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DISCUSSION PAPER NO. 309

The Impact of RRSPs on Capital Accumulation with Progressive Personal Taxes

by Robert Androkovich, Michael J. Daly, and Fadle Naqib

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RÉSUMÉ

Les auteurs rapporte dans le présent document les résultats de certaines simulations concernant l'effet des régimes enregistrés d'épargne-retraite (REER) sur l'épargne et l'accumulation de capital dans le cas de divers régimes d'impôt personnel progressif. Ces situations sont fondées sur un modèle de croissance en situation d'équilibre général comportant un secteur des ménages formé de générations chevauchantes d'invididus, un secteur de la production, et un secteur public qui requiert dans chaque période un montant fixe de recettes provenant d'impôts personnels, quelle que soit l'assiette de l'impôt.

D'après les simulations effectuées, un impôt progressif de consommation génère un important gain de bien-être en situation d'équilibre, de la même façon qu'un impôt proportionnel de consommation; c'est dire que les gains d'efficacité résultant de l'adoption d'un impôt de consommation ne proviennent pas, comme l'ont cru certaines personnes, de la substitution de la progressivité à la proportionnalité. Les auteurs constate également que la déductibilité d'impôt illimitée de l'épargne de pair avec un impôt progressif sur le revenu pourrait même être d'une efficacité plus dynamique qu'un impôt progressif de consommation.

ABSTRACT

This paper reports the results of some simulations concerning the impact of registered retirement savings plans (RRSPs) on saving and capital accumulation under alternative progressive personal tax systems. These simulations are based on a steady state general equilibrium growth model involving a household sector comprised of overlapping generations of individuals, a production sector, and a government sector which in each period requires a fixed amount of revenue from personal taxes irrespective of the tax base.

According to our simulations, a progressive consumption tax generates a large steady state welfare gain, just like a proportional consumption tax; that is, the efficiency gains associated with switching to a consumption tax are not due to substituting proportionality for progressivity, as some people have thought. We also find that unrestricted use of tax-deductible saving in conjunction with a progressive income tax could be more dynamically efficient than even a progressive consumption tax.

CONTENTS

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The authors are greatly indebted to Gary Lastman of the Department of Applied Mathematics at the University of Waterloo for preparing the computer simulation program, details of which are found in Appendix B. Helpful comments and suggestions from John Burbidge, Jim Davies and Denis Gauthier are also gratefully acknowledged. The findings of this paper are the sole responsibility of the authors and, as such, have not been endorsed by the members of the Economic Council of Canada.

I INTRODUCTION

Among the most interesting debates in the public finance literature during the past few years has been that over the effect of income taxes on saving behaviour, and the extent of the long-run welfare gains that could be obtained by switching from an income tax to a consumption tax. For example, Summers (1981), in his comparison of proportional income and consumption taxes, Auerbach, Kotlikoff and Skinner (1983), in their comparison of progressive as well as proportional income taxes with a proportional consumption tax, and Fullerton, Shoven and Whalley (1983), in their examination of a progressive consumption tax, all report substantial dynamic efficiency gains resulting from the replacement of income taxes with a consumption tax. Notwithstanding these gains, an overnight switch to a consumption tax remains unlikely for two reasons. First, it would lead to undesirable windfall losses for the generation just retired, and second, the strong incentives to conceal wealth held on the changeover date would make such a switch infeasible. Only a gradual transition from one tax system to the other would avoid significant windfall gains and losses.

As it turns out, that is precisely what has been happening in Canada and, to a lesser degree, in the U.S. with the increased use of tax-deductible or registered savings schemes.[1] Known as registered retirement savings plans (RRSPs) in Canada and individual retirement accounts (IRAs) and Keogh plans in the U.S., these schemes were introduced into the income tax systems of both countries in 1957 and 1974, respectively. The periodic relaxation of limits on contributions to such schemes is widely perceived as a practical method of gradually transforming a progressive income tax into a progressive lifetime expenditure tax.[2] Hence, one would expect the removal of limits on contributions to registered savings plans to yield efficiency gains similar in magnitude to those resulting from a switch to a progressive consumption tax.

Interestingly enough, the simulations which follow suggest that a progressive consumption tax generates a large steady-state welfare gain, just like a proportional consumption tax, and that the efficiency gains from switching to a consumption tax are not due to the substitution of proportionality for progressivity. Furthermore, permitting unlimited tax-deductible saving under a progressive income tax could have a more favourable impact on total personal saving and capital accumulation than even a switch to a progressive consumption tax. These findings are extremely robust within a plausible range of values for the parameters of the individual's utility function. Before discussing these simulation results in more detail, we describe the theoretical model underlying them in the next section.

The rest of this paper is organized as follows. Section II provides some background concerning RRSPs. Section III describes the theoretical model underlying our simulations. The results of these simulations are reported in Section IV. The final section discusses the implications of our results for tax policy and suggests some avenues for future research.

II THE ROLE OF RRSPs IN THE CURRENT TAX SYSTEM

First introduced in 1957, RRSPs have become an increasingly popular method of saving during the past decade or so. Whereas in 1970 fewer than a quarter of a million persons contributed $225 million to such plans, by 1982 over 2.1 million people contributed a record $4,317 million (see Table 1). Although originally designed to allow taxpayers lacking adequate employer-sponsored pension provision to make their own retirement income arrangements, RRSPs can be used for non-retirement purposes also.

The attractiveness of RRSPs can be attributed to the substantial tax concessions accorded to them by Canada's personal income tax system. The Income Tax Act provides that contributions to an RRSP are, within certain prescribed limits, deductible from current gross income in determining taxable income. Individuals who do not participate in an occupational pension plan can contribute as much as 20 per cent of their annual earned income, up to $5,500, to an RRSP. Those who do participate in an occupational pension plan, but contribute less than 20 per cent of their annual earned income, up to $3,500, may contribute the difference to an RRSP.

The individual contributor therefore gains in two ways. First and foremost, by contributing to an RRSP, tax liability can be deferred until retirement, at which time such savings are received

Table 1

Registered Retirement Savings Plans, 1957-1982

Year	Amount of Contributions ($ thousands)	Number of Contributions
1957	n.a.	n.a.
1958	19,004	n.a.
1959	n.a.	n.a.
1960	27,787	n.a.
1961	34,640	n.a.
1962	40,456	n.a.
1963	46,457	n.a.
1964	57,704	n.a.
1965*	81,997	n.a.
1966	100,618	n.a.
1967	118,864	n.a.
1968	142,618	171,894
1969	178,580	205,879
1970	225,214	248,719
1971	319,779	347,674
1972*	645,123	545,416
1973	922,595	757,925
1974	1,243,724	936,385
1975	1,524,281	1,078,152
1976*	2,115,539	1,291,349
1977	2,368,901	1,425,239
1978	2,675,385	1,571,174
1979	3,091,044	1,725,959
1980	3,611,701	1,851,713
1981	3,879,173	1,954,002
1982	4,317,349	2,100,333

Notes: n.a. not available.
* indicates years when limits on contributions were increased.

Source: Unpublished data provided by Revenue Canada, Taxation.

as income. In most cases, a person's marginal rate of income tax will be lower during retirement than it is at the time contributions are paid in, largely because a retired individual has few, if any, employment earnings.[3] Second, interest accruing on RRSP savings is generally not subject to tax until withdrawn.

Not surprisingly, the role of RRSPs in Canada's personal income tax system is a controversial issue. The tax concessions accorded to these schemes are widely regarded as a step in the direction of a personal consumption tax system. The Meade Committee, for example, considered the gradual lifting of limits on registered saving as a 'conservative' method of transition from a tax system based on income to one based on expenditure.[4] Needless to say, the latter has fervent supporters and equally, if not more, fervent opponents.

Critics of RRSPs argue that they seriously undermine the progressivity of the personal tax system because in any one year, it appears to be the highest income groups, facing the highest marginal tax rates, who obtain the greatest tax saving. This argument is somewhat superficial, however, because a taxpayer's lifetime is a more relevant period for equity considerations than any one year. When viewed within the context of a life-cycle model (see Daly, 1981), it becomes clear that an RRSP is a particularly convenient device enabling the individual to do his own lifetime income averaging for tax purposes, and can therefore be justified on horizontal equity grounds under a progressive income tax structure. Indeed, one could argue for the removal of the existing constraints on RRSP contributions because they impede full lifetime income averaging. Hence, the tax-deductibility of RRSP contributions *per se* should be regarded as a move towards a more equitable income tax system rather than a step in the direction of a consumption tax. Only the provision which renders interest accruing on RRSP balances tax-exempt prior to withdrawal constitutes a distinct step in the latter direction. Such a provision is undesirable under a progressive income tax system because taxpayers with the highest lifetime incomes (and thus the highest marginal tax rates) benefit most, but quite acceptable under a progressive consumption tax.

As far as the future use of RRSPs is concerned, remark that the 1985 Federal Budget contained two important provisions which, if implemented, will likely lead to a dramatic increase in the proportion of personal savings channeled into such plans. First, the annual limit on RRSP contributions by individuals belonging to money purchase plans is to be raised in stages from its current level of $5,500 to $15,500 in 1990. Then, starting in 1991 contribution limits are to be indexed to the average industrial wage. Second, RRSP contributors will be allowed to carry forward any unused contributions for a period of seven years.

Notwithstanding the increased use of RRSPs in recent years, there has been no analysis of their impact on personal saving. Have they encouraged saving or merely resulted in the substitution of tax-deductible saving for other forms of saving? The purpose of this paper is to model the preferential tax treatment accorded to RRSPs in a general equilibrium framework and to simulate the impact of such plans on overall saving and capital accumulation. Our simulation model is presented in the next section.

III SIMULATION MODEL

Our analysis of the impact of alternative tax regimes is conducted by comparing steady state equilibria obtaining in the economy. Three steps are involved. We begin by modelling the behaviour of a representative rational individual who works, consumes and saves in order to maximize the discounted value of his lifetime utility. Needless to say, the person's behaviour is influenced by the opportunities open to him in the labour, capital and goods markets as well as by the tax structure. We then aggregate over all individuals to derive the aggregate demand for capital (assets), k^d, which is a function of the interest rate (i) and the parameter (ϕ) which characterizes the tax regime; that is, $k^d(i, \phi)$.[5] The supply of capital (assets), $k^s(i)$, is derived from a Cobb-Douglas production function. In equilibrium,

$$k^d(i, \phi) = k^s(i).$$

Equilibrium values for i and ϕ are obtained by simulating the above equation holding total tax revenue (T) constant. This enables us to calculate the economy's steady state capital-labour and output-labour ratios, as well as saving and consumption propensities for purposes of comparison between alternative tax regimes.

In order to ensure that the revenue raised by each tax regime is the same, we use a tax function which takes the form

$$\tau = \phi z^{\psi},$$

where z is the tax base and ϕ and ψ are constants. If different tax regimes are required to collect a fixed amount of revenue ($\bar{T}$), this implies that either ϕ or ψ or both must change with adoption of a new tax base. In the subsequent simulations we keep ψ fixed and allow ϕ to vary to ensure that the tax revenue raised is equivalent to an average tax rate of approximately 24 per cent under an income tax system.[6] The parameter ψ was estimated from the 1984 Canadian income tax schedule to be 1.3111, so that the tax function used in our simulations to some extent reflects the degree of progressivity embodied in the existing tax structure.

The government's budget constraint $\bar{T} = T(i, \phi)$ together with the capital market equilibrium condition, $k^d(i, \phi) = k^s(i)$, capture the essential features of our general equilibrium model. The two equations are solved to yield equilibrium values for the two variables i and ϕ.[7]

Three tax systems are examined: (A) a progressive tax with unlimited use of RRSPs, (B) a progressive income tax, and (C) a progressive consumption tax. As A captures the features of both B and C, details of the latter are relegated to Appendix A.

Model A: A Progressive Income Tax with RRSPs

1 The Individual's Behaviour

Consider an individual who starts working at economic age 0 with an initial endowment of assets $a(0) \geq 0$, retires at age R, and dies at age D leaving bequests to his heirs $a(D) \geq 0$. His lifetime utility (u) depends on the future stream of consumption c(t) together with bequests,[8] discounted at rate ρ. More specifically,

$$u = \int_0^D \frac{c(t)^{1-\delta}}{1-\delta} e^{-\rho t} \, dt + \frac{a(D)^{1-\delta}}{1-\delta} e^{-\rho D}. \qquad (1)$$

We assume that the individual is free to borrow and lend at a market rate of interest, i, which is constant over time. The wage rate, w, is given exogenously.

The individual is permitted to deposit (or withdraw) any amount r(t) to (or from) his registered retirement savings plan, where contributions are tax-deductible (and withdrawals are taxable). At the age of retirement, R, we assume that total RRSP assets v(R) are used to purchase an annuity yielding an annual income of b(t) until his death.

The individual thus has two types of assets: registered assets v(t) and non-registered assets a(t). Changes in these assets over a person's lifetime are described by the following two equations:

$$\dot{a}(t) = \begin{cases} ia(t)+w(t)-r(t)-\tau(\cdot)-c(t), & 0<t<R \\ ia(t)+b[v(R)]-\tau(\cdot)-c(t), & R<t<D \end{cases} \qquad (2)$$

$$\dot{v}(t) = iv(t) + r(t), \qquad v(0) = 0, \qquad (3)$$

where the tax schedule is

$$\tau(\cdot) = \phi\, z^{\psi}, \qquad (4)$$

$$\text{and taxable income } z(t) = \begin{cases} i\,a(t) + w(t) - r(t), & 0<t<R \\ i\,a(t) + b(t), & R<t<D. \end{cases} \qquad (5)$$

A dot over a variable denotes the derivative of that variable with respect to age.

The individual's optimization problem (that is, the maximization of (1) subject to the constraints (2) and (3)) can be solved using Pontryagin's Maximum Principle. Accordingly, we form the Hamiltonian function:

$$H = \frac{c(t)^{1-\delta}}{1-\delta} e^{-\rho t} + \lambda(t)\{ia(t)+w(t)-r(t)-\tau(\cdot)$$

$$+ \chi(t)[b(v(R))-\tau(\cdot)]-c(t)\}_{[R,\ D]}$$

$$+ \mu(t)\{i\ v(t) + r(t)\}, \qquad (6)$$

where $\chi(t)$ is a characteristic function such that $\chi(t)=0$ when $0<t<R$, and $\chi(t)=1$ when $R<t<D$.

The first-order conditions are:

$$\frac{\partial H}{\partial c} = 0,\ e^{-\rho t} c(t)^{-\delta} - \lambda(t) = 0 \qquad (7)$$

$$\frac{\partial H}{\partial p} = 0,\ -\lambda(t)(1-\tau') + \mu(t) = 0 \qquad (8)$$

$$-\frac{\partial H}{\partial a} = \dot{\lambda}(t),\ -\lambda(t)i(1-\tau') = \dot{\lambda}(t) \qquad (9)$$

$$-\frac{\partial H}{\partial v} = \dot{\mu}(t),\ -i\mu(t) = \dot{\mu}(t), \qquad (10)$$

where τ' is the marginal tax rate, and $\tau' = \phi\ \psi z^{\psi-1}$.

The transversality conditions are:

$$\lambda(D) = e^{-\rho D} a(D)^{-\delta} \qquad (11)$$

and

$$\mu(R) = \int_R^D \frac{\partial b}{\partial v(R)}\big(1-\tau'(t)\big)\lambda(t)dt. \qquad (12)$$ [9]

The latter condition ensures that the value of an additional dollar of income contributed to an RRSP at age R is equal to the increase in the stream of utility from consumption that it generates via a taxable annuity during retirement (between R and D).

(i) <u>The optimal path of c(t)</u>

Differentiating (7) with respect to age we get

$$\delta \frac{\dot{c}}{c} = - \frac{\dot{\lambda}}{\lambda} - \rho, \qquad (13)$$

which after substituting for $\dot{\lambda}$ from (9) gives the optimal path of consumption

$$\frac{\dot{c}}{c} = \frac{i(1-\tau')-\rho}{\delta}, \qquad (14)$$

while (7) and (11) imply the boundary condition[10]

$$c(D) = a(D). \qquad (15)$$

(ii) The optimal path of r(t)

Differentiation of (8) with respect to age gives

$$\dot{\mu}/\mu = \dot{\lambda}/\lambda - \dot{\tau}'/(1-\tau'). \tag{16}$$

As $\dot{\mu}/\mu = -i$ and $\dot{\lambda}/\lambda = -i(1-\tau')$, equation (16) can be written as

$$i\tau'(1-\tau') - \dot{\tau}' = 0, \tag{17}$$

which implicitly describes the optimal path of r(t) because

$$\tau'(t) = \begin{cases} \phi\ \psi[i\ a(t) + w(t)-r(t)]^{\psi-1}, & 0 \leq t \leq R \\ \phi\ \psi[i\ a(t) + b]^{\psi-1}, & R \leq t \leq D. \end{cases} \tag{18}$$

The foregoing optimality condition reflects the two-fold benefit to a taxpayer from contributing to an RRSP as opposed to saving in the non-registered form. First, tax liability can be deferred from one period to another thereby yielding a tax saving of $-\dot{\tau}'$ per additional dollar of contributions over the period t to t+dt. The tax saving is positive if the marginal tax rate where the dollar is withdrawn from the RRSP is less than when it was paid in, that is, if $\dot{\tau}' \leq 0$. On the other hand, if the marginal tax rate upon withdrawal is greater than when contributions were made, so that $\dot{\tau}' > 0$, more taxes are paid. Second, interest accruing on RRSP assets is not subject to tax until withdrawn, an incremental tax saving of $i\tau'(1-\tau')$ on a dollar of RRSP savings compared to non-registered savings between the ages t and t+dt. Hence, according to optimality condition (17), a taxpayer should contribute to (or withdraw from) an RRSP until at each point in time over the life cycle, the incremental tax saving derived therefrom, that is, $i\tau'(1-\tau') - \dot{\tau}'$, is equal to zero.

Complete specification of the optimal path for r(t) requires a boundary condition. At age R equation (8) becomes

$$\mu(R) = \lambda(R)\left(1-\tau'(R)\right) \tag{19}$$

which together with equation (12) implies that

$$\lambda(R)\left(1-\tau'(R)\right) = \int_R^D \frac{\partial b}{\partial v(R)} \left(1-\tau'(t)\right)\lambda(t)dt. \tag{20}$$

Assuming the individual withdraws his RRSP deposits in equal amounts b during retirement,[11]

$$b = \frac{e^{-iR}v(R)}{\int_R^D e^{-it}dt}, \tag{21}$$

which upon differentiation yields

$$\frac{\partial b}{\partial v(R)} = \frac{e^{-iR}}{\int_R^D e^{-it}dt}. \tag{22}$$

Substituting (20) into (21) and using (7) we can derive the boundary condition for τ',

$$\tau(R) = 1 - \frac{e^{(\rho-i)R}c(R)^{\delta}}{\int_R^D e^{-it}dt} \int_R^D \left(1-\tau'(t)\right)c(t)^{-\delta}e^{-\rho t}dt \tag{23}$$

and therefore the boundary condition for $r(t)$.

(iii) <u>The optimal path of v(t)</u>

The equation of motion for $v(t)$ given by (3) is solved to yield

$$v(t) = \int_0^t r(\xi)e^{i(t-\xi)}d\xi, \tag{24}$$

so that at age R

$$v(R) = \int_0^R r(t)e^{i(R-t)}dt. \tag{25}$$

Substituting (25) into (21) we have

$$b = \frac{\int_0^R r(t)e^{-it}dt}{\int_R^D e^{-it}dt}. \qquad (26)$$

(iv) <u>The optimal path of a(t)</u>

The equation of motion for a(t) can be written as

$$\dot{a}(t) = \begin{cases} i\ a(t)+w(t)-r(t)-\phi[i\ a(t)+w(t)-r(t)]^{\psi}-c(t), & 0 \leq t \leq R \\ i\ a(t)+b-\phi[i\ a(t)+b]^{\psi}-c(t), & R \leq t \leq D \end{cases} \qquad (27)$$

$$a(0) \geq 0$$

where b is given by (26).

Remark that as b appears in (27), the solution to the model involves three differential equations (14), (17) and (27).

In our model of individual behaviour, therefore, RRSPs enable taxpayers to arrive at the lifetime profile of taxable income that minimizes the discounted value of taxes paid, while non-tax-deductible saving allows them to choose their optimal lifetime consumption path and bequests.

2 The Economy's Steady State

The age distribution of the economy's population depends on the rate of population growth (n). In a steady state the age density function takes the form

$$f(t) = \frac{ne^{-nt}}{1-e^{-nD}}. \tag{28}$$

Aggregate consumption in the economy is therefore

$$C = \int_0^D c(t)f(t)dt. \tag{29}$$

Steady state growth implies that

$$S = nK = wL + iK - C - T, \tag{30}$$

where S, K and L respectively denote aggregate saving, aggregate capital stock and aggregate labour supply. From (30) it follows that

$$\frac{K}{wL} = \frac{1-\frac{C}{wL}}{n-i} \tag{31}$$

Substitution of (28) into (29) and the latter into (31) implies that

$$\frac{K}{wL} = \left[1 - \frac{\int_0^D c(t)e^{-nt}dt}{\int_0^R e^{-nt}dt} \right] / (n-i) \tag{32}$$

which is our aggregate demand for capital per unit of labour income $k^d(i, \phi)$.

With an aggregate Cobb-Douglas production function

$$Q = XK^{(1-\alpha)}L^{\alpha}, \tag{33}$$

where Q denotes aggregate output, X a constant which measure efficiency, and α labour's share of output, $k^s(i)$ can be written as

$$k^s(i) = \frac{K}{wL} = \frac{(1-\alpha)}{\alpha i} = \frac{1}{3i} \tag{34}$$

if we assume that α=0.75. The economy's capital market equilibrium condition is therefore

$$k^d(i, \phi) = 1/3i. \tag{35}$$

The government's budget constraint is

$$\bar{T} = \int_0^R \phi[ia(t)+w(t)-r(t)]^{\psi}f(t)dt+\int_R^D \phi[ia(t)+b]^{\psi}f(t)dt \qquad (38)$$

where $\psi = 1.3111$.

Remark that at any time total bequests equal total inheritances, which implies that for each individual $a(0) = e^{-nD}a(D)$

The simultaneous solution of equations (35) and (36) where c(t) is given by equations (14) and (15), r(t) is described by equations (17), (18), and (23), and the path of a(t) is given by equations (26) and (27), therefore yields values for i and ϕ along with the optimal paths of c(t), r(t) and a(t).

IV SIMULATION RESULTS

Our simulation results are reported in Table 2 which shows the ranking of the alternative tax systems from a dynamic efficiency standpoint under different assumptions regarding the parameters of the utility function. We find that switching to a progressive consumption tax would generate a large steady-state efficiency gain.[12] Furthermore, not only does the introduction of RRSPs into a progressive income tax system encourage saving and capital formation, but unrestricted use of tax-deductible saving under an income tax system could be more dynamically efficient than even a progressive consumption tax.

The results show that with $\delta = 0.75$, the steady state capital-labour ratio under a progressive income tax without any restrictions on RRSPs (6.924) is about 8 per cent above that which would be achieved under a progressive consumption tax (6.406). This gap widens with higher values of δ. With $\delta = 1.0$ and $\delta = 1.5$, the respective capital-labour ratios are 16 per cent and 34 per cent greater under a progressive income tax allowing unlimited tax-deductible saving than under a progressive consumption tax. The capital-labour ratio under a progressive consumption tax is over 50 per cent higher than that under a progressive income tax. As the intertemporal elasticity of substitution (σ) between consumption in different periods has been estimated to lie well below unity,[13] and $\delta = 1/\sigma$, it follows that within a range of plausible

Table 2

Ranking of Steady States Under Alternative Progressive Tax Systems

Tax System	i	ϕ	w	K/L	Y/L	C/L	S/L	T/L
$\underline{\delta = 0.75}$								
Progressive Income Tax with RRSPs	0.054	0.208	1.122	6.924	1.496	1.088	0.109	0.304
Progressive Consumption Tax	0.057	0.289	1.100	6.406	1.466	1.070	0.092	0.304
Progressive Income Tax	0.080	0.215	0.982	4.095	1.310	0.942	0.061	0.304
$\underline{\delta = 1.0}$								
Progressive Income Tax with RRSPs	0.053	0.203	1.140	7.171	1.520	1.108	0.108	0.304
Progressive Consumption Tax	0.059	0.289	1.098	6.160	1.463	1.070	0.089	0.304
Progressive Income Tax	0.082	0.215	0.982	3.976	1.310	0.946	0.060	0.304
$\underline{\delta = 1.5}$								
Progressive Income Tax with RRSPs	0.051	0.196	1.178	7.700	1.571	1.152	0.116	0.304
Progressive Consumption Tax	0.063	0.289	1.093	5.769	1.475	1.071	0.082	0.304
Progressive Income Tax	0.087	0.214	0.982	3.761	1.309	0.949	0.056	0.304

Note: These calculations assume $\rho=0.05$, $n=0.015$, $\alpha=0.75$, $R=45$, $D=55$ and $\phi=1.311$.

values for δ, an income tax permitting unrestricted use of RRSPs is superior to a progressive consumption tax.

This result is due to the "postponement effect" associated with the deferral of taxes through the use of an RRSP. The latter is a convenient do-it-yourself income 'averaging' device enabling taxpayers to rearrange taxable income over their lifetimes so that they are taxed at more uniform rates.[14] Under a progressive income tax with unlimited use of RRSPs, larger contributions would be made to registered saving schemes than under a progressive consumption tax so that more of the tax burden would be shifted into the future. The postponement of tax burden reduces the present value of lifetime taxes for the representative individual in the steady state, and the attendant wealth effect increases present as well as future desired consumption. The increase in desired future consumption leads to a rise in total saving.

Needless to say, the existing personal tax system is far removed from the progressive income tax embodying unlimited RRSPs examined in our simulation model. In actual fact, limits are imposed on the annual amount of RRSP contributions, and balances held in RRSP accounts are constrained to be non-negative.[15] Moreover, tax-deductibility of interest payments on non-registered loans used to finance RRSP contributions was eliminated as a result of the 1981 Federal Budget.[16] Our analysis does not attempt to capture any of the foregoing restrictions. Instead, our intent is to show that a progressive tax system without any restrictions whatsoever on the individuals freedom to choose the degree to which saving is tax-deductible or not could be more advantageous from a dynamic efficiency standpoint than a consumption tax requiring that all saving be tax-deductible.[17]

V CONCLUSIONS AND POLICY IMPLICATIONS

Judging from the simulation results presented in the previous section, as far as dynamic efficiency is concerned, a progressive income tax allowing unlimited use of RRSPs appears to be superior to a progressive consumption tax and the latter considerably better than a progressive income tax without RRSPs. Hence, one would expect the relaxation of limits on RRSP contributions proposed in the 1985 federal budget to substantially increase the overall level of personal saving in the long run and not result in a mere substitution of RRSPs for other saving.

Ironically, however, greater use of RRSPs, which can be viewed as a further step in the direction of an expenditure-based tax system, is not without its drawbacks. In particular, the ensuing substitution of registered for non-registered saving could have an adverse effect on the manner in which savings are invested because, hitherto, the bulk of RRSP funds appear to have been placed in relatively low-risk, interest-yielding investments. This situation is at least partly due to the fact that RRSPs do not benefit from the preferential tax treatment normally accorded to capital gains and dividend income, features of the existing tax system not captured by our simple simulation model. Greater use of RRSPs could therefore have harmful consequences for the allocation of saving between risky and non-risky investments unless the bias against channelling RRSP funds into equity investments is somehow removed.[18]

As regards future research on the same subject, the effects of not allowing tax-deductibility of interest payments associated with non-registered borrowing and exempting interest on non-registered savings from tax will also be investigated.[19] Furthermore, we shall examine the transition paths from one tax system to another. Finally, in comparing tax systems, we shall keep constant not only the total tax revenue collected but also the degree of progressivity embodied in different tax structures, because it is quite possible that dynamic efficiency gains are obtained with some accompanying loss of progressivity.

NOTES

1 "Tax-deductible" and "registered" are used interchangeably.

2 It is doubtful whether anything other than a graduated consumption tax would be politically acceptable as an alternative to a graduated income tax.

3 The use of RRSPs need not be confined to retirement purposes. Withdrawal can be made during any period (e.g., unemployment, child-rearing, study leave) when earnings drop.

4 Compared to commodity taxes, the tax-deductible or registered saving route to a lifetime expenditure tax would not only mitigate the intergenerational transfers from the old to the young associated with shifting to a consumption tax but also facilitate the continued use of a progressive tax structure.

5 Wages do not appear as an argument in the function $k^d(i, \phi)$ because the individual's labour supply is considered fixed and so wages are exogenous as far as each individual is concerned. The wage rate faced by all individuals is, however, endogenously determined in our general equilibrium model. Empirical estimates of labour supply elasticities for prime age males suggest that our fixed labour supply assumption is not altogether unrealistic.

6 In 1982, total federal and provincial taxes payable were approximately 24 per cent of taxable income assessed.

7 Our model involves a closed economy in which higher saving leads to lower interest rates and thus greater investment. Canada's ability to maintain an interest rate different to that prevailing in the rest of the world is, of course, limited insofar as it is a small open economy and capital is mobile internationally. In such a situation, there would be little, if any, connection between domestic saving and domestic investment. Judging from the empirical evidence reported by Feldstein and Horioka (1980), Feldstein (1983) and Summers (1985), however, there appears to be a strong positive correlation between domestic savings and investment rates among O.E.C.D countries, a phenomenon which indicates that capital may not be perfectly mobile internationally. Hence, our closed economy assumption is not inappropriate.

8 We ignore any labour supply response to changes in the tax system because in Canada the work behaviour of neither prime-aged males nor married women appears to be much influenced by after-tax wage rates. See, for example, Ham and Hsiao (1984) and Nakamura and Nakamura (1983).

9 For a derivation of this transversality condition, see Daly and Naqib (1984).

10 This specification of the bequest motive is rather restrictive because it assumes that a weight of unity is placed on the bequest component. In other words, the utility from bequests is the same as one would derive from consuming the bequest oneself if one lived for an additional year. The problem of parameterizing the bequest sub-function has thus been solved arbitrarily. Unfortunately, there is little evidence regarding the size of average bequests, and in any case a detailed analysis of individuals' bequest behaviour is beyond the scope of this particular paper.

11 The current tax regulations require that before the end of the year in which the planholder turns seventy-one, the proceeds of an RRSP must be converted into an annuity or transferred to a registered retirement income fund (RRIF); otherwise the plan is deregistered and the entire balance subject to income tax in the same year. With regard to the annuity option, the individual has the choice between a life annuity and a fixed-term annuity which provides benefits until age ninety. If the planholder prefers to establish an RRIF, an increasing fraction of the fund must be withdrawn in each year so that it is depleted by the time the person reaches age ninety.

12 Note that the steady-state efficiency gains from switching to a consumption tax are achieved at the expense of the older generation, who, during the transition period would experience large increases in tax burdens and accompanying losses in consumption. For an analysis of the transition from one tax system to another, see Daly, Lastman and Naqib (forthcoming).

13 Grossman and Shiller (1980) estimated σ to lie between 0.07 and 0.35 whereas Hall (1981) found values below 0.1.

14 Note that averaging is not complete because taxable income and therefore marginal tax rates rise over the individual's lifetime. Full income averaging would occur if interest from non-registered assets were non-taxable and interest payments on non-registered loans were non-tax-deductible. See Daly and Naqib (1985).

15 The latter constraint turns out to be non-binding for our simulations.

16 Remark that in the U.S. tax-deductibility of interest payments on borrowing associated with IRAs is permitted on the grounds that IRA income is tax-deferred rather than tax-exempt.

17 Even under a consumption tax, it is generally conceded that certain assets, such as, owner-occupied housing and consumer durables would have to be designated as non-registered, and therefore subject to tax prepayment on administrative grounds. See Bradford (1980).

18 A proposal in the ill-fated 1979 budget by the previous Progressive Conservative government would have permitted common stock investments through RRSPs to enjoy roughly the same favourable tax treatment as investments made by individuals using non-registered saving. This proposal has never been pursued since, partly, it is suggested because of the serious administrative difficulties involved in keeping account of the components of the funds accumulated over long periods (Brown, 1981).

19 Remark that a progressive consumption tax unlike a flat-rate consumption tax distorts the optimal path of consumption and, therefore, saving decisions. This would not be the case with a progressive wage tax incorporating RRSPs (see Daly and Naqib, 1985).

APPENDIX A

Model B: A Progressive Income Tax

1 The individual's behaviour

The Hamiltonian is:

$$H = \frac{c(t)^{1-\delta}}{1-\delta} e^{-\rho t} + \lambda(t)\{ia(t)+w(t)-\tau(z)-c(t) \qquad \text{(B1)}$$

$$\text{where } z = \begin{cases} ia(t)+w(t), & 0<t<R \\ ia(t), & R<t<D. \end{cases}$$

The first-order conditions are:

$$\frac{\partial H}{\partial c} = 0,\ e^{-\rho t} c(t)^{-\delta} - \lambda(t) = 0 \qquad \text{(B2)}$$

$$-\frac{\partial H}{\partial a} = \dot{\lambda}(t),\ -\lambda(t)i(1-\tau') = \dot{\lambda}(t), \qquad \text{(B3)}$$

where $\tau' = \phi\psi z^{\psi-1}$.

The transversality condition is:

$$\lambda(D) = e^{-\rho D} a(D)^{-\delta}. \tag{B4}$$

From equations (B1) and (B3) we have:

$$\delta\frac{\dot{c}}{c} = \begin{cases} i-\rho - i\phi\psi[ia(t) + w(t)]^{\psi-1}, & 0\leq t\leq R, \\ i-\rho - i\phi\psi[ia(t)]^{\psi-1}, & R\leq t\leq D, \end{cases} \tag{B5}$$

which together with (B4) describes the optimal path of consumption.

From (B2), the optimal path of a(t) is

$$\dot{a}(t) = \begin{cases} ia(t) + w(t) - \phi[ia(t) + w(t)]^{\psi} - c(t), & 0\leq t\leq R, \\ ia(t) - \phi[ia(t)]^{\psi} - c(t), & R\leq t\leq D \end{cases} \tag{B6}$$

2 <u>The economy's steady state</u>

We have to solve the two equations

$$k^d(i,\phi) = k^s(i) \tag{B7}$$

and $T(i,\phi) = \bar{T}$, (B8)

which take the form

$$\left[1 - \frac{\int_0^D c(t)e^{-nt}dt}{\int_0^R e^{-nt}dt} \right] / (n-i) = \frac{1}{3i} \qquad \text{(B9)}$$

$$\int_0^R \phi\,[ia(t)+w(t)]^{\psi} f(t)dt + \int_R^D \phi[ia(t)]^{\psi} f(t)dt = \bar{T}, \qquad \text{(B10)}$$

where c(t) and a(t) are given by the differential equations (B5) and (B6), and f(t) is given by equation (28).

Model C: A Progressive Consumption Tax

1 The individual's behaviour

The Hamiltonian is:

$$H = \frac{c(t)^{1-\delta}}{1-\delta} e^{-\rho t} + \lambda(t)\{ia(t)+w(t)-\tau(z)-c(t)\} \qquad \text{(C1)}$$

where z(t) = c(t).

The first-order conditions are:

$$\frac{\partial H}{\partial c} = 0,\ e^{-\rho t} c(t)^{-\delta} - \lambda(t)(1+\tau') = 0, \qquad \text{(C2)}$$

$$-\frac{\partial H}{\partial a} = \dot{\lambda}(t),\ -\lambda(t) = \dot{\lambda}(t). \tag{C3}$$

The transversality condition is:

$$\lambda(D) = e^{-\rho D} a(D)^{-\delta}. \tag{C4}$$

Equations (C2) and (C3) imply that

$$c(t)[1+\tau'(t)]^{1/\delta} = c(0)[1+\tau'(0)]^{1/\delta} e^{\gamma t} \tag{C5}$$

where $\gamma = (i-\rho)/\delta$,

and $\tau'(t) = \phi\psi c(t)^{\psi-1}$.

Equation (C2) can be solved to yield:

$$a(D) = e^{iD}a(0) + e^{iD}\int_0^R w(t)e^{-it}dt - e^{iD}\int_0^D [c(t)+\tau(\bullet)]e^{-it}dt \tag{C6}$$

Assuming $a(0) = e^{-nD}a(D)$ and given that $\tau = \phi c(t)^{\psi}$, (C6) can be rewritten as

$$a(D)[1-e^{(i-n)t}] + \int_0^D c(t)[1+\phi c(t)^{\psi-1}]e^{-it}dt = \int_0^R e^{-rt}dt. \tag{C7}$$

Equation (C5) and (C7) determine the optimal path of consumption.

Equation (C5) and (C7) determine the optimal path of consumption.

2 The economy's steady state

As in the previous model, we have to determine the values for i and ϕ with satisfy equations (B7) and (B8), where (B7) can be rewritten as (B9), and the government's budget constraint corresponding to (B10) is

$$\int_0^D \phi c(t)^{\psi} f(t)dt = \bar{T} \qquad (C8)$$

where c(t) is given by equations (C5) and (C7), and f(t) is given by equation (28).

APPENDIX B

Notes on the Computational Method Used to Solve Models A, B, and C

For each of the models we are required to solve a system of nonlinear equations

$$F_j(x_1,\ldots,x_k) = 0 \qquad j = 1,\ldots,k$$

for the unknowns $x_1,\ldots,x_k$. In order to evaluate each function F_j, we integrate numerically a system of m first-order ordinary differential equations from t=0 to t=D. The unknowns, x_j, are parameters in the right-hand sides of the differential equations, or initial values of the dependent variables in the differential equations.

The problems involving Models A, B, and C were solved numerically in double precision FORTRAN, using WATFIV, on the IBM 4341 at the University of Waterloo. The basic part of the solution method was concerned with solving the equations $F_j=0$ by the IMSL subroutine ZDPOW, a variant of Powell's method for nonlinear equations. The differential equations were integrated numerically using the Runge-Kutta-Fehlberg method of the subroutine RKF45, as given in the book by G.E. Forsythe, M.A. Malcolm and C.B. Moler, Computer Methods for Mathematical Computations, Prentice-Hall, 1977.

The subroutine ZSPOW requires an initial guess for the unknowns, x_j. The subroutine tries to satisfy the equations $F_j=0$ to within the requested accuracy. When this is obtained, or if the subroutine cannot continue, the resultant "converged" solution is accepted and the computations terminate.

The differential equations contain terms of the form z^b, where b is not an integer. Consequently, z is required to be positive. Subroutine ZSPOW might obtain estimates of the unknowns, x_j, which would make z negative. In such cases the unknowns are not feasible estimates; this was indicated to ZSPOW by changing the computed values of F_j by a factor of 10^5. In this way, only feasible solutions were accepted by ZSPOW.

For all three models we checked the accuracy of the "converged" solutions by re-integrating the differential equations and re-computing the functions F_j. This was done on an IBM PC using the Turbo Pascal language and an 8087 non-stiff mode. In each case the re-computed time paths of the variables c(t) and w(t) were in close agreement with those values obtained on the IBM 4341. Also, the equations $F_j=0$ were satisfied to within the accuracy requested.

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