

A noteworthy feature of Table 2 is that the total welfare loss increases more than the resource use in the financial sector. That is, most of the loss is due to the fact that desired consumption smoothing is not undertaken rather than to costs incurred in financial transactions.

The path of income, consumption and wealth is illustrated in Figure 1. The paths for consumption and income are shown on a log scale, illustrating the point that the optimal solution involves a switch in the rate of growth of consumption at the point where net wealth becomes positive.

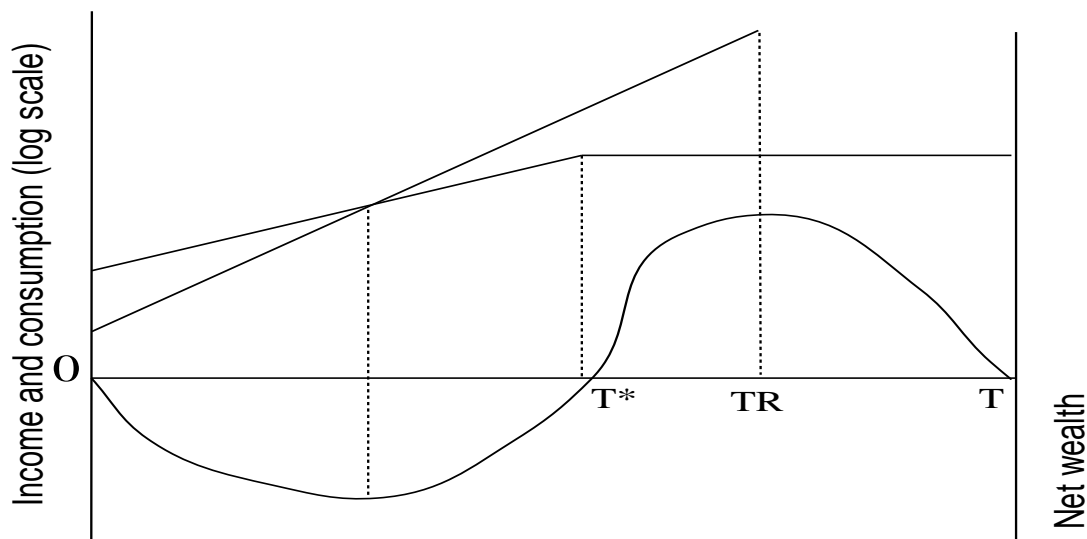
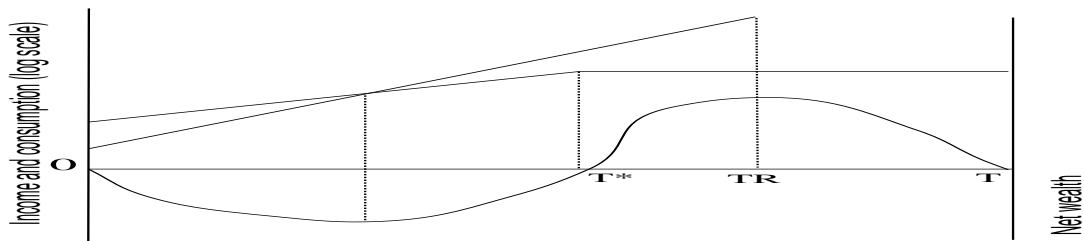


Figure 1: Time-path of income, consumption and wealth



III Taxes
Figure 1: Time-path of income, consumption and wealth

The results derived above show that a change that does not affect the present value of lifetime disposable income may nevertheless affect welfare. The taxation system provides one instrument through which government can influence the lifetime distribution of income. Hence there is a potential for Pareto-improving intervention through policies which change the life-cycle distribution of income (net of taxes and transfers).

The power to tax gives the government power to redistribute income between individuals, and (more relevant here) to redistribute individual income over time. When transaction costs of borrowing and lending are present, there exist feasible redistributions of income over time that increase individual welfare without changing the present value of income or of government revenue (evaluated at the marginal rate of return to capital). In particular, the solution derived above and illustrated in Figure 1 is characterised by the fact that the marginal utility of additional disposable income is highest in the early years when consumption exceeds income. The tax burden on young people is higher with a consumption tax than with a wage tax and higher with a wage tax than with an income tax. Hence there are *prima facie* grounds for supposing that an income tax will be preferred to a wage tax, and a wage tax to a consumption tax.

This argument does not depend, in any essential way, on an assumption that the government can borrow on international markets at the world interest rate r . The ability to redistribute individual tax burdens over time is consistent with a constraint that the government budget should always be in balance, or that the government should always have a positive holding of financial assets. However, if governments are net debtors and face transactions costs in borrowing, the present value constraint on lifetime tax payments becomes more complex, and their ability to redistribute income over time is compromised. This problem does not appear to be serious for governments of more developed countries such as Australia, which can generally borrow at rates lower than those available to private borrowers. However,

less developed country governments, particularly those with a high perceived risk of default, may face substantial transactions costs. The results presented here should be qualified in this case.

Some of these points have been made using the notion of liquidity constraints (Hubbard and Judd 1986). However, there are some important issues in the taxation debate which can be adequately addressed only in a model in which the financial sector is represented explicitly. Most notably, these include the taxation treatment of the financial sector itself. In most VAT systems of consumption tax, financial services have been either zero-rated or exempted from taxation (see Chisholm, Freebairn and Porter 1990, Bakker and Chronican 1987). The model presented here permits an analysis of the welfare effects of including or excluding financial services from the tax-base. This analysis, which would not be feasible in a liquidity constraint model, yields the conclusion that financial services should be exempt, at least insofar as they reflect costs of borrowing and lending. Taxation of financial services acts to increase the margin between the borrowing and lending rates inherent in the costly nature of transactions. As a result, taxation is likely to magnify the deviation from the first-best perfect costless capital market outcome.

This result must be qualified in two ways. First, because the operations of the financial sector and the associated transactions costs, are not modelled explicitly, the model necessarily abstracts from the impact of tax regimes with the operations of the financial sector. It is probable that tax systems affect the kinds of transactions costs associated with financial markets. However, writers such as Stiglitz and Weiss, who represent models of financial sector transactions costs, have not in general incorporated any effects of the tax system.

The second qualification is that the present model has only a single consumption good, and hence the consumption tax model is a single rate tax with no exemptions. In practice, it is impossible to levy the tax on some items of consumption, such as overseas holidays, and consumption taking place in the illegal or informal economy. In addition, most consumption taxes involve some politically determined exemptions or rate variations on items such as food, clothing, health, education, housing, gambling and legal drugs. For the usual second-best reasons, the result derived here on the suboptimality of taxing financial

services does not necessarily apply in the case of a consumption tax with partial coverage.

The welfare loss in the liquidity constraint model is entirely due to the fact that consumption is below the optimal level. Since there is widespread concern, particularly in Australia and the United States, that levels of saving are too low, this conclusion may seem implausible. Even if the model is valid, the conclusion that consumption by the young is too low may be invalidated by the existence of other imperfections tending to depress saving and raise consumption. By contrast, the present model stresses welfare losses arising from the consumption of resources in the financial sector. Given the spectacular dissipation of resources in the US savings and loans industry and parts of the Australian financial sector over the 1980s, the conclusion that the financial sector may be too large seems plausible.

It will be assumed that the government is required to raise a fixed revenue, which may be expressed as a proportion of the present value of wage income at the real interest rate r . In order to avoid issues of inter-generational redistribution, it will be assumed that the present-value of tax payments made by any individual is fixed. The revenue is spent in a way which does not affect intertemporal consumption decisions¹.

The proportional wage tax provides a base for comparison with other tax systems. By the CRRA assumption on utility, a proportional reduction in W implies a proportional reduction in C_t for all t . The results in Tables 1 and 2 apply except that all consumption levels are reduced by an amount proportionate to the tax rate τ .

Thus, the wage tax is lump-sum. However, the properties of consumption and income taxes depend on individual saving and borrowing decisions. The usual equivalence between wage taxes and consumption taxes does not hold. Also, the relative efficiency of consumption, income and wage taxes cannot be determined by *a priori* arguments based on the undesirability of distorting consumption decisions. Instead it is necessary to derive an explicit solution of the optimal time-path of consumption under each of these tax régimes.

As was argued above, a consumption tax is likely to perform better if financial services are exempt. The optimal time-path for consumption must satisfy the constraints:

¹ It is assumed that any goods provided by public expenditure enter the utility function in an additively separable fashion. If this condition is satisfied, public expenditure may be ignored for the purposes of the present analysis.

$$\int_0^{t^*} (C_{t^*}/(1-\tau)e^{-\eta t} - W_t)e^{-\rho t} dt = 0 \quad (7)$$

and

$$\int_{t^*}^T (C_{t^*}/(1-\tau)e^{\eta t} - W_t)e^{-rt} dt = 0 \quad (8)$$

Since $1/(1-\tau)$ is a constant, imposition of a consumption tax at a rate τ will yield the same pattern of consumption as imposition of a wage tax at a rate τ . This is in line with the intuition derived from the observation that an increase in the price of the consumption good will be equivalent to a corresponding reduction in the real wage. However, when transaction costs are present, the consumption tax will not yield the same revenue as the wage tax. The present value of the consumption tax will be lower by the difference between the present value of consumption and the present value of wages. As was shown above, this is equal to the present value of resources consumed by the financial sector. In order to raise a given present value from the consumption tax, it is necessary to raise the rate of taxation by an amount equal to the resource use of the financial sector. The welfare loss associated with a shift from wage taxation to this form of consumption tax is given by $\Delta\tau$, where Δ is the proportion of resources consumed by the financial sector. For example, given the parameter settings above, with m set to 3 per cent and $\sigma = 0.5$, the final row of Table 1 indicates that Δ is 2.3 per cent. Hence, for $\tau = 0.25$, the welfare loss is equal to 0.6 per cent of total income. Similarly with m set to 3 per cent and $\sigma = 0.33$, Table 2 shows that Δ is 3.6 per cent. Thus, with $\tau = 0.25$, the welfare loss is 0.9 per cent of total income. The results are tabulated in Table 3 for a range of parameter values.

TABLE 3

WELFARE LOSSES FROM CONSUMPTION TAX WITH EXEMPTION OF FINANCIAL SERVICES

	$\sigma = 0.5$			$\sigma = 0.33$		
Transaction cost m (%)	2	3	4	2	3	4
Welfare Loss (%) ^a	0.6	0.6	0.4	0.5	0.9	0.9

a: As proportion of present value of wage income

The alternative specification of the consumption tax is one in which the services of the financial sector are subject to taxation. This implies that the transaction cost m must be replaced by $m/(1-\tau)$. The interest rate facing borrowers becomes $\rho^* = r + m/(1-\tau)$. The optimisation problem (1) - (3) may now be solved with ρ^* replacing ρ . In particular, when $m = 0.03$, $\tau = 0.25$, we have $m/(1-\tau) = 0.04$. That is, the effective interest margin facing borrowers rises from 3 per cent to 4 per cent. Hence, the optimal time-path of consumption corresponds to the solution in Tables 1 and 2 with m set to 4 per cent. The associated welfare loss, relative to the wage tax, is given by the difference in welfare between this solution and the solution with m set to 3 per cent.

In Table 4, welfare losses are tabulated for values of m from 2 to 4 per cent and $\sigma = 0.5, 0.33$. The tax rate τ is set at 0.25. When $\sigma = 0.5$, the welfare loss is 0.7 per cent. This is larger than the welfare loss of 0.6 per cent derived for the same parameter values on the assumption that financial services are exempt from the tax (see Table 3). Similarly, for $\sigma = 0.33$, Table 2 yields a welfare loss of 2.4 per cent.

TABLE 4

WELFARE LOSSES FROM CONSUMPTION TAX WITH TAXATION OF FINANCIAL SERVICES

	$\sigma = 0.5$			$\sigma = 0.33$		
Transactions cost m (%)	2	3	4	2	3	4
Welfare Loss (%) ^a	0.7	0.7	0.3	2.1	2.4	2.3

a: As proportion of present value of wage income

The welfare losses for the case $\sigma = 0.5$ are comparable to those in the case when financial sector services are untaxed. However, for $\sigma = 0.33$, welfare losses are at least twice as large when financial services are included in the tax base. This result arises because the welfare losses for the value $\sigma = 0.33$ are large in relation to the resources consumed in the financial sector. Hence, an increase in the interest rate facing borrowers leads to a large reduction in welfare.

The next case is that of a proportional income tax. Both wage and interest income are

taxed. Interest payments to lenders are not deductible. Since r , the real rate of return to capital, is determined by the international capital market and interest payments from all sources are taxed, the net interest rate for savers becomes $r(1-\tau)$. Because the tax base is increased by the inclusion of interest income, the required tax rate is reduced. Since the level of interest income is determined endogenously by savings-consumption decisions, the required tax rate is also endogenous.

Quiggin (1991) shows that the profile of consumption during the period of indebtedness will be almost unaffected by changes in the rate of interest payable on savings. Hence, over the period of indebtedness, the only difference between consumption under the wage tax and consumption under the income tax will arise from the fact that the income tax rate is lower than the wage tax rate. Welfare over this period will be increased unambiguously. The beneficial effect depends on the transaction costs associated with the financial sector. Conversely, consumption and welfare over the period in which asset holdings are positive will be reduced. Furthermore, the intertemporal allocation of consumption over this period will be distorted by the tax. The loss incurred over the period of positive asset holdings is essentially independent of the transaction costs associated with borrowing.

In Table 5, these effects and the net welfare impact are calculated for a range of values of m . The tax rate is set at 25 per cent, the real rate of return on capital is 5 per cent, and the intertemporal substitution parameter, σ , is 0.5. Because the effects are quite small, they are given to two decimal places. The first row of Table 5 shows the welfare loss incurred over the period of positive assets from the taxation of interest and the associated distortion of intertemporal allocation of consumption. The second row shows the benefit associated with expansion of the tax base. The third row is the net effect, derived from summing the first two.

TABLE 5

COMPARISON OF INCOME TAXES AND WAGE TAXES ($\sigma = 0.5$)

Transaction cost m (%)	0	1	2	3	4	5	6
Loss (%) ^a	-0.57	-0.58	-0.59	-0.60	-0.60	-0.61	-0.61
Tax Benefit (%) ^b	0.55	0.62	0.71	0.80	0.87	0.91	0.93

Net Effect (%) ^c	-0.02	0.07	0.12	0.20	0.27	0.30	0.32
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a: From taxation of interest and consumption distortion

b: From reduced tax rate

c: Gain (loss) from income tax as a proportion of present value of wage income

As would be expected *a priori*, the net effect of shifting from a wage tax to an income tax is negative when transaction costs are absent. The total effect is small, however. This is partly due to the fact that all of the loss is incurred after t^* . In the present-value calculation, therefore, the loss is discounted by a factor of at least e^{α^*} relative to first-period consumption. Second, the distortion in the relative prices of present and future consumption is small, and hence the associated Harberger triangle is second-order.

This result is consistent with Harberger's own (1962, 1964) analysis. More recent estimates such as that of Summers (1981), using a more sophisticated life-cycle model, and focusing on the general equilibrium effects of changes in the capital stock, have suggested a significantly larger efficiency loss. Summers (1981) appears to claim that the increase in estimated deadweight loss from an income tax, is a result of the shift from a two-period model to a continuous-time model. However, the critical feature which generates large losses in Summers' model is not the use of continuous time but the endogeneity of capital stock. This may be seen by a comparison with the results of Hall (1968). Hall uses a continuous-time, open-economy model and obtains very small welfare effects.

When the value of m is not close to zero, the income tax outperforms the wage tax. This result is reversed, however, when $\sigma = 0.33$. The increase in aversion to inter-temporal variations in consumption raises the welfare loss associated with the tax. The effect on tax

revenue is ambiguous. The rate of saving during the period of positive assets is higher. However, as shown in Table 2, the crossover date is later, so that the period during which positive assets are held is shorter. With the parameters used here, the second of these effects predominates. This arises from the fact that $\delta = r$. Hence, for $\tau = 0$, $\gamma = 0$ and the profile of consumption after t^* is independent of σ . For small τ , changes in σ have only a small effect on γ and hence on the tax revenue available.

Thus, the comparison between the efficiency effects of a wage tax and an income tax is ambiguous. However, the consumption tax is least efficient over almost the entire parameter space, excepting only the region where m is very close to zero.

IV Progressive taxation

Thus far, several alternative tax bases have been considered. An equally important issue is the choice of tax schedule. The income tax has been fairly steeply progressive, although the existence of exemptions and avoidance schemes means that the actual degree of progression is less than that in the official tax schedules.

This question will be examined by simulating the effects of a switch from a flat wage tax to a progressive wage tax. The main reason for not examining progressive income taxes in the present paper is one of analytical tractability. The problem is quite complex, whereas a very simple solution can be found for the wage tax.

It may be worth considering the implications of progression using the other tax bases considered here. If consumption taxes are levied at the point of sale, there is no scope for significant progression. Some progression may be achieved if goods with a high income elasticity of demand are more heavily taxed, but this involves both additional distortions and administrative difficulties. An alternative form of consumption tax is an income tax with an exemption for savings. Such a tax could be progressive. Once again, it seems likely that substantial administrative difficulties would be encountered. The income tax is progressive in most countries, including Australia.

Consider first a tax schedule specified so that the initial wage level is tax-free and the tax rate is an exponential function of wage income in excess of the tax-free threshold. That is

$$\tau(W) = 1 - W^{-\tau^*} \quad (9)$$

When pre-tax wage income follows the increasing path e^{kt} , post-tax wage income takes the form $e^{(1-\tau^*)kt}$. Hence the form of the solution derived above for the optimal consumption path is unchanged.

In order to make the progressive tax comparable to a flat rate tax, we require that the present value of revenue should be the same for the two systems. That is

$$\int_0^{TR} (e^{kt} - e^{(1-\tau^*)kt}) e^{-rt} dt = \int_0^{TR} \tau e^{kt} e^{-rt} dt \quad (10)$$

or

$$\int_0^{TR} e^{(1-\tau^*)kt} e^{-rt} dt = \int_0^{TR} (1-\tau) e^{kt} e^{-rt} dt \quad (11)$$

With $\tau = 0.25$, solution of (11) yields $\tau^* = 0.59$. The proportion of wage income paid in taxes, derived from substituting this value into (9), rises over the individual's lifetime from zero to 37 per cent. For some parameter values, the steeply progressive nature of this tax system means that the optimal solution involves liquidity constrained behavior. The critical question is whether $\sigma m = \eta > \kappa(1-\tau^*)$, where η is the optimal rate of growth of consumption (for an interior solution) over the period $[0, t^*]$ and $\kappa(1-\tau^*)$ is the rate of growth of post-tax income. With $\sigma = 0.5$, the critical value of m is approximately 0.024. Above this level, changes in m do not affect the profile of consumption under the progressive tax.

The welfare effects of a progressive wage tax of the form set out in (9) are summarised in Tables 6 and 7. Table 6 deals with the case when $\sigma = 0.5$. The first row shows the transaction cost and the second row shows the crossover year. The third row shows the gains associated with a shift from a flat wage tax to a progressive wage tax. To compare a progressive wage tax to a flat-rate consumption tax, it is necessary to add the welfare gain in the third row of Tables 6 and 7 to the welfare loss associated with a shift from a wage tax to a consumption tax (see Table 3). The resulting total welfare gain is given in the final row of Tables 6 and 7.

TABLE 6

WELFARE GAINS FROM PROGRESSIVE TAXATION, $\sigma = 0.5$

Transaction cost m (%)	0	1	2	3	4	5	6
Crossover year t^*	22.9	18.8	14.9	13.6	13.6	13.6	13.6
Welfare Gain ^a (%)	0	1.8	3.2	4.0	4.7	5.0	5.0
Total gain ^b (%)	0	2.2	3.8	4.6	5.1	5.2	5.0

a: Move from flat wage tax to proportional wage tax

b: Move from flat consumption tax to proportional wage tax

With $m = 0$, there is no gain, since individuals are indifferent as to the lifetime distribution of their post-tax income. Note that although the time-profile of consumption under the progressive income tax is unchanged for $m \geq 0.03$, welfare gains keep increasing because the loss associated with transaction costs in the base situation is rising. The comparison for $m = 0.06$ represents the case when no borrowing takes place under either tax regime, and individuals consume their post-tax income over the interval $[0, t^*]$. For $m = 0.03$, $\sigma = 0.5$, the total efficiency loss associated with the consumption tax is 4.6 % of the present value of income. Since tax revenue is 25% of income, this implies a welfare loss of 18 cents per dollar of revenue raised. As would be expected, the effects are greater when $\sigma = 0.33$. This is shown in Table 7. For the case $\sigma = 0.33$, with m set at 3 per cent, the total efficiency loss is 10.0% or 40 cents per dollar of revenue raised.

TABLE 7

WELFARE GAINS FROM PROGRESSIVE TAXATION, $\sigma = 0.33$

Transaction cost m (%)	0	1	2	3	4	5	6
Crossover year t^*	22.9	20.3	17.5	15.0	12.8	11.3	11.3
Welfare Gain ^a (%)	0	3.8	6.5	9.1	10.9	13.5	14.8
Total gain ^b (%)	0	4.3	7.3	10.0	11.8	14.3	15.4

a: Move from flat wage tax to proportional wage tax

b: Move from flat consumption tax to proportional wage tax

Thus, the equity case for progressive taxation appears in the life-cycle setting as an efficiency argument. Even in a community of identical individuals, a progressive income tax may be preferred to a consumption tax when borrowing is costly.

V Qualifications and generalisations

As with the majority of the life-cycle models which have been employed in the analysis of tax policy, the model presented here is a highly simplified representation of reality. It is natural therefore, to consider the qualifications which must be placed on the policy implications of the model and possible generalisations which might overcome these problems.

A major difference between the model presented here and a number of those in the literature (notably that of Summers 1981) is that the economy is assumed small and open. The transactions costs of borrowing are assumed to apply only to households and not to borrowing to finance investment. Hence, the real return to capital and the capital stock are determined on the world market. Tax policy affects only the holdings of capital stock by residents of the country concerned.

The large benefits found by Summers to arise from a consumption tax are due to the fact that increased saving increases the capital stock and hence raises the marginal (and average) product of labor. The model presented here also omits an analysis of the effects of tax policy on capital accumulation and on the equilibrium growth path of capital stock.

The relevance of this qualification depends partly on the country to which the analysis is applied. The small open economy assumption applies naturally for Australia, but is less clearly appropriate for the United States. Even for the US, however, Summers' model implicitly relies on unspecified transactions costs associated with international borrowing. In the absence of such costs, the effects of taxation on domestic capital formation would be much smaller than those derived by Summers. The sensitivity of results on the effects of taxation on capital formation to assumptions about the role of international capital markets is discussed by Slemrod (1988).

A more critical objection to the Summers analysis is that it fails to take account of public sector saving (or dissaving). Implicit in the Summers model is the assumption that public sector saving is independent of the private sector capital stock and of the choice of tax base. As has been pointed out by critics such as Bosworth (1988), an increase in public sector saving would seem to be a far more reliable tool for building capital stock than would a move to consumption taxes. At a theoretical level, the main point is that any model in which the private sector capital stock is endogenously determined by taxation policy must also include an account of the determination of public sector saving. The critical issue is the extent to which public saving adjusts to offset the reduction in private savings associated with capital taxation (Little and Mirrlees 1974).

The model presented here does not include incentive effects of taxation on labor supply. It may be noted that, for the flat-rate tax systems, the substitution effect on the labor-leisure choice is essentially unaffected by the choice of tax base. Since the consumption tax is less efficient, the tax burden, and the incentive effect, will be larger for a given revenue. Progressive tax systems potentially involve more severe incentive effects than flat-rate systems.

In principle, these could be incorporated into the model presented here, so that both labor supply and consumption are determined in an optimising framework. The natural approach would be to regard the fixed wage income in the present model as representing total income. Total income is the amount the individual could earn if she worked the maximum possible number of hours. Total income may be 'spent' either on leisure or on the purchase

of goods. In this representation, the effect of taxing money income is to distort within-period allocation decisions in favor of leisure.

A rough and ready approach to policy analysis may be made by adding a preferred estimate of the efficiency gains in labor-leisure choices associated with the incentive effects of a shift from progressive to flat-rate taxation with the intertemporal efficiency losses derived here for the flat-rate consumption tax. The critical parameter in determining this efficiency gain is the elasticity of labor supply. Pencavel (1986, Table 1.19) reports a range of estimates for the United States from -0.16 to 0.14, the high estimate being Wales and Woodland (1979). A simple Harberger triangle approach applied to the Wales and Woodland estimate suggests a welfare loss of 2.3% for a wage tax rate of 57 % (the welfare loss at a 20 per cent tax rate is negligible). Averaging over the entire earning period in the present model yields a loss of less than 1 per cent of total welfare or 5 cents per dollar of revenue raised.

It appears likely that this procedure will slightly overestimate the cost of progressive taxation. This is because the in-period welfare losses associated with the distortion of labor-leisure choices will be greatest in periods of high wage income. The fact that borrowing is costly means that consumption will be higher in these periods than it would be in the case of zero transaction costs. Thus, the distortion of labor-leisure choices will tend to work in the opposite direction to the distortion of intertemporal choices.

Finally, the comparisons here have been undertaken on the basis that the present value of the tax liabilities of each individual should be the same for each of the tax systems used. An alternative basis for comparison is that annual tax revenues should be the same for each system. Given the assumption that the population is uniformly distributed over the age range $[0, T]$, annual tax revenues are largest for the income tax and smallest for the consumption tax. Also annual revenues are higher for progressive taxes, imposed at the rates derived from (## NO TEXT IN MARKER: "Taxrate" ##) than for the corresponding flat-rate taxes. (This follows from the fact that these taxes collect more tax late in life when the present value of revenue is lower). Thus, a comparison on the basis of annual tax revenues would reinforce the results derived here.

Nevertheless, I believe that the criterion adopted here is the correct one. This is

because a shift from a consumption tax to an income tax, at rates calculated to yield the same annual revenue, would involve a redistribution of income away from individuals living at the time of the change and towards future generations. Individuals alive and earning income at the time of the change would already have paid high taxes on their previous consumption and would be faced with higher than anticipated taxes over their remaining lifetime. Their losses would outweigh the benefits to individuals at or near retirement, for whom the real value of accumulated savings would rise. The apparent gain in annual revenue from an income tax reflects a once-off redistribution of this kind. The requirement that each individual should pay the same lifetime taxes (in present value terms) ensures that no intergenerational redistribution can take place.

VI Concluding Comments

The fact that capital markets consume resources is obvious. Yet it is rarely taken into account in formal economic analysis. Even when the assumption of perfect capital markets is dropped, it is often replaced with an assumption that borrowers are liquidity constrained, so that capital markets are still costless, and financial institutions still do not exist. These assumptions do not yield a satisfactory representation of the intertemporal allocation problem facing households.

When the costs of borrowing are incorporated into an intertemporal model, a more realistic representation of the problem is obtained. The distribution of income over the life-cycle, irrelevant in the standard model, is now a central concern. The fact that financial transactions are costly invalidates several of the central conclusions of the recent taxation literature arising out of the life-cycle hypothesis, and bolsters the traditional case for progressive taxation. Taxes, such as consumption taxes, that bear most heavily on people when they are young and relatively poor involve a higher burden than taxes which bear most heavily on people at peak income levels.

The results in the paper are driven by the fact that governments can redistribute income over the individual's lifetime by the selection of tax instruments. Unlike individual borrowing and saving, this process does not incur the transactions costs associated with the

financial system. However, any system of taxation involves deadweight losses. It is an empirical question whether the deadweight losses associated with a progressive tax system (relative to those of a flat-rate system) exceed the transactions costs associated with the financial system.

The implications of costly borrowing go well beyond this, however. For example, comparisons of the performance of private and publicly owned firms rarely include the costs associated with the imposition of discipline through the market for corporate control. Explicit consideration of the costs of financial sector transactions will imply a reconsideration of a wide range of policy issues.

Analysis of the costs and benefits of a shift from income to consumption taxes raises a wide range of issues that have not been addressed here. These include effects on tax evasion and avoidance, balance of payments effects and the macroeconomic implications of the transition. Thus the present paper does not constitute a demonstration that such a shift is undesirable. Rather, it shows that the standard efficiency case in favor of such a shift is untenable when financial sector transactions are costly.

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