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TAXATION AND RISK TAKING: A GENERAL EQUILIBRIUM PERSPECTIVE

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ABSTRACT

Taxation and risk taking are examined in a general equilibrium model that incorporates uncertain government revenue in a nonrestrictive manner and allows the government to influence its revenue through portfolio investments as well as through tax policy. It is demonstrated that each of a wide range of taxes can be decomposed into some combination of a wage tax, an ex ante wealth tax, and a modification of the government's investment portfolio. For example, a tax on investment returns (from risky and riskless assets) is equivalent, with an adjustment in the government's portfolio, to a tax on the riskless component of investment returns or to an ex ante wealth tax -- both of which absorb no private risk and yield certain revenue. The concept of equivalence employed is strong: two regimes are equivalent if, for each state of nature, individuals' wealth and government revenue are the same under both regimes and total investment in each asset is the same. Implications for behavior (private and total risk taking) and welfare are immediate. Moreover, these results are independent of the government's objective function, the manner in which individual utility depends on government expenditures, and some of the restrictive assumptions found necessary in previous treatments of the problem.

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1. Introduction

The modern study of taxation and risk taking commenced with Domar and Musgrave (1944) and has been surveyed in Allingham (1972), Atkinson and Stiglitz (1980), and Sandmo (1985).¹ From the beginning, this work has focused primarily on how different forms of taxation affect private risk (the extent to which investors allocate their portfolios to risky assets, accounting for any reduction in risk due to taxation) and social or total risk (the portion of investment allocated to risky assets, consisting of private risk and that absorbed by the government through taxation).² While many forms of taxation have been examined in increasingly sophisticated models, many investigations use partial equilibrium analysis that ignores government revenue. Those considering government revenue invoke assumptions that limit the range of application.³ These omissions and restrictions are critical when government revenue is uncertain because its expenditure will affect risk-taking behavior and welfare.⁴

Regardless of the model employed, most studies undertake little if any welfare analysis. Attention is generally confined to whether private and social risk taking rise or fall under various assumptions concerning the risk aversion properties of investors' utility functions. Whether such a rise or fall is desirable -- as a matter of first- or second-best analysis -- is not

¹ Other notable contributions include Feldstein (1969), Mintz (1981), Mossin (1968), Stiglitz (1969, 1972), and Tobin (1958).

² For example, Atkinson and Stiglitz (1980) introduce their discussion by stating that the "principal issue is the effect of taxation on 'risk-taking.'" They explicitly indicate that they will not examine the difficult normative issues presented.

³ The most common assumption of those incorporating government revenue is that it is rebated lump sum to individuals. See, e.g., Atkinson and Stiglitz (1980), Gordon (1985), Stiglitz (1972). This assumption greatly limits the analysis, for taxes typically would be employed only if some other use of the revenue were contemplated. Nor can uses be wholly divorced from taxation. For example, if the intended use is a certain expenditure on a public good, while the tax source produces uncertain revenue, some further reconciliation must be made, as noted in Bulow and Summers (1984). Hines' (1991) recent investigation, developed concurrently with that here, addresses this issue. See note 33.

⁴ These limitations, although not much explored (see note 3), have often been noted. See, e.g., Atkinson and Stiglitz (1980), Sandmo (1985). See also Mintz (1982).

considered.⁵ Nor is there usually any account made of other government policies that might be pursued to offset any adverse effect of taxation on risk taking or to create any desirable effect without having to resort to a particular form of taxation. Finally, different authors often examine somewhat different forms of taxation and make different comparisons, rendering it difficult to achieve a unified understanding of the subject.

This investigation addresses these concerns. It begins in section 2 with the most familiar model in the literature, involving a representative individual who allocates his portfolio between a riskless asset and a risky asset so as to maximize expected utility. A general equilibrium model is created by incorporating two aspects of government action. First, government revenue is accounted for in a nonrestrictive manner, allowing for expenditures on public goods (that may enter utility functions in any manner) and supplementary tax and transfer policies (including a lump-sum rebate of tax proceeds). Second, the government is permitted to buy and sell the same assets available to investors. The government must be assumed to have some investment opportunities if one wishes to compare tax regimes that collect revenue in different periods -- for example, a wage tax and a consumption tax. Also, including this component gives the government an instrument, in addition to taxation, by which it can influence the riskiness of its revenue.

The analysis focuses on equivalences among various forms of taxation, in the spirit of Musgrave's (1959) concept of differential tax incidence.⁶ The concept of *equivalence*, presented in section 3, is strong: two regimes of taxation (deemed to include the government's portfolio choice) are said to be equivalent if *in every state of nature* the two regimes involve individuals

⁵ Some of the literature, notably Domar and Musgrave (1944), implicitly or explicitly suggests that more risk taking is desirable, without explaining the source of this presumption. (The more natural presumption would seem to be that the amount of risk taking in an otherwise undistorted economy is optimal.) The literature seems to be responding to a generally held view that taxation discourages risk taking, but, except for brief and conflicting references in Kaldor (1955), no academic support for such a view is cited. Moreover, the literature emphasizes the uncompensated effect on risk taking rather than substitution effects, the latter of which would be relevant in comparing tax regimes. See note 39.

⁶ Some of the relationships have been noted before, see, e.g., Allingham (1972), but in the context of partial equilibrium models.

having the same after-tax wealth and the government having the same revenue at its disposal. It is also required that total investment in each asset be the same under the two regimes. As a result, both behavior and welfare for equivalent tax regimes are the same. When two regimes differ, understanding the equivalences among some of their components may greatly simplify analysis.

Sections 4 and 5 examine a wide range of taxes that have been studied previously. It is demonstrated that all these taxes (including ex post taxes that generate uncertain revenue) have effects that can be decomposed entirely into those resulting from a wage tax or an ex ante wealth tax (both of which generate certain revenue) and those that can be wholly nullified by the government adjusting its investment portfolio. To illustrate, consider a proportional tax on excess returns. Combining this tax with the government selling shares of the risky asset and using the proceeds to purchase the riskless asset produces a sort of "musical shares." The tax is a compulsory exchange wherein investors must forfeit some of their risky asset (the portion being the tax rate) for which they receive an amount of the riskless asset of equal value. (Formally, the tax takes a share of the total return of the risky assets they hold and credits individuals with the return on the riskless asset that would be earned by an equally valued number of shares.) This induces individuals to sell the additional riskless shares they implicitly own and use the proceeds to purchase risky shares. To complete the story, the government portfolio policy is to purchase those riskless shares and sell the required risky shares. The final result is a wash -- i.e., when the music stops, no shares are added or removed from the economy and both individuals and the government will receive the same returns in all states of nature as before. In contrast, familiar partial equilibrium results entail individuals buying more risky shares, with the government left holding the risky shares it implicitly acquired (through the tax), and no account being taken of the resulting disequilibrium in asset markets.

One can build on this illustration in a number of ways. For example, a tax on investment returns (risky and riskless) is equivalent to an ex ante tax on wealth, with a corresponding adjustment in the government's portfolio -- the tax on risky returns is nullified and the tax on riskless returns is

equivalent to a wealth tax. Thus, the behavioral effects of a tax on investment returns consist entirely of wealth effects and any change in welfare will be simply that caused by shifting wealth to the government. In all the simple forms of taxation examined here, the surprising result is that -- aside from wealth and related effects -- taxation has no important effect on risk taking.

Because the analysis is limited to equivalences, it is incomplete. The effects of a simple ex ante tax on wealth, for example, obviously depend on how government revenue is spent and how such expenditures affect individual utility. Moreover, determining the optimal government tax and portfolio policy requires investigating the effects of the government bearing risk. Finally, the results here should be explored in models with added complexity. The analysis thus suggests the need for such further study while demonstrating that many issues involving taxation and risk can be clarified or resolved independently of such investigations. Section 6 comments on these issues and other aspects of the analysis, and section 7 provides a conclusion.

2. Model

The model here supplements the simple, standard model used in the literature [see, e.g., Atkinson & Stiglitz (1980), Sandmo (1985)] by incorporating government action -- the government's choice of an investment portfolio and the use of government revenue -- in a general manner. The representative individual's after-investment wealth in period 1, in the absence of taxes, is

$$(1) \quad W = y[(1-a)(1+r) + a(1+x)] = y[1 + (1-a)r + ax],$$

where y is a given level of wage income in period 0 (all of which is invested), r is the rate of return on a riskless asset, x is the uncertain rate of return on a risky asset ($x \geq -1$), and a is the portion invested in the risky asset. (There is no constraint that $0 \leq a \leq 1$.) All returns in period 1 are consumed. The individual chooses a to maximize expected utility, where utility is a concave function of period 1 wealth (consumption) and also a function of government revenue in period 1. There is no restriction on the

manner in which utility depends on government revenue, which can be imagined to be spent on public goods, rebated lump-sum, or whatever. Also, beyond concavity, no assumption is made concerning how utility depends on wealth.

The government's decisions relate to tax policy, expenditure policy, and investment portfolio policy. For purposes of establishing equivalences, expenditure policy need not be modeled explicitly; the government is simply assumed to maximize the same objective function regardless of which tax regime produces the revenue it has available in each state. Investment portfolio policy consists of the government using period 0 tax revenue to purchase (possibly negative) amounts of each asset in period 0. Government revenue in period 1 can be expressed as

$$(2) \quad R = \alpha_s(1+r) + \alpha_u(1+x) + T_1, \text{ with}$$

$$\alpha_s + \alpha_u = T_0,$$

where T_i is tax revenue collected in period i , and α_s and α_u are the amounts invested in the assets with safe and uncertain returns. As with expenditure policy, the results derived below require no special assumption concerning how the government chooses $\alpha=(\alpha_s, \alpha_u)$ for a given tax regime; they require only that the objective function determining the choice be independent of the tax regime generating the period 0 revenue to be invested and period 1 revenue to be spent and that α is relevant only as it affects revenue and behavior.

Among the familiar assumptions of the model are: no inheritance or other sources of wealth, no choice between initial consumption and savings, no choice between labor and leisure, only two assets (with one riskless), no borrowing or lending constraints (or differences in the interest rate for borrowing and lending), and only one period in which investment decisions are made. The taxes examined are proportional and nondiscriminatory, with full loss offsets. As will become apparent, many of these assumptions -- including some that have been important in previous studies -- are unnecessary to reach the conclusions derived here.

Aside from allowing government revenue to enter individual utility in a general manner, the only addition to the usual assumptions concerns government portfolio policy. It is assumed that the government has access to the same investment opportunities as do individuals: i.e., it borrows and lends at the same rate and may purchase or sell short the risky asset.⁷ The results below depend upon the government's ability to affect the riskiness of its revenue in period 1 (and, as a by-product, the total level of investment in each asset in period 0) through its portfolio choice as well as its selection of a tax regime. This addition to conventional models is unavoidable if one wishes to account for government revenue: any comparison of tax regimes, some of which collect revenue ex ante and some of which collect revenue ex post, must specify what is done with the tax proceeds from period 0 before they are spent by the government in period 1.

3. Equivalent Taxes -- A Definition

DEFINITION: Two tax regimes are equivalent if, for any set of tax rates and a government portfolio choice under one regime, there exists a set of tax rates and a government portfolio choice under the other regime such that, when individuals behave optimally given each regime, all of the following conditions hold:

1. *In every state of nature, individuals have the same after-tax wealth in period 1 under both regimes.*
2. *In every state of nature, the government has the same revenue in period 1 under both regimes.*
3. *Total investment in each asset in period 0 is the same under both regimes.*

⁷ This assumption is not as strong as it may appear, because all the results will involve total investment in each asset being unaffected. Thus, each investment opportunity need not be unlimited, but only accessible to the government. If the model allowed heterogeneity among individuals with regard to access to investments, the results would still hold so long as the government had access to each investment. See note 28.

These conditions for equivalence are strong, but in ways that are important for understanding the effects and desirability of tax policy.⁸

1. Individuals: For many purposes, it might be sufficient to determine whether individuals have the same expected utility. If they do, the rest of the analysis would be irrelevant for determining social welfare. Even more loosely, one could simply ask whether social welfare is the same. Often, however, both of these determinations will be difficult to make. But if individuals have the same wealth in all states and the second condition also holds, results concerning behavior and welfare will be trivial. (In particular, if this condition and the next holds, the existence of equivalence will be sufficient for the regimes to produce equal welfare regardless of how social welfare depends on individuals' consumption and government expenditures.)
2. Government Revenue: Much of the prior literature (i.e., partial equilibrium analysis of the subject) ignores government revenue. Two familiar errors in understanding may occur when government revenue is uncertain. First, even if individual behavior or utility from period 1 wealth is unchanged, social welfare may differ because government revenue affects social welfare.⁹ Second, the uses of government revenue will affect behavior. Thus, if government revenue in some states varies among tax regimes (even if expected revenue is the same), one must account for the effects of that variation to determine whether the posited individual behavior constitutes an equilibrium. By contrast, when equivalence is present, one may ignore how government revenue is spent. For, if government revenue is the same in all states and individual wealth is the same as well (condition 1), the government

⁸ Weaker conditions might be useful in other contexts. Because all the results below can be demonstrated with this strong condition and substantially weaker conditions would yield no additional insights along the lines investigated here, alternative definitions are not considered.

⁹ One attempt to address the welfare consequences is Auerbach's (1981) construction of a "risk-adjusted effective tax rate," which involves weighting tax revenue in different states not by their probabilities but rather by implicit prices for goods in different states.

would spend its revenue in the same manner under both tax regimes, regardless of the government's objective function and the opportunity set for government expenditures. Otherwise, one would have to model explicitly how government revenue enters individual utility functions to determine both behavioral effects and welfare.¹⁰

3. Investment: If investment in assets changes, it may be inappropriate to employ the assumption that rates of return are unaffected, and the analysis would be further complicated. When the first two conditions hold, this final condition must also be satisfied in this model: if individual wealth plus government revenue is unchanged in all states, it must be that aggregate investment return in all states is unchanged, which can only happen if total (individual plus government) investment in each asset is unchanged.

Although these conditions are strong, it is important to note the implications of their not being met. If any condition fails (and, if one fails, the others typically will as well), a model must explicitly consider how government expenditures in different states are determined, how government expenditures enter individual utility functions, and how, in turn, the demand for assets will be affected in order to determine behavior, let alone social welfare. Since most of the literature neither demonstrates equivalence in this strong sense when making comparisons nor models important components identified here, valid general equilibrium results are not produced.¹¹ Moreover, in light of some of the conclusions below, there is reason to doubt that most partial equilibrium results are robust, even as to simple behavioral effects.

¹⁰ Stiglitz (1969) and others have suggested comparing various taxes to lump-sum state-contingent taxes, because it is not possible to compare different sorts of taxes under a standard that requires the same revenue to be produced in each state. As demonstrated here, however, this impossibility vanishes when government portfolio policy is incorporated.

¹¹ Hines (1991), see note 33, is the most substantial attempt to address these concerns.

4. Some Familiar Results Extended

4.1. Wealth Taxes

DEFINITION: An ex ante wealth tax (a tax on investment) at rate t_w entails:

$$T_0 = t_w Y,$$

$$T_1 = 0, \text{ and}$$

$$W_t = (1-t_w)Y[1 + (1-a)r + ax] = (1-t_w)W,$$

where W_t denotes after-tax wealth in period 1.¹²

DEFINITION: An ex post wealth tax (a tax on gross returns, or production) at rate t_w entails:

$$T_0 = 0,$$

$$T_1 = t_w Y[1 + (1-a)r + ax] = t_w W, \text{ and}$$

$$W_t = (1-t_w)W.$$

PROPOSITION 1: An ex ante wealth tax is equivalent to an ex post wealth tax at the same rate.

Proof: Let a^* be the portion the individual invests in the risky asset when the government employs an ex ante wealth tax at rate t_w^* and invests α_0^* in the risky asset in period 0. Consider an ex post wealth tax at rate t_w^* , where the government invests $\alpha_0^* - t_w^* a^* y$ in the risky asset. (I.e., the government reduces its period 0 investment in the risky asset by the amount individual investment would have been reduced by the ex ante wealth tax when individuals' portfolio proportions are unchanged.) The next step is to demonstrate that this leaves individuals' decision problems and government revenues in each state unchanged. First, individuals' period 1 after-tax opportunities are the same in both regimes, as is apparent from the definitions. In particular,

¹² Throughout, the expression for W_t may be seen as following from the definition of the tax rather than as being part of it.

individuals obtain the same after-tax wealth with the ex post tax by choosing a^* , as they did with the ex ante tax. When individuals make this choice, government revenue is the same as with the ex ante tax. For the ex ante wealth tax,

$$(3) \quad R = (t_w^* y - \alpha_u^*)(1+r) + \alpha_u^*(1+x).$$

For the ex post wealth tax,

$$(4) \quad R = -(\alpha_u^* - t_w^* a^* y)(1+r) + (\alpha_u^* - t_w^* a^* y)(1+x) + t_w^* y[(1-a^*)(1+r) + a^*(1+x)] \\ - (t_w^* y - \alpha_u^*)(1+r) + \alpha_u^*(1+x).$$

Thus, for any outcome under the ex ante wealth tax, the government can choose a portfolio under an ex post wealth tax at the same rate that yields the same outcome.¹³ (The converse holds, mutatis mutandis.) Finally, note that when such equivalent choices are compared, government investment in each asset increases (decreases) by precisely the amount that individual investment decreases (increases), so total investment in each asset is the same as well. Q.E.D.

Remark: Because of the equivalence established in proposition 1, it will often be convenient in what follows to refer simply to a wealth tax, without indicating whether it is ex ante or ex post. In interpreting the results, however, note that in a multi-period model, or one that involved consumption in period 0, there is some ambiguity as to what constitutes a wealth tax. (E.g., does an ex ante wealth tax include period 0 consumption or only the wealth that remains after consumption, and thus is invested?) The usage here is consistent with that in the literature, which sometimes refers to the ex ante wealth tax as a tax on investment and the ex post wealth tax as a tax on gross proceeds or production.¹⁴

¹³ The government's problem is to choose α , R , and tax rates to maximize its objective function subject to the revenue constraint (2) and the assumption that individuals choose a to maximize $EU(W,R)$. The argument in text demonstrates that, with appropriate transformation for α , these government maximization problems (necessarily implying the individuals' maximization problems as well) are the same in terms of the available outcomes despite the difference in tax regimes.

4.2. Wage and Consumption Taxes

In this model, where there is no consumption in period 0, wage and consumption taxes are equivalent, respectively, to ex ante and ex post wealth taxes.

PROPOSITION 2: A wage tax is equivalent to a consumption tax at the same rate.

Remarks: If one allowed for consumption in period 0, this equivalence would continue to hold, even though the equivalence between these taxes and wealth taxes would not. Any wages consumed in period 0 would yield the same period 0 tax payment under each regime and individuals would have the same opportunity sets for the portion of period 0 wages they choose to save.

The equivalence between a wage tax and a consumption tax is familiar, although it is not typical for analysts to note precisely what government portfolio choice and expenditure policy is necessary for the result to hold. Nor is it usually stated that these taxes are equivalent in the presence of uncertainty. In fact, uncertainty and its effect on government revenue are sometimes advanced as qualifications to equivalence. See, e.g., Bradford (1986), Graetz (1980). In the model presented here, such qualifications are incorrect. For any formulation of either tax, there exists a precise equivalent for the corresponding tax that differs as between ex ante and ex post implementation.¹⁵ This equivalence holds even when returns are uncertain and when one accounts for aggregate investment in each type of asset and differences in the flow of government revenue. Thus, the familiar suggestion that a wage tax differs importantly from a consumption tax, because the former is ex ante and the latter ex post, is misleading.

¹⁴ In this representative individual model, an ex ante wealth tax is also equivalent to a lump-sum tax. In a model with heterogeneous individuals, the two would differ, but to the extent one finds results primarily involving wealth effects, the difference would not affect one's understanding of the basic intuitions.

¹⁵ For the certainty case, government portfolio behavior consists simply of lending and borrowing -- i.e., purchases (sales) of the riskless asset.

Note that, if one does not assume that the government would engage in offsetting portfolio activity, this equivalence would fail. Individual behavior would be affected by different patterns of government revenue. This would change the amount invested in each asset, which in turn would affect returns on investment and thereby feed back upon individual behavior. Understanding these effects may be enhanced by noting that they are the same as those that would arise from keeping the tax regime unchanged and instead making a corresponding change in the government's portfolio.

5. Taxes on Investment Returns

Much of the analysis of taxation and risk taking has been motivated by a desire to understand the effects of taxes on investment returns, particularly the effects of an income tax.¹⁶ The variations explored in this section bear directly on this central objective.

5.1. Tax on Excess Returns

DEFINITION: A tax on excess returns at rate t_{er} entails:

$$T_0 = 0,$$

$$T_1 = t_{er}y_a(x-r), \text{ and}$$

$$W_t = W - t_{er}y_a(x-r).$$

(Recall that full loss offsets are assumed.) It is this tax, or its presence as an aspect of other taxes (e.g., a tax on all investment returns or an income tax), that has received the most attention.

PROPOSITION 3: A tax on excess returns is equivalent to not having any tax.

Proof: Let a^* be the portion the individual invests in the risky asset when the government employs a tax on excess returns at rate t_{er}^* and invests a_0^*

¹⁶ Often an income tax is defined in a manner that corresponds to the "tax on investment returns" defined below. See, e.g., Atkinson and Stiglitz (1980). The "income tax" as defined here is a combination of a tax on investment returns with a tax on initial wages, thus corresponding to the more familiar Haig-Simons definition employed elsewhere in discussions of taxation.

in the risky asset in period 0. A regime with no tax can be made identical to this tax regime (and conversely, *mutatis mutandis*) by the government purchasing $a_0^* + t_{r,0}^* a^* y$ of the risky asset in period 0 and selling an equivalent amount of the safe asset. This produces the same revenue in all states. (Abstracting from the revenue produced by the government's period 0 portfolio in the regime with a tax on excess returns, the tax on excess returns itself yields $x-r$ per unit of tax, while the purchase of the risky asset in the regime with no tax yields x per unit and the sale of the safe asset yields $-r$ per unit.) Individuals' opportunity sets are also the same. In particular, they can produce the same wealth in all states as under the regime with a tax on excess returns by reducing the portion of their portfolios invested in the risky asset to $(1-t_{r,0}^*)a^*$. (This reduces risky returns by $t_{r,0}^* a^* yx$ and increases the safe return by $t_{r,0}^* a^* yr$, which just equals the effect on period 1 wealth of the tax on excess returns.) Because the same revenue pattern results from the government's portfolio adjustment, individuals would be induced to make such a choice. The individuals' and government's choices together imply that the same total amount will be invested in each asset under both regimes. Q.E.D.

Remark: For some time it has been understood that a proportional tax on excess returns left individuals unaffected because they could gross up their level of investment in risky assets so as to leave private risk and return unchanged. Yet, in partial equilibrium treatments, total (social) risk increases, although the behavioral and welfare implications of this effect have not been explored in a general manner.¹⁷ In sharp contrast, the equivalence stated here indicates that, quite generally, a tax on excess returns will have no effect on private risk-taking, total (social) risk

¹⁷ Atkinson and Stiglitz (1980) briefly offer one case -- they call it a polar case -- in which, assuming the tax (one on excess returns and riskless returns, see below) is rebated to individuals, there is no effect on total risk-taking. In fact, there is no effect on anything, although this is not stated explicitly. See also the discussion of Gordon (1985) in note 42. But no one has suggested that the purpose of taxation is to rebate the proceeds to the individuals who paid the tax, so the implication of their special case is unclear. Moreover, they indicate that with any other assumption about the use of government revenue, different results would hold -- each with particular effects on private risk-taking and with varying effects on social welfare, not always explicitly derived. See also Hines (1991), discussed in note 33, and Mintz (1982).

taking, the pattern of government revenue and expenditures, and, most importantly, individual and social welfare.

Most analyses do not consider a tax solely on excess returns when addressing taxation and risk taking. Thus, exploration of other forms of taxation is in order.

5.2. Tax on Riskless Returns

A tax on riskless returns refers to a tax on all investment as if it earned the riskless return. (This tax may be contrasted to a tax only on the return to investment in the riskless asset.)

DEFINITION: A tax on riskless returns at rate t_{rr} entails:

$$T_0 = 0,$$

$$T_1 = t_{rr}yR, \text{ and}$$

$$W_t = W - t_{rr}yR.$$

PROPOSITION 4: A tax on riskless returns is equivalent to a wealth tax.

Proof: Consider an ex ante wealth tax at the rate $t_w^* = t_{rr}r/(1+r)$. If adopted in place of the tax on excess returns, this would yield period 0 revenue of $t_{rr}yR/(1+r)$. The government can invest the proceeds entirely in the safe asset -- i.e., the government's investment in the safe asset equals what would have been the government's investment in the safe asset with the tax on riskless returns plus the proceeds of the ex ante wealth tax -- yielding in period 1 the amount $t_{rr}yR$. This precisely equals the revenue produced by the tax on riskless returns at the rate t_{rr} . Individuals' opportunities are also unaffected. In particular, under the ex ante wealth tax they would reduce their investment in the safe asset (compared to the level under the tax on riskless returns) by precisely the amount the tax on riskless returns would have collected, discounted to period 0 present value, thereby yielding the same period 1 after-tax wealth as under the tax on riskless returns (with its correspondingly different period 0 portfolio allocation). Finally, this set of government and individual behavior leaves

total investment in each asset the same under each regime. (The converse -- that any wealth tax outcome can be replicated with a tax on riskless returns -- follows mutatis mutandis.) Q.E.D.

Remark: It is not surprising that a tax on riskless returns is equivalent to an ex ante wealth tax (or an investment tax). Although the tax on riskless returns is in form ex post, it depends only on ex ante information: the amount of wealth available to invest and the riskless rate of return. The tax on riskless returns is also equivalent to an ex post wealth tax, which does depend on individuals' investment returns (although, as noted in the discussion of proposition 1, the portfolio adjustments of individuals and the government serve to eliminate any difference in this respect).

5.3. Taxes on Investment Returns

A tax on investment returns is simply a tax on excess returns plus a tax on riskless returns, where both taxes are at the same rate. Alternatively, this may be viewed as a tax on the gross return with a deduction for basis (the amount invested).

DEFINITION: A tax on investment returns at rate t_{ir} entails:

$$T_0 = 0,$$

$$T_1 = t_{ir}yR + t_{ir}ya(x-r) = t_{ir}(W-y), \text{ and}$$

$$W_t = W - (t_{ir}yR + t_{ir}ya(x-r)) = W - t_{ir}(W-y) = W(1-t_{ir}) + t_{ir}y.$$

PROPOSITION 5: A tax on investment returns is equivalent to a wealth tax.

Proof: A tax on investment returns is equivalent to a tax on riskless returns combined with a tax on excess returns. The former is equivalent to a wealth tax (proposition 4) and the latter to no tax (proposition 3). Q.E.D. (Alternatively, from the expressions for T_1 and W_t , it is apparent that government revenue and individual wealth in different states depend only on initial wealth, final wealth, and the tax rate, which implies that a tax on investment returns is equivalent to a wealth tax.)

Another form of taxing investment returns, introduced in Auerbach (1991), involves a retrospective tax: the tax on an investment in period 1 is determined by assuming that the value resulted from earnings at the riskless rate on an investment made in the initial time period.

DEFINITION: A retrospective tax on investment returns at rate t_{rir} entails:

$$T_0 = 0,$$

$$T_1 = t_{rir} \frac{r}{1+r} W, \text{ and}$$

$$W_t = (1 - t_{rir} \frac{r}{1+r}) W.$$

PROPOSITION 6: A retrospective tax on investment returns is equivalent to a wealth tax.

Proof: Comparing the definition of the retrospective tax on investment returns to that of an ex post wealth tax, it is clear that they are identical, where one defines $t_w = t_{rir}r/(1+r)$. Q.E.D.¹⁸

COROLLARY: A retrospective tax on investment returns is equivalent to a (direct) tax on investment returns.

Remark: Auerbach (1991) introduced the retrospective tax on investment returns as an alternative to a direct tax on investment returns because the retrospective tax avoids deferral and lock-in problems in a multi-period model. His analysis focuses on what he terms holding-period neutrality and considers the investor's behavior in a partial equilibrium setting. He does not explicitly account for differences between the tax regimes in terms of their effects on the timing and riskiness of government revenue or the risks individuals bear directly. A retrospective tax extracts less revenue than an ordinary accrual tax on investment income in states where returns are high and more revenue when returns are low. One might have thought that this difference in the division between government revenue and individual wealth in

¹⁸ Auerbach (1991) notes this equivalence when discussing the ex ante fairness of his system.

different states would have affected the results in a general equilibrium setting. As the corollary to proposition 6 states, no differences arise in the model here,¹⁹ although this result may not be immediately apparent if one examines only the difference in the definitions of the two tax regimes.

5.4. Income Tax

An income tax, in a model such as the present one, consists of a wage tax plus a tax on investment returns.

DEFINITION: An income tax at rate t_1 entails:

$$T_0 = t_1 y,$$

$$T_1 = t_1(1-t_1)(W-y), \text{ and}$$

$$W_t = (1-t_1)y[1 + (1-a)r(1-t_1) + ax(1-t_1)] = (1-t_1)[(1-t_1)W + t_1y].$$

*PROPOSITION 7: An income tax is equivalent to a wage tax plus a wealth tax.*²⁰

Proof: An income tax is a wage tax plus a tax on investment returns, and the latter is equivalent a wealth tax (proposition 5). Q.E.D.

Remarks: Note that the government portfolio adjustment required to establish the stated neutrality involves many components: the tax on investment returns at the riskless rate equals a wealth tax after some adjustments and that on excess returns equals no tax after other adjustments. To compare an income tax and a consumption tax rather than a wage tax would require another set of portfolio adjustments.

¹⁹ It would be useful to see whether these particular results generalize to a multi-period model, since Auerbach's motivation concerns a practical problem that only exists in such a setting.

²⁰ In this model, as noted previously, a wage tax is equivalent to a wealth tax because there is no consumption in period 0, so one could assert the further proposition that an income tax equals a wealth tax. But this equivalence, unlike those presented in the text, is entirely an artifact of the model. (I.e., if there is period 0 consumption and an ex ante wealth tax includes only savings in its base, a wage tax would differ from a wealth tax, but proposition 7 would still hold.)

In comparing an income tax with consumption or wage taxes, it is commonly stated that the difference is that the former involves taxing wealth while the latter do not. These discussions, however, usually do not make explicit whether the equivalence is formal and complete or merely suggestive, whether the equivalence holds in the case of uncertainty, or what assumptions are made regarding government revenue and portfolio policy.²¹ In fact, one or more of the dimensions of equivalence examined here is often disclaimed. For example, it is emphasized that an income tax is an ex post tax.²² Yet, as the proposition demonstrates, *an income tax is equivalent to the combination of two ex ante taxes -- a tax on wages and an ex ante tax on wealth.* The latter, in turn, is equivalent to a tax on all investment as if it earned the riskless rate of return (proposition 4). That an income tax is equivalent to a wage tax plus a tax on riskless returns is familiar. The addition here is that the equivalence is exact when investment returns are uncertain and one accounts for government revenue and adjustment of the government's and individuals' portfolios.²³

6. Discussion

6.1. Government Portfolio Policy and Government Revenue

Explicit consideration of government portfolio policy and government revenue is central to the results derived here. It has been remarked that the

²¹ Warren (1980a) argues that, even in the presence of uncertainty, a consumption tax is equivalent to an income tax that allows a deduction for the riskless rate of return when account is made for investors' portfolio adjustments. His analysis parallels the standard partial equilibrium treatment, initially presented in this context in Brown (1957), which implies greater social risk taking with an income tax, the difference being absorbed by the government.

²² See, e.g., Warren (1980b). Graetz (1980) makes the related point that horizontal and vertical equity notions are inherently ex post, as circumstances can only be evaluated once results are known. Yet, if individuals have identical opportunities, and if truly identical ex ante would make identical choices, it is unclear why one would object based upon ex post results that, if unfavorable, were fully compensated for ex ante.

²³ In any event, one could compare a consumption tax to an income tax (both ex post) or a wage tax to a wage tax plus an ex ante tax on investment (equivalent to a tax on riskless returns). While the relationship between a consumption tax and a wage tax is frequently noted, the ex ante analog of the income tax is not discussed, and the ex post nature of the income tax is often seen as one of its most basic features.

effect of a proportional tax on investment returns is somewhat like making the government a silent partner in the enterprise subject to the tax.²⁴ Surprisingly, this suggestive analogy has not been pursued directly by considering the possibility of the government becoming a partner through share purchases.²⁵

In the model considered here, government portfolio activity is a perfect substitute for many changes in tax regimes. Because of this relationship, it is possible to change tax regimes without changing private and social risk-bearing by adjusting the government's portfolio.²⁶ Instead, one may wish to determine the effects of changing to a tax regime with apparently different risk properties under the assumption that the government's investment portfolio would not be adjusted. In this case, results could be derived by the alternative approach of assuming that the tax regime remained the same and considering the effects of a corresponding shift in the government's portfolio. For example, changing from an ex ante to an ex post form of taxation, holding the government's portfolio fixed, is the same as the government borrowing to invest in risky assets, holding the tax regime fixed.

There are some differences between the government bearing risk through taxation and it bearing risk through direct ownership of risky assets. If the government actually owned a substantial share of many enterprises, it would have to consider how to exercise its influence.²⁷ Moreover, while it is straightforward in principle for the government to purchase shares of publicly

²⁴ See, e.g., Atkinson and Stiglitz (1980). Bulow and Summers (1984) suggest in passing that an excess returns tax (what they refer to as a tax on the risk premium) is "the equivalent of [the government's] acquiring stock market futures contracts." Stiglitz (1972) briefly notes that "one way of viewing a profit tax is as an investment tax with the proceeds of the tax used to purchase shares in the given firm."

²⁵ In another context, Bohn (1990) states: "To my knowledge, a proposal suggesting government participation in the stock market has not been made before."

²⁶ The equivalence results simply note that by combining a tax change with the negative of the portfolio component that is a perfect substitute, the effects of both are nullified.

²⁷ By owning nonvoting shares through taxation -- in the past, shares approaching or exceeding 50% -- rather than directly, the government is subject to the other shareholders diverting proceeds to themselves at the expense of the silent partner -- i.e., through tax avoidance and evasion.

traded companies, investment in closely held enterprises might be more difficult.²⁸ This limitation, however, may not be important with regard to the government's ability to influence the systematic risk of its revenue flows.

Aside from (negative) investment in government debt, direct government portfolio activity is not generally undertaken, at least for the purpose of affecting the systematic risk of government revenue.²⁹ Alternatives may be pursued instead, such as changing tax rates and government expenditures depending on the health of the economy. Only by including these dimensions in the analysis can one determine the effect of tax policy on risk taking and, more importantly, on welfare for cases in which portfolio adjustments will not be made to offset the effects of taxation on risk-bearing. Moreover, the government's current portfolio (consisting mostly of debt and real estate) would only by coincidence be optimal both for the tax regime now in place and for other quite different regimes existing in the recent past.³⁰

²⁸ Further exploration of why investment in closely held enterprises is not publicly available is required before determining the consequences for the present analysis. (Although the government could force the sale of a share of the enterprise, significant valuation problems would arise.) If, for example, entrepreneurs voluntarily bear nonsystematic risk to improve their incentives, the provision of government compulsory partial insurance through taxation would be welfare reducing. See Kaplow (1991). But if shares could not be marketed due to adverse selection, the welfare consequences of taxation may differ. See, e.g., Dahlby (1981). Investments not accessible to the government also raise the possibility that there may be economic profits. (Mintz (1981) explores the effect of taxing profits in a partial equilibrium model.)

²⁹ The government does hold risky assets (other than debt) -- for example, much of the real estate it uses. It also absorbs risk in other ways -- for example, through cost-plus contracts.

³⁰ Bohn (1990) suggests one respect in which the government's current portfolio may be suboptimal. As an extension to Barro's (1979) argument that the government should smooth tax rates over time to minimize deadweight loss, Bohn argues that the government similarly should smooth tax rates across states of nature. Because tax revenue is correlated with economic fluctuations, he suggests that the government (among other investments) take a short position in the stock market rather than raising tax rates when revenue is low and lowering rates when revenue is high. But tax revenue has this procyclical character because the government chooses to tax sources exhibiting systematic risk. Taking a short position in equities is tantamount to decreasing the tax rate on risky assets. Bohn does not examine the form of taxation. Also, he assumes that ex post tax rates have the familiar distorting effects, not considering the potential relevance of the literature on taxation and risk taking that is examined here. (Consider the simple case in which the government employs only a tax on excess returns and the returns are always positive. When returns are low, the tax rate is raised sufficiently to produce actual revenue equal to expected revenue; when returns

The inquiry into how government expenditures affect private risk taking and social welfare is related to inquiries concerning the ability of the government to "absorb" systematic risk.³¹ Bulow and Summers (1984), Gordon (1985), and some others favor the view that the government cannot absorb systematic risk beyond what can be accomplished by the market, since the risk ultimately is borne by individuals. Others suggest that market imperfections raise the possibility that the government can enhance welfare by absorbing some risk (presumably nonsystematic risk), although the particular imperfections usually are not specified.³²

The government's ability to absorb risk depends not only on imperfections in financial markets but also on the nature of government expenditures. For example, if it could spend revenue on a public good with constant returns in production and constant (separable) marginal utility in consumption, it may be optimal for the government to bear all systematic risk, allowing expenditures on the public good to vary in different states. More realistically, all public goods at some point reach diminishing returns in production and diminishing marginal utility in consumption. But, so long as public goods are not perfect substitutes for private consumption, as seems likely, the

are high, the rate is correspondingly reduced. This regime is identical to an ex ante wealth tax or a tax on riskless returns, at a rate sufficient to produce expected revenue. That it is described as a tax on excess returns, with a higher or lower rate depending on the economic conditions, does not cause it to produce more deadweight loss than an ex ante tax at a given rate.)

³¹ This issue is generally explored when considering the appropriate discount rate in performing cost-benefit analysis for government projects. See Bailey and Jensen (1972), Graham (1981), Grinols (1985), Lind (1982).

³² Moral hazard is undoubtedly one of the most important reasons nonsystematic risk is borne, but compulsory government insurance (directly, through relief policies, or indirectly, through taxation) would typically reduce welfare, even after taking account of how individuals would adjust their contractual risk-sharing arrangements. See Kaplow (1991) and note 28. Atkinson and Stiglitz (1980) sketch a general equilibrium example involving the agency problem, noting that taxes may affect the risk-sharing arrangements. They do not, however, analyze the effect, perform welfare analysis, or consider the use of government revenue.

Many individuals bear significant nonsystematic risk by holding much of their wealth in the form of owner-occupied housing, which they may do because of incentive considerations, tax benefits, or other factors. If minimizing moral hazard is not the primary reason, taxing the returns on housing (by taxing imputed income) may produce substantial welfare gains. Rosen, Rosen, and Holtz-Eakin (1984) consider the effects of taxation on housing tenure decisions when uncertainty is taken into account. Berkovec and Fullerton (1990) reconsider the issue in a general equilibrium model, in which they also compute welfare effects.

government can absorb risk through such expenditures because, in a sense, public goods are additional assets -- ones that can be purchased only by the government.³³

When government portfolio policy is considered together with tax policy when analyzing uncertainty, the government's ability to absorb risk can be treated separately. That is, whatever is the optimal extent to which the government should bear systematic risk, it can bear risk to that extent independently of the form of taxation it chooses. As a result, government expenditure and portfolio policy can, in a sense, be "ignored," as it has been in much of the previous literature. But the relevant "black-box" treatment is not that uncertain revenue simply evaporates. Rather, social risk -- which is what is relevant for both behavior and welfare -- should be seen as constant in simple, nondiscriminatory models of taxation when one is attempting to choose between ex post forms of taxation (in which it appears that the government is absorbing private risk and being subjected to uncertainty in its flow of revenue) and ex ante forms of taxation (in which no private risk is absorbed and government revenue is certain). Thus, most familiar partial equilibrium results are incorrect except for those concerning wealth effects, but these typically would be the same for two tax regimes that produced a government sector of the same size.³⁴ The remaining policy choice thus

³³ Among the few general equilibrium treatments, some, like Gordon (1985), consider only the case in which revenue is rebated to individuals and Stiglitz (1972) examines the related possibility that the government purchases a commodity that is a close substitute in consumption for the private good as well as the case in which revenue has no effect. Hines (1991) offers an interesting model in which the full range of effects on individuals are possible, depending on the value of a parameter that defines the ratio (assumed in his illustration to be fixed) of (1) the change in the marginal utility of private consumption as public expenditure increases to (2) the change in the marginal utility of private consumption as private wealth increases. His model does not allow for government portfolio adjustments or for an asset's rate of return to depend on aggregate demand for the asset.

³⁴ The most obvious exception involves taxation that discriminates in various ways, in which case substitution effects would be central. This point is sometimes obscured. For example, in Atkinson and Stiglitz's (1980) examination of the exemption for capital gains -- modeled as a tax on the return to the riskless asset only -- they suggest that the effect on risk taking is indeterminate, contrary to conventional wisdom. The substitution effect favors the risky asset, but the wealth effect from taxing the riskless asset, implicitly compared to not taxing it, reduces risk taking (assuming that the wealth elasticity of demand for the risky asset is positive). But the wealth effect is from taxation itself, not its discriminatory form. The appropriate comparison is between the tax on only the riskless asset and a

concerns the level of taxation rather than its form, and risk-taking considerations would not seem as important in the ways that usually have been considered.

6.2. Relevance to Practical Considerations in Taxation

Better understanding the behavioral and welfare effects of different forms of taxation is obviously important in formulating tax policy. Note that the equivalence results here provide an element of practical guidance in addition to conceptual illumination. If two forms of taxation are equivalent, the choice between them can be made on grounds other than those concerning the revenue they raise or their primary effects on behavior. For example, if a wage tax is simpler to administer or easier to enforce than a consumption tax, it can be employed without worrying about the government's role in bearing risk.³⁵ Or, if Auerbach's (1991) retrospective capital gains tax avoids distortions resulting from deferral and lock-in but is equivalent in principle to accrual taxation (as demonstrated here in a model with only one period of resolution of uncertainty), one could favor its adoption without concern for the possible equity or efficiency implications of the differences between the regimes concerning risk, because the differences do not exist when the model is completed in the manner developed here.³⁶

6.3. The Model's Assumptions

Most of the model's assumptions, as noted in section 2, are familiar in the literature, but their implications are not necessarily the same as in a

nondiscriminatory tax that reduces wealth by the same amount. Only the substitution effect would remain.

³⁵ Which form of taxation is easier to administer is a difficult question. Ex ante forms may avoid later valuation and timing problems, but may require that one, for example, precisely identify the difference between wage and investment income, a simple matter for many employees but not for some entrepreneurs.

³⁶ Auerbach assumes that his tax produces different results from accrual taxation when defending its fairness.

If one does not adopt retrospective taxation, there remains the problem of selective realization of losses and thus the use of limitations on loss offsets. But if ex ante taxation is equivalent, it could be employed instead, without having to worry about selective realization. (The relationship between ex ante and ex post taxation would be more complex in a multiperiod model, as discussed below.)

partial equilibrium model. For example, Sandmo (1977) demonstrates the effect of there being more than one risky asset in the familiar partial equilibrium model, but the analysis here does not depend on the number of risky assets.³⁷ Similarly, the omission of the choices between consumption and savings and between labor and leisure is not critical: with regard to what is ultimately saved, the analysis shows that there is no difference in individuals' opportunity sets when shifting among equivalent taxes, so these other margins would be unaffected.³⁸ Also, a substantial portion of partial equilibrium results depend on various assumptions concerning the concavity of individuals' utility functions, particularly whether relative risk aversion rises, falls, or remains constant with increases in wealth. By contrast, the results established here do not require concavity to be specified further.³⁹

Other restrictions, such as the assumption that individuals can borrow and lend at the same rate, remain relevant. Similarly, the results depend on examining simplified forms of taxation: taxes that are proportional⁴⁰ and nondiscriminatory⁴¹ with full loss offsets and rates that do not change over time.⁴² The general themes developed here would continue to apply in other

³⁷ The proofs considered only individuals' and the government's offsetting shifts in their portfolios between the riskless and risky assets. For this purpose, the risky asset could have been many assets.

³⁸ In contrast, these omissions are relevant in partial equilibrium models. See, e.g., Ahsan (1976) (consumption and portfolio allocation).

³⁹ If one explored, for example, the difference between a wealth tax and no tax, relative risk aversion would determine the effect on risk taking, but welfare does not depend in any direct way on whether risk taking rises or falls. Because there is no substitution effect, there is no distortion.

⁴⁰ Warren (1980a) discusses graduated rates and the limitations of cumulative averaging in the presence of uncertainty. The rationale for progressive marginal tax rates, however, may be different for wages or wealth than for uncertain investment income. If progressive taxation is employed because of different earnings abilities or inheritances, the rationale is most relevant to wages or wealth. (Of course, ability and work effort may be difficult to disentangle from investment returns of entrepreneurs.) As between two individuals with equal ability and ex ante wealth, progressive taxation of excess investment returns may affect investment in a manner analogous to that arising from limits on loss offsets (which entail progressive marginal rates -- a zero rate for negative realizations and a constant positive rate for positive realizations). There is, however, no obvious connection with familiar redistributive norms. Ex post taxation can be seen as an attempt to force investors to reduce the risk they bear. A proportional tax on excess returns does involve the rich (ex post) paying more in total and as a fraction of their uncertain investment returns, although it has no ultimate effect in the model here. But even if investors did not negate the effect of such ex post taxation, what would be rationale with regard to redistribution? If risk

settings, although the particular equivalence results would no longer hold.

Another important restriction is that the model considers only investment behavior in one period. Allowing many periods, with labor, consumption, and investment decisions in each, makes the definition and practical implementation of ex ante and ex post concepts more complex. For example, problems of deferral and lock-in arise only in a multi-period setting.⁴³ While the model has not been extended in this way, it is clear that the approach it embodies would continue to be important.

7. Conclusion

One must take into account how government revenue is spent and how the government's portfolio choice affects its revenue to obtain valid general equilibrium results in the presence of uncertainty. These aspects of the problem influence risk taking, both private and total. Related, when examining changes in tax regimes, one must be sure that total investment in different assets is unaffected or that the effects of changes in real investment are considered. Finally, the effect of taxation on social welfare

is not systematic, the effect of ex post taxation is one of insurance, which could be obtained by ex ante equals if they so choose. If risk is systematic, all investors are to that extent in the same position ex post (all are wealthy or all are poor), and systematic risk cannot be extinguished by redistribution.

⁴¹ Compare Mintz (1981), who uses a partial equilibrium model to study the effects of differential treatment of debt and equity by the corporate income tax.

⁴² Consider Gordon's (1985) model of corporate capital income taxation, which contains many details of taxes actually imposed but is still a "simple" tax regime in the sense described here. Through numerical examples and extensive derivations, he demonstrates that his taxes have no effect on welfare although they raise revenue, on average. This should not be surprising. Much of the detail he models involves taxing excess returns, while rebating the proceeds to individuals. What remains is the tax on riskless returns and a property tax. In his numerical examples, the riskless rate of return is negative, and the tax on it offsets the property tax. (Both are forms of wealth taxes, as that concept is defined here.) In his derivations, his condition is that the net tax on riskless returns from all sources be zero, so the total effect of the tax system reduces to that of a tax solely on excess returns. (He claims that the assumption that all taxes are rebated to individuals is necessary for his result, but the analysis here shows it holds quite generally, if one allows for an adjustment in the government's portfolio.) That tax revenue is still collected on average is presented as a virtue, but as Bulow and Summers (1984) note, the expected positive revenue has no economic value. See note 3.

⁴³ And, as Gordon and Wilson (1989) demonstrate, some intertemporal distortions arise only in multi-period models.

depends on government revenue and portfolio policy, both because they influence behavior and because government expenditures directly affect individual welfare.

The model examined here incorporates these features in a general manner: how the government chooses to spend uncertain revenue, how expenditures affect individual utility, and the social welfare function did not need to be specified. Nor was it necessary to model the supply of investment opportunities. Yet, this more complete and more general model yields stronger and simpler results than previous investigations of taxation and risk taking. In particular, ex post taxes, in which revenue is uncertain and the government appears to absorb private risk, are equivalent to ex ante taxes, in which revenue is certain and no private risk is absorbed, as long as the government is permitted to alter its investment portfolio. Effects on behavior and welfare are thus both trivial and dramatically different from many results in the literature. Moreover, the equivalences demonstrated here do not depend on many of the assumptions necessary in prior work. Of course, they do depend on other important restrictions inherent in the model as well as the fact that only very simple taxes (e.g., a proportional income tax with full loss offsets) were examined. Further exploration is thus required, but the approach employed here may simplify or at least clarify the problems that remain.

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