THE INCIDENCE AND ASSET-PRICING EFFECTS
OF REALIZATION-BASED CAPITAL GAINS TAXES

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Abstract: Many analyses of capital gains taxation assume that actual realization-based taxes are economically similar to accrual-based taxes. In this paper, I show that realization and accrual taxes have quite different asset-pricing effects and incidence, due to differing effects on agents’ marginal payoffs from asset holdings. While asset prices are reduced by future accrual taxes and unaffected by current accrual taxes, they are increased by current realization taxes and are affected by future realization taxes in a manner that depends upon investors’ trading patterns and tax rules. While the burden of an accrual tax falls on those who own assets when it is announced, much of the realization tax’s burden falls on those who trade assets when it is levied, with the burden divided between buyers and sellers in a manner similar to inverse-elasticity models of excise-tax incidence.

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In most countries, holders of assets do not pay income tax on capital gains as they accrue. Instead, tax is deferred until the holder sells shares of the asset, when she is taxed on her realized gains, the gross sale proceeds minus a "basis" deduction that reflects the cost of purchasing the shares. For tractability, however, many economic models of capital gains taxation ignore the realization nature of the tax and assume that capital gains are taxed upon accrual. In this paper, I investigate the validity of treating accrual and realization taxes as economically similar and find that the two tax systems have dramatically different incidence and asset-pricing effects.

I analyze a stochastic discrete-time exchange economy with complete markets and infinite-lived agents whose preferences satisfy a standard aggregation condition. Each agent's first-order conditions require that, in each period and state of the world, the marginal cost of acquiring (or retaining) an asset equal the infinite-horizon present discounted value of its expected marginal cash flows, discounted at the agent's marginal rate of substitution. The equilibrium effects of accrual and realization taxes are then determined by the manner in which they modify the marginal cost and marginal cash flows that appear in agents' first-order conditions.

In the no-tax equilibrium, the first-order conditions simply imply that each asset's price equals the present discounted value of its future dividends. Under accrual taxation, each asset's marginal cash flows are reduced by the future taxes expected to apply to its accrued gains. In general equilibrium, this yields the well-known result that asset prices decline by the present value of the expected future taxes, so that the incidence of the taxes falls upon the agents who own assets when the taxes are announced. If tax rates vary across agents, the equilibrium price change is a weighted combination of agents' marginal tax burdens, with weights given by agents' absolute risk tolerance (absolute willingness to substitute consumption between periods and states of the world). The agents then adjust the allocation of their consumption across periods and states in response to their differing aftertax rates of return, resulting in exchange inefficiency.

Under realization-based taxation, however, current and future taxes enter agents' first-order conditions in a dramatically different manner. For agents who are selling an appreciated asset, the current realization tax reduces the marginal cost of the asset (the revenue foregone by selling one less share) to the asset's price minus the current
tax liability imposed on the sale of the marginal share. For agents who are buying the asset, marginal cost continues to equal the asset price.

The effects of future realization taxes on assets' marginal cash flows are also quite different from the corresponding effects of future accrual taxes, because the base of each period's tax is different. While an accrual tax in future period $s$ applies to the quantity of each asset held in period $s$, a realization tax in period $s$ applies to the quantity sold during period $s$, which is the quantity held in period $s-1$ minus the quantity held in period $s$, if greater than zero. For agents who sell during period $s$, therefore, the period-$s$ realization tax imposes a marginal tax on holdings in period $s-1$ and a marginal subsidy of equal magnitude to period-$s$ holdings. In general, the period-$s$ realization tax also imposes a complex set of marginal taxes or subsidies on holdings in periods prior to $s-1$, because purchases and sales during those periods affect the per-share basis deduction that sellers may claim in period $s$. The signs and magnitudes of these "future-basis effects" and the implied taxes and subsidies depends upon agent's trading sequences and the nature of the basis-designation rules used to allocate the costs of purchases in different periods among the sales in subsequent periods.

If these future-basis effects are small enough to ignore, the equilibrium asset-pricing effects are particularly simple. Asset prices rise in response to current realization taxes, partially compensating sellers for the marginal tax on sales, with the magnitude of the price increase depending upon the comparative risk tolerances of buyers and sellers. In equilibrium, the familiar "lock-in" effect not only reduces trading volume, but also increases asset prices. In contrast, realization taxes anticipated in future periods have no net impact on current asset prices, due to the offsetting marginal taxes and subsidies they impose on holdings in consecutive periods. The anticipation of a realization tax in period $s$ leaves asset prices unchanged in periods prior to $s$, increases prices in period $s$, and leaves prices unchanged after period $s$ (the same effects as that of an accrual-based subsidy to holdings in period $s$ combined with an offsetting accrual-based tax on holdings in period $s-1$). The expected temporary price increase in period $s$ reduces the expected pretax return to holding assets from period $s-1$ to $s$, while increasing the expected pretax return to holding assets from period $s$ to $s+1$. Both effects increase the expected pretax payoff from asset sales in period $s$ and provide a general-equilibrium offset to the expected tax on such sales.
In this simple case, the incidence of the period-s realization tax falls upon agents who buy and sell assets in period s, rather than agents who own assets when the tax is announced. Also, the buyers' and sellers' respective burdens are inversely proportional to each group's aggregate absolute risk tolerance (willingness to substitute consumption), which is analogous to the public-finance inverse-elasticity formula for excise-tax incidence.

More generally, the asset-pricing impacts also incorporate the marginal taxes and subsidies implicit in the future-basis effects. If the tax system uses the First-In First-Out method to identify which shares are sold (the primary default rule in the United States), anticipated realization taxes impose a marginal tax on prior asset holdings and, in equilibrium, current prices are reduced by anticipated taxes. The price declines are generally smaller than those from equal-revenue accrual taxes, but magnitudes are sensitive to agents' trading sequences. Under a Last-In First-Out rule and some other basis-designation rules, anticipated taxes may actually increase asset prices in earlier periods.

I also conclude that the asset-pricing effects identified in the exchange-economy analysis are likely to be qualitatively unchanged (but smaller) in production economies, if new investment is taxed similarly to purchases of existing assets, as is true for noncorporate investment in the United States. However, anticipated realization taxes tend to systematically reduce asset prices (and investment), if investment expenditures are themselves taxed as capital gains, as is effectively true for reinvested corporate earnings in the United States. This analysis is consistent with empirical evidence that anticipated realization taxes reduce corporate equity prices, but indicates that different results are applicable to the noncorporate assets that generate the majority of realized capital gains.

The paper is organized as follows. In section I, I describe the no-tax equilibrium and review the familiar asset-price effects of accrual taxes. I analyze the effects of realization taxes in Section II and apply the results to a simple economy, with life-cycle trading, in section III. I discuss the extension to production economies in section IV and other extensions in section V and conclude in section VI.
I begin by examining a simple asset-pricing model of a stochastic discrete-time exchange economy, solving for its no-tax equilibrium, and reviewing the familiar first-order effects of introducing small accrual taxes on capital gains. This analysis provides a benchmark for comparison with my analysis of realization taxes below.

I assume that agents are infinitely-lived. Each agent can be interpreted as a "dynasty" of altruistically-linked finite-lived individuals with operative bequest motives, as in Barro (1974), but I defer further elaboration, since the this interpretation does not affect the analysis of the no-tax equilibrium or of accrual taxes.

Each agent $i$ has preferences of the following form,

$$U(i) = \sum_{t=1}^{\infty} \beta^t E\left\{ \left( C_t - M_{it} \right)^{-\gamma} \right\} / (1 - \gamma),$$

where the curvature parameter $\gamma$ and the utility-discount factor $\beta$ are identical across agents (if $\gamma$ equals unity, the utility function is logarithmic). However, the parameters $M_{it}$, which can be interpreted as subsistence levels of consumption, may differ across agents and periods and may be stochastic. If an agent's subsistence parameters are zero, her utility function is isoelastic, with constant relative risk aversion equal to $\gamma$.

I consider a pure exchange economy with an exogenous endowment, as in Lucas (1978), deferring analysis of production until section IV. The stochastic aggregate endowment of the perishable consumption good in period $t$ is denoted $C_t$. A portion of the endowment is distributed among the agents as nontradable income, with $X_{it}$ denoting the (generally stochastic) nontradable income received by agent $i$ during period $t$. If each agent consists of a dynasty of finite-lived individuals, then $X_{it}$ might, for example, depend upon the age of the dynasty's living representative, as in the application studied in section III.

The remainder of the endowment is paid as dividends on $N$ distinct tradable assets, with $D_{nt}$ denoting the (generally stochastic) dividend paid by asset $n$ during period $t$. Agents may also trade zero-net-supply financial assets, including safe bonds of various maturities. Markets are complete, i.e., the set of traded assets spans the stochastic factors affecting either the allocation of nontradable income among agents or the values of $M_{it}$.

Agents trade assets at the end of each period, before learning the dividend payoffs and asset prices that will prevail in the next period. After dividends are paid in the next period, agents can trade again. Let $P_{nt}$ denote the
The ex-dividend price of asset \( n \) at the end of period \( t \) and \( Z_{int} \) denote the number of shares of each asset held by each agent at the end of period \( t \) (beginning of period \( t+1 \)), i.e., the number of shares held after the period \( t \) trading session has concluded. Each agent faces the following budget constraint in each period,

\[
\sum_n Z_{nt} P_n - X_n + \sum_n \left( D_n + P_n \right) Z_{n,t-1} - C_n, \quad \forall i.
\]

The budget constraints (2) requires that each agent's wealth at the end of a period equal her nontradable income received during the period plus the dividends paid on the shares held from the previous period's trading plus her wealth at the beginning of the period minus her consumption during the period.

Each agent's asset holdings at the beginning of period one, \( Z_{i0} \) are exogenous. Each agent also faces a transversality condition requiring that the expected marginal-utility value of her wealth converge to zero,

\[
\lim_{t \to \infty} \mathbb{E} \left( \beta^t \left( C_{it} - M_{it} \right)^{-\gamma} \left( \sum_n Z_{nt} P_{nt} \right) \right) = 0, \quad \forall i.
\]

Because markets are complete, the ratio of marginal utilities across agents is a deterministic constant. Defining the aggregate subsistence level \( M_t \equiv \sum_n M_n \), the following condition holds in each period and state of the world,

\[
\frac{C_{it} - M_{it}}{\lambda_i(C_t - M_t)} = \lambda_i(C_t - M_t),
\]

where each \( \lambda_i \) is a constant determined by the agent's initial tradable wealth, expected nontradable income, and expected subsistence requirements. By construction, these constants sum to unity.

In equilibrium, each agent obeys a first-order condition equating the marginal cost of acquiring each asset to the infinite-horizon present discounted value of its expected cash flow, with discount factors given by the agent's marginal rates of substitution,

\[
P_{nt} = \frac{\sum_{n'=1}^N \beta^{-n'} E_t \left[ D_n (C_n - M_n)^{-\gamma} \right]}{(C_n - M_n)^{-\gamma}}, \quad \forall i, n.
\]

The market-completeness condition (4) permits (5) to be rewritten in terms of aggregate consumption.

\[1\] The first-order conditions (5) can also be obtained by writing the conventional Euler equations linking adjacent periods and solving forward, imposing the transversality condition (3). Conversely, the conventional Euler equation can be obtained by writing (5) for period \( t \) and for period \( t+1 \) and taking their difference.
\[ P_{n,t} = \sum_{t=1}^{\infty} \beta^{t-n} E_{\gamma} \left[ D_{\gamma} (C_{\gamma} - M_{\gamma})^{-\gamma} \left( C_{\gamma} - M_{\gamma} \right)^{-\gamma} \right], \forall n. \]

Now, assume that a sequence of accrual taxes at rates \( a_{n,t} \) is announced unexpectedly at the beginning of period one. The tax rates may vary across agents and assets and over time, and may be stochastic. The period-\( t \) tax applies to the capital gain (or loss) that accrued on each share since the end of the previous period, \( P_{n,t} P_{n,t-1} \), and is collected from the agent who held the share during period \( t \) when the appreciation occurred. Revenues are contemporaneously rebated back to the agents in lump-sum form, where the allocation of rebates among agents is unrestricted and may be time-varying and stochastic. The taxes and rebates modify the budget constraints (2) to

\[ \sum_n Z_{n,t} P_{n,t} = X_{n,t} + \sum_n \left[ D_{n,t} + P_{n,t} (1 - a_{n,t}) + a_{n,t} P_{n,t-1} \right] Z_{n,t-1} - C_{n,t}, \forall i, \]

where \( X_{n,t} \) now includes each agent's lump-sum rebates.

With accrual taxes, the first-order conditions equating the cost of acquiring the asset to the present discounted value of its aftertax payoffs now take the form,

\[ P_{n,t} = \sum_{t=1}^{\infty} \beta^{t-n} E_{\gamma} \left[ \left\{ D_{\gamma} - a_{\gamma} (P_{\gamma} - P_{\gamma-1}) \right\} (C_{\gamma} - M_{\gamma})^{-\gamma} \right], \forall i, n. \]

The new first-order conditions (8) differ from (5), because the future accrual taxes reduce the asset's marginal cash flow (assuming that the asset is expected to appreciate).

I linearize the first-order conditions (8) around the no-tax equilibrium to examine the first-order effect of introducing a sequence of small accrual taxes,

\[ dP_{n,t} = E_{\gamma} \sum_{t=1}^{\infty} \beta^{-t} \left[ dD_{\gamma} \left( P_{n,t-1} - P_{n,t} \right) + \gamma dP_{n,t} \left( \frac{dC_{\gamma} - C_{\gamma} - M_{\gamma}}{C_{\gamma} - M_{\gamma}} \right) \left( \frac{dC_{\gamma} - C_{\gamma} - M_{\gamma}}{C_{\gamma} - M_{\gamma}} \right)^{-\gamma} \right], \forall i, n. \]

Since aggregate consumption and assets' dividend yields are fixed in this exchange economy, equilibrium is maintained by changes in asset prices and in the allocation of consumption among the agents. In equation (9), the absolute change in each agent's consumption is multiplied by \( 1/(C_{i,t}M_{i,t}) \), which is her absolute risk tolerance,

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2 However, if redundant assets exist (so that the stochastic return on one asset or combination of assets exactly matches the return on another asset or combination of assets), the equivalent assets must be taxed at the same rate.

3 Taxation of nominal, rather than real, accrued capital gains can be accommodated in this analysis by multiplying \( P_{n,t-1} \) by the ratio of the general price level in period \( t-1 \) to that in period \( t \).
Absolute risk tolerance (the reciprocal of absolute risk aversion) measures the agent's absolute willingness to substitute consumption between periods and states of the world, i.e., the absolute consumption change she makes in response to changes in rates of return.

With complete markets and the maintained preference assumptions, equation (4) guarantees that, along the no-tax equilibrium path, each agent's absolute risk tolerance is inversely proportional to the constant $\lambda_i$ in each period and state of the world, making aggregation straightforward (for small perturbations around that path). For each asset, multiply each agent's first-order condition (9) by $\lambda_i$, add across agents, and impose the equilibrium condition that aggregate consumption is unchanged. The agents' individual consumption changes cancel (in each period and state of the world)$^4$, yielding

$$\sum_{e=1}^{\infty} \beta^e E \left\{ \sum_k \lambda_i da_{e,i} \left( P_{m,e} - P_{e,e-1} \right) \left( C_e - M_i \right)^{-\gamma} \right\} \forall n$$

The equilibrium price changes are particularly simple if tax rates are identical across agents. Each asset's price then declines by the present discounted value of the taxes imposed on the asset. For agents to remain willing to hold the asset, the price must rise to offset the marginal tax burden associated with holding the asset, restoring aftertax rates of return to their no-tax-equilibrium level. Since aftertax rates of return are unchanged, agents' asset holdings and their allocation of consumption across periods and states is also unchanged and the accrual tax is a lump-sum tax. Also, in accordance with Ricardo's analysis of a tax on an asset in fixed supply, the incidence of the accrual tax falls upon those who hold assets when the tax is announced.

More generally, when tax rates vary across agents, equation (10) states that the price decline equals a weighted combination of the agents' marginal tax burdens, with weights given by $\lambda_i$. The net effect of the tax and price change is that some (low-tax-rate) agents face aftertax rates of return higher than the no-tax-equilibrium return, while other (high-tax-rate) agents face lower aftertax rates of return. Agents respond to the different rates

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$^4$ This is the aggregation result of Rubinstein (1974), which applies when preferences are of the Hyperbolic Absolute Risk Aversion (HARA) form, as in (1), with identical curvature parameters and discount factors, and markets are complete. The HARA class also includes exponential (constant-absolute-risk-aversion) utility, obtained as $\gamma$ approaches infinity. Rubinstein noted that, with exponential utility, aggregation holds even when $\beta$ differs across individuals and markets are incomplete, since the ratio of agents' absolute risk aversion is necessarily constant when each agent's absolute risk aversion is constant.
of return by changing their asset holdings, altering the allocation of their consumption across periods and states. This divergence of aftertax returns across agents introduces exchange inefficiency into the economy. Note that the equilibrium price changes are more sensitive to the tax rates imposed on those agents who are more willing to substitute consumption.

The above analysis also applies to other accrual taxes (taxes for which each period's tax liability depends upon the agent's asset holdings in only that period), including dividend taxes, property taxes, and estate taxes levied on holdings at death. In each case, anticipated future taxes reduce the asset's marginal cash flow and cause asset prices to decline. However, I now show that the economic effects of realization taxes are fundamentally different, because such taxes have different effects on the cost of acquiring assets and their marginal cash flows.

II. Asset-Pricing Effects and Incidence of Realization-Based Taxes

Actual capital gains taxes in the United States and in other countries are normally levied only when capital gains are realized by asset sales. However, due to the complexity of realization taxes, many economic analyses of capital gains taxation assume that gains are taxed on an accrual basis. (Because deferral of the tax liability until the date of sale reduces its present value, these studies generally model the capital gains tax as an accrual tax levied at an "accrual-equivalent" rate lower than the stated rate of the actual realization tax.) For example, the asset-pricing models of Brinner and Brooks (1981), Feldstein (1983, Chapters 10-13), and Chiang and Rodriguez (1990) treated capital gains taxes as accrual-based and found price reductions similar to those described above. Similarly, policy analysts, implicitly or explicitly relying on these models, often argue that reducing the tax rate on capital gains will increase asset prices.

These models assume that, if magnitudes are comparable, realization and accrual taxation are fundamentally economically equivalent. I now evaluate this assumption by introducing realization taxes into the model and examining their asset-pricing effects.

I assume that a sequence of tax rates \( r_{int} \) on realized capital gains is unexpectedly announced at the beginning of period one. As before, tax rates may vary across agents and assets and over time and may be stochastic. For
example, some assets, such as bonds, might not be subject to capital gains tax (and might be taxed under an accrual regime). Also, revenues are again rebated back in lump-sum form and the allocation of rebates among agents may be time-varying and stochastic.

A. Design of Realization-Based Taxes

Because realization taxes raise some issues that do not arise under accrual taxation, it is necessary to describe the design of the tax system more completely. Under a realization tax, an agent is taxed on an asset only in periods in which she sells shares of the asset. For this tax system to be viable, agents must be unable to replicate the effects of asset sales through transactions that are not treated as sales by the tax code. Stiglitz (1983) and Constantinides (1983) noted that agents can, under certain conditions, avoid realization taxes with strategies that do not require changes in their consumption in any period or state of the world. However, as recognized in the literature, taxpayers’ actual ability to employ such strategies appears to be quite limited. Following previous authors, I now impose assumptions that preclude this type of tax avoidance for sufficiently low tax rates,

- (A1) Short sales "against the box" are not permitted, i.e, an agent cannot sell short shares of any asset while holding other shares of the same asset.
- (A2) No redundant asset or portfolio exists in the no-tax equilibrium, i.e., it is not possible to exactly replicate the stochastic return on any asset or portfolio with any other asset or portfolio, and the cost of introducing a redundant asset is bounded away from zero.

These assumptions ensure that a small capital gains tax raises revenue. If costless unrestricted short sales against the box are permitted, agents could sell the asset without paying tax, by opening a short position alongside their existing long position. Similarly, if redundant assets exist (or are introduced in response to the tax), agents could sell shares of an identical asset, rather than the appreciated assets that they hold. I discuss these tax-avoidance strategies further in section V and argue that (A1) and (A2) are reasonable modeling assumptions.

I make two other simplifying assumptions (also discussed in section V),

- (A3) Wash sales are not permitted, i.e., an agent cannot both sell and buy shares of the same asset in a period.
- (A4) No short sales occur in the no-tax equilibrium.
If an agent sells shares of an asset, she is taxed on her gross sale proceeds minus a basis deduction that reflects the purchase costs that the tax system attributes to those shares. Each agent's tax liability with respect to each asset in each period can be written as \( r_{nt} P_{nt} S_{nt}(Z_{nt, t-1} - Z_{nt}) - r_{nt} S_{nt} B_{nt} \), where \( B_{nt} \) is the agent's basis deduction and \( S_{nt} \) is an indicator variable equal to one if the agent sells asset \( n \) in period \( t \) (if \( Z_{nt} < Z_{nt, t-1} \)) and zero otherwise, so that \( S_{nt}(Z_{nt, t-1} - Z_{nt}) = \text{Max}(0, Z_{nt, t-1} - Z_{nt}) \). Since agents will generally have made either purchases or sales of the asset's shares in each past period, at many different prices, the tax system must specify basis-designation rules that allocate the costs of past purchases among sales transactions in subsequent periods. These rules might, for example, identify the shares that are deemed to be sold using the First In First Out (FIFO) or the Last In First Out (LIFO) inventory methods or might use an average-cost rule that averages prices from all past purchases. Alternatively, a specific-identification rule might allow agents to specify which shares are deemed sold in each transaction. The tax code must also specify whether purchase costs are indexed for inflation and must prescribe the treatment of shares acquired by inheritance.

The following assumption is sufficient for present purposes,

- (A5) Conditional on the history of an asset's past prices, the total basis deduction that an agent may claim with respect to current sales of the asset is a continuous function of the agent's current and past holdings of the asset, \( f(Z_{nt}, P_{nt}), s \leq t \), differentiable except (perhaps) on a space of measure zero. The basis deduction does not depend upon tax rates in any period.

Assumption (A5) encompasses a broad class of basis-designation rules, including FIFO (the default rule in the United States), the average-cost rule (applied in some cases in the United States), and LIFO. However, it does not include the specific-identification rule (applied in some cases in the United States), since an agent's choice of basis deductions in each period depends upon the pattern of tax rates over time. Assumption (A5) also accommodates the basis-stepup rule provided by section 1014 of the U.S. Internal Revenue Code (under which agents who inherit assets are treated as if they purchased them at market value on the date of inheritance)\(^5\) and either the presence or absence of inflation indexation of basis.

It is now possible to describe investor optimization under realization taxes.
B. Investor Optimization with Realization-Based Taxes

Letting $X_i$ again include the lump-sum rebates received by each agent in each period, the taxes and rebates alter the budget constraints (2) to

\[
\sum_{n} Z_{nt} P_{nt} = X_i + \sum_{n} \left[ D_{nt} + P_{nt} Z_{n,t-1} - r_{nt} P_{nt} S_{nt} (Z_{n,t-1} - Z_{nt}) + r_{nt} S_{nt} B_{nt} \right] - C_v, \forall i
\]

As can be seen from (12), realization taxes imply that each agent's payoff function is nondifferentiable at the mathematical point at which she neither buys nor sells shares of an asset, where the $S_{nt}$ indicator variable changes discretely between zero and unity. As noted by Cook and O'Hare (1992) and other authors, realization taxes induce a "region of inaction," which is a range of shocks for which an agent, who sold shares of an asset in the no-tax equilibrium, now neither buys nor sells. With a discrete realization tax, there is a positive probability that, in any given period, an agent will choose a corner solution in which she neither buys nor sells, locating at this "kink" in her payoff function. Kupiec (1996, pp. 119-120) made the same observation for securities-transaction taxes.

However, for a small realization tax, agents remain at an interior solution with arbitrarily high probability.\(^6\) At an interior solution, agents continue to obey the first-order conditions equating the marginal cost of acquiring the asset to the present discounted value of its expected marginal cash flows,

\[
P_{nt} - r_{nt} S_{nt} \left( P_{nt} - \frac{\partial B_{nt}}{\partial Z_{nt}} \right) = \sum_{n=1}^{\infty} \beta^{-n} E \left[ \sum_{n=1}^{\infty} \partial B_{nt} \left( \frac{C_v - M_v}{C_v - M_v} \right) \right], \forall i, n.
\]

A comparison of the first-order conditions (13) to the no-tax first-order conditions (5) and the accrual-tax first-order conditions (8) clarifies the distinctive effects of realization taxes of assets' marginal costs and cash flows, as reflected in the two tax-related terms in (13).

The new term in the LHS of (13) modifies the opportunity cost of acquiring an additional share of each asset in period $t$. As reflected by the presence of the $S_{nt}$ indicator variable, this term differs from zero only for agents

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5 The assumption also encompasses the alternative basis-carryover rule, in which the heir is given a basis deduction for the original purchaser's costs. However, as discussed in section V, the analysis must be modified if unrealized gains are taxed at death, as in Canada and some other countries.

6 Since points with no purchases or sales are a space of measure zero, I assume that no agents are at such points along the no-tax equilibrium path.
who sell asset \( n \) in period \( t \). This divergence of buyers' and sellers' first-order conditions reflects a fundamental difference between realization and accrual taxation. Under accrual taxation, the first-order condition does not depend upon whether an agent is buying or selling an asset. Under realization taxation, however, the marginal opportunity cost of the asset differs across buyers and sellers. For buyers, the marginal opportunity cost (the cost of buying one more share) still equals the asset price. For a seller, the marginal opportunity cost (the revenue foregone by selling one less share) now equals the asset price minus the tax imposed on the sale of the marginal share, \( P_w - \frac{\partial B_{w,t}}{\partial Z_{w,t}} \). Note that this term depends only upon the period-\( t \) tax rate, not upon future tax rates. In contrast, the current accrual tax rate did not appear in the first-order conditions (8), because the current tax was a sunk cost that must be paid by the period-\( t \) holder, regardless of her trading decisions at the end of the period.

By causing marginal opportunity costs to differ across buyers and sellers (and across sellers with different marginal basis), a realization tax necessarily induces exchange inefficiency, even if tax rates are the same for all agents. If the asset's current price exceeds sellers' marginal basis in the asset, sellers have a lower opportunity cost of holding the asset and therefore hold an inefficiently high amount (sell an inefficiently low amount) of the asset.\(^8\)

This tendency of realization-based capital gains taxes to inefficiently reduce asset trading is known as the "lock-in effect" and has been a major focus of academic study and policy discussion. Englund (1985, 1986), Balcer and Judd (1987), Kovenock and Rothschild (1987), Kiefer (1990), Cook and O'Hare (1992), Auerbach (1992), and Haliassos and Lyon (1994) used theoretical models of asset trading to specify the magnitude and dynamics of the effect in particular economic environments and Kupiec (1996) provided a similar analysis of securities transaction taxes. Numerous empirical studies, critically surveyed by Gravelle (1994, pp. 144-151), have exploited variations across years, individuals, or stocks to test for the lock-in effect and have usually found a significant effect, although

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7 Many basis rules are nondifferentiable with respect to current or previous asset holdings at selected mathematical points. For example, under FIFO or LIFO, an agent's per-share basis deduction abruptly jumps at each point at which she moves from selling the last share attributed to one purchase period to selling the first share attributed to another purchase period. Since these points are a space of measure zero, I again assume that no agents are at these points in the no-tax equilibrium, permitting analysis of small taxes. A discrete realization tax would drive agents to these nondifferentiable points with positive probability.

8 In this model, accrual taxes are superior to realization taxes, because realization taxes inescapably induce exchange inefficiency, while accrual taxes are efficient if tax rates are the same for all agents. The superiority of accrual taxes could be altered by introducing transaction costs, liquidity constraints, or valuation difficulties, any of which would diminish the attractiveness of taxing unrealized gains.
its magnitude and dynamics remain controversial. However, these studies primarily examined the trading-volume and revenue implications of the lock-in effect, while I consider its asset-pricing and tax-incidence implications.

The new term in the RHS of (13) reflects the effects of future taxes on the asset’s marginal cash flows. With accrual taxes, each period’s tax rate applies to that period’s holdings and reduces the marginal cash flow generated by holding the asset in that period. With realization taxes, the effects of future taxes on the marginal cash flow from holding the asset are quite different. A realization tax in future period $s$ results in tax payments equal to

$$r_{ins}S_{ins} \left[ P_{ns}(Z_{ins}, s-1) - B_{ins} \right].$$

The tax liability directly depends upon asset holdings in both period $s$ and period $s-1$ and generally holdings in previous periods, since such holdings enter the function determining $B_{ins}$. The period-$s$ tax therefore alters the marginal payoff from holding the asset in all of these periods.

For analytical simplicity, it is useful to first consider a highly special case in which the basis deduction $B_{ins}$ simply equals the number of shares sold multiplied by a per-share basis $b_{ins}$ that is not affected (on the margin) by holdings in any previous periods, so that $B_{ins} = b_{ins}(Z_{ins}, s-1, Z_{ins})$. The period-$s$ tax liability then depends only upon $Z_{ins}$ and $Z_{ins}$, with derivatives given by $-r_{ins}S_{ins}(P_{ns} - b_{ins})$ and $r_{ins}S_{ins}(P_{ns} - b_{ins})$, respectively. The tax increases the agent’s marginal payoff from holding the asset during period $s$, while reducing the payoff from holding the asset during period $s-1$, with no change in payoff to holding the asset in other periods.

In this special case, the term $\sum_{t>s} \frac{\partial B_{ins}}{\partial Z_{ins}}$ equals zero, for all $s > t$. While future accrual taxes reduce the payoff to holding assets, future realization taxes have no net impact on the payoff, because each period's realization tax imposes offsetting marginal taxes and subsidies on holdings in consecutive periods.

In the general case, however, the period-$s$ tax payment depends upon holdings in many past periods, because transactions in those periods affect $B_{ins}$. The term $\sum_{t>s} \frac{\partial B_{ins}}{\partial Z_{ins}}$ then measures the effect on period-$s$ basis deductions of acquiring or retaining an additional share in period $t$ and holding it thereafter. The sign and magnitude of this effect depends upon the agent’s trading sequence and the basis-designation rules.
For example, consider FIFO, the general default basis-designation rule in the United States. FIFO deems the shares currently held to be sold, in the order purchased, in consecutive sale periods after the current period (without regard to whether purchases are made in any intervening periods). If an agent is buying shares in period $t$, purchasing an additional share and holding it does not change basis deductions until the period in which the last share deemed held in period $t$ is deemed to be sold. In that period, one additional share deemed purchased in period $t$ displaces one share deemed purchased in a later period (the share that would otherwise have been the last share sold). A sequence of displacements occurs in subsequent sale periods, with the share displaced from the previous sale period displacing a marginal share in that period. For sellers, the sale of one less share in period $t$ implies that the marginal share deemed sold in period $t$ will instead be sold in the next sale period, displacing the marginal share (deemed purchased in a later period), with a similar displacement occurs at each subsequent sale date. With FIFO rules and prices rising over time, acquiring or retaining an additional share in period $t$ tends to reduce future basis deductions, since it results in earlier-purchased share displacing later-purchased shares in future sale periods. Future realization taxes then reduce the expected cash flows from holding the asset. The magnitude of these effects are very sensitive to agents' trading sequences. I discuss these effects further in the application in section III and the appendix.

In contrast, with LIFO (which is not a recognized basis-designation rule in the United States) and rising prices, holding an additional share actually increases basis deductions, since later-purchased shares displace earlier purchased shares. With an average-cost rule, the effects are of ambiguous sign. A specific-identification rule poses more complex issues, since the introduction of a period-$s$ tax could change agents’ decisions on which shares to designate as sold in that or other periods. Assumption (A5) precludes this rule and others that would have such effects.

C. Equilibrium Asset-Pricing Effects of Realization-Based Taxes

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$^9$ Treasury Regulation 1.1012-1(c) permits taxpayers to choose the shares that are deemed sold at each date by making a written designation prior to sale, if the broker confirms the designation shortly after the sale. If no designation is made, the regulation requires the use of FIFO (except for mutual-fund shares, for which taxpayers may choose the average-cost rule). Taxpayer compliance with the regulation appears to be imperfect. President Clinton has proposed that the average-cost rule be used in all cases, but Congress has not adopted this proposal.
To find the asset-price effects of a small realization tax, I linearize the first-order conditions (13) around the no-tax equilibrium,

\[ \frac{dP}{dr} - \frac{\partial B}{\partial Z} \]

\[ \sum_{i=1}^{n} \beta^{-t} E \left[ \left( \frac{dC_v}{C_v - M_v} - \frac{dC_i}{C_i - M_i} \right) \left( C_i - M_i \right)^{\gamma} \right] \forall i, n. \]

As before, multiply the change in each agent's first-order condition by \( \lambda \) and sum across agents. The consumption changes again cancel in each period and in each state of the world, yielding the following equations for the changes in the assets' prices,

\[ \frac{dP}{dr} = \sum_{i=1}^{n} \lambda_i \left( P \frac{\partial B}{\partial Z} \right) \sum_{n} dr + \sum_{i=1}^{n} \beta^{-t} E \left[ \sum_{i=1}^{n} \lambda_i dr \frac{\partial B}{\partial Z^{\gamma}} \left( C_i - M_i \right)^{\gamma} \right] \forall n. \]

First, consider the role of the current (period-\( t \)) tax rate. With accrual taxes, the current tax rate has no impact on the current price. With realization taxes, however, equation (15) states that the asset price depends positively upon the current tax rate, assuming that the asset's current price exceeds sellers' marginal basis in the asset. Specifically, the price increase is a weighted sum, with weights \( \lambda_i \), of the sellers' marginal tax liabilities.

The different effects of the current tax rate reflect the different incentive effects under the two tax systems. As noted above, the current accrual tax is a sunk cost that must be paid by current holders of the asset and has no behavioral effects, while the current realization tax is paid by an agent only if she sells at the end of the period and creates a disincentive to sell. In equilibrium, the price rises to partially compensate sellers for this tax burden. Since the sum of \( \lambda_i \) across all sellers is strictly less than unity (recall that the sum across all agents is unity), this compensation is only partial, so sellers still reduce the number of shares they sell, while buyers respond to the higher price by reducing the number of shares they purchase. Relative to a planning optimum, trading is too low, with sellers of each asset having too much exposure to the asset's risk and buyers having too little exposure.

This burden of the current realization tax is divided between those who buy and sell in each period to which the tax applies. The tax is collected from the sellers, but the price increase shifts a portion of the tax payment to the buyers in that period. Inspection of equation (15) reveals that the ratio of the buyers' tax burden to the sellers'
tax burden is inversely proportional to the sum of $\lambda_i$ across each group. Since the reciprocal of $\lambda_i$ measures each agent's absolute willingness to substitute consumption between periods and states of the world, (15) states that each group's share of the burden is inversely proportional to its aggregate absolute willingness to substitute consumption. This result is an application of the standard inverse-elasticity result from the partial-equilibrium analysis of excise-tax incidence (see Kotlikoff and Summers (1987, pp. 1045-1047)), which states that the ratio of the buyer's burden to the seller's burden equals the supply elasticity divided by the demand elasticity, so that burden is divided between buyers and sellers in inverse proportion to their ability to substitute out of the market.

The excise-tax analogy also explains why the weights in equation (15) depend upon each seller's value of $\lambda_i$, rather than upon the quantity she sells. The incidence of a tax depends upon agents' ability to substitute at the margin, rather than the quantities of their inframarginal transactions.

Equation (15) has cross-sectional asset-pricing implications. In each period, the impact of the current tax rate on each asset's price depends upon the number of agents who are selling the asset, their absolute risk tolerances, and the amount of their marginal accrued gains. Equation (15) also implies that asset prices are history-dependent. If an asset has appreciated sharply in the past, so that the current asset price greatly exceeds sellers' marginal basis, equation (15) implies that the current realization tax will induce a larger price increase. If the asset price has declined in the past, so that the current asset price is less than sellers' marginal basis, the current realization tax lowers the asset price (and trading volume increases, due to a "lock-out" effect). Of course, the basis-designation rules and agents' trading sequences must be specified to determine which past prices determine sellers' current basis in the asset.

Equation (15) states that future realization taxes affect the current asset price only to the extent that current transactions affect future basis deductions. It is again analytically useful to consider the special case in which such effects are absent. The anticipation of a realization tax in period $s$ then leaves asset prices unchanged in periods prior to $s$, increases prices in period $s$, and leaves prices unchanged after period $s$ (the same effects as that of an accrual-based subsidy to holdings in period $s$ combined with an offsetting accrual-based tax on holdings in period $s-1$). The expected temporary price increase in period $s$ reduces the expected pretax return to holding assets from period $s-1$ to $s$, while increasing the expected pretax return to holding assets from period $s$ to $s+1$. Both effects
increase the expected pretax payoff from asset sales in period $s$ and provide a general-equilibrium offset to the expected tax on such sales. The differing effects of current and future taxes is a relevant finding, since capital-gains tax rates have varied substantially over time in the United States and other countries.

However, a complete description of the tax's impact must allow for the effect of current transactions on future basis deductions. Since these effects are sensitive to many features of the tax code and the economy, I provide an illustrative analysis for a simple economy with life-cycle trading.

III. Application

For purposes of the application, I specialize the preferences (1) by assuming that $M_{it}$ is zero for all agents in all periods and states, so that agents have constant relative risk aversion with coefficient $\gamma$. I also assume that the log of $C_{t+1}/C_t$ is independently and identically normally distributed, with mean $\mu$ and variance $\sigma^2$. A constant fraction $1-x$ of the endowment is paid as a dividend on a tradable asset, "equity". Without loss of generality, the number of shares of equity is normalized to unity. The remaining fraction $x$ is nontradable income.

I assume that each agent is a dynasty of altruistically linked individuals. Each dynasty has a single living representative in each period, with a new representative "born" and entering the economy in the period immediately after the period in which the previous representative dies. Each individual's lifespan is deterministic and equal to $N$ periods. In period one, there are $N$ cohorts of dynasties, with the age of their living representatives varying from 1 through $N$. I assume that each cohort has equal wealth. Without loss of generality, each cohort can be treated as consisting of a single dynasty. I assume that each individual receives nontradable income in the first $L < N$ periods of life. Aggregate nontradable income is divided equally among the $L$ youngest cohorts, each receiving $x/L$ of the endowment, while the $N-L$ most elderly cohorts do not receive nontradable income.

The solution of the no-tax equilibrium applies standard asset-pricing tools and is described in the Appendix. I summarize the salient features here. Three key assumptions (fixed division of the endowment between the equity dividend and each cohorts' nontradable income, isoelastic preferences, and i.i.d. consumption growth) jointly imply that trading the single equity asset completes the markets and that the price-dividend ratio is constant. They also
imply that, although the equity price fluctuates stochastically with variations in the endowment, equity holdings are
deterministic function of age. (The age of the current dynasty representative is the sole determinant of the extent
to which the dynasty's nontradable income is exposed to the economy's single risk and therefore the amount of
equity the dynasty must hold to attain the equilibrium risksharing).

As indicated by the analytical expressions in the appendix, each dynasty purchases equity when its living
representative is in the first \( L \) periods of life (and receives nontradable income) and sells equity when the living
representative is in the last \( N-L \) periods of life (and receives no nontradable income). Each infinite-lived dynasty
effectively faces alternating "working" and "retirement" periods and saves during the former to provide for the
latter. This life-cycle pattern captures a major feature of actual trading decisions, since, as noted by Haliossis and
Lyon (1994, p. 283) and other authors, capital gains are disproportionately realized by older taxpayers. If negative
bequests are precluded, the infinite-horizon maximization assumption is meaningful only for parameters for which
desired bequests are positive.

I calibrate the model by treating the length of each trading period as one year, setting \( N=55 \) and \( L=40 \). I set
\( \mu=0.025 \) and \( \sigma=0.03 \), so that the mean annual growth rate of real consumption (and the mean real annual capital gain
on equity) is 2.58 percent. I set preference parameters for which the mean real annual return on equity is 5.12
percent, so the ratio of ex-dividend price to annual dividend is 40.4 (annual dividend yield is 2.48 percent).

Each dynasty's asset-holding path in the no-tax equilibrium is shown in Figure 1. The cohorts' end-of-period
holdings range from .0094 shares for the age-55 cohort to .0289 shares for the age-40 cohort. The 40 youngest
cohorts purchase equity in each period, with purchases ranging from .0003 shares for the age-1 old cohort to .0008
shares for the age-40 cohort. The 15 oldest cohorts sell equity in each period, with sales ranging from .0011 shares
for the age-41 cohort to .0015 shares for the age-55 cohort. During each period, .0194 shares are traded and .0094
shares are inherited.

I assume that the realization tax rate is the same for all dynasties, the basis-designation rule is FIFO, and
inherited shares receive basis stepup, that basis deductions are not adjusted for inflation, and that the deterministic
annual inflation rate is 2.5 percent. Since FIFO deems shares currently held to be those from the most recent
purchase periods, their deemed purchase dates can be identified by summing purchases across the most recent
purchase periods in reverse order until cumulative purchases equals the number of shares currently held. Applying
FIFO to this trading pattern indicates that, from ages 41 through 47, individuals sell only inherited shares (which
the tax code treats as if they had been purchased in the year prior to the individual's first year of life). Individuals
sell inherited shares and shares purchased at age 1 while aged 48, shares purchased at ages 1 through 5 while aged
49, shares purchased at ages 5 through 9 while aged 50, shares purchased at ages 9 through 13 while aged 51,
shares purchased at ages 13 through 16 while aged 52, shares purchased at ages 16 through 20 while aged 53,
shares purchased at ages 20 through 23 while aged 54, and shares purchased at ages 23 through 26 while aged 55.
Some shares purchased at age 26 and all shares purchased at ages 27 through 40 are bequeathed and escape tax.
The holding period associated with the marginal share sold ranges from 29 years for the age-55 cohort to 47 years
for the age-47 and age-48 cohorts.

Equation (15) states that the asset-pricing impact of the current tax equals a weighted combination of the
marginal tax liabilities triggered by sale. Since all dynasties have equal wealth and zero subsistence parameters, $\lambda_i$
equals 1/55 for each dynasty. The marginal basis deduction for each of the 15 selling cohorts depends upon the
historical pattern of equity prices. I consider the case in which nominal equity prices rose at the mean rate of 5.14
percent in each of the preceding 41 years. The age-55 cohort then receive a basis deduction equal to 23 percent of
the sale price on its marginal share sold and face a marginal tax liability of $.77Pdr$, while the age-47 and age-48
cohorts receive a basis deduction equal to 9 percent of the sales price and face a marginal tax liability of $.91Pdr$, and
the other selling cohorts face intermediate marginal tax burdens. Multiplying the marginal tax liability of
each of the 15 selling cohorts by $1/55$ and summing yields $.235Pdr$, implying that a 1 percent realization tax rate
increases the current equity price by $.235$ percent.

In the appendix, I describe the impact of future realization taxes on the payoff. To holding equity differs for
buying and selling cohorts. In general equilibrium, prices decline to partly offset these payoff reductions. The
resulting pattern of price effects is shown in Figure 2. Note that, under these assumptions, taxes in periods 15 to
29 years in the future have no impact on the current asset price, because holding an additional share does not
trigger any tax in those periods. For comparison, I also show the price effects of an equal-rate accrual tax. It can
be seen that the price effects are much smaller than those of an accrual tax (the realization tax’s revenue yield is a quarter of the accrual tax’s revenue).

Obviously, the specific results of this application have limited applicability. It would be more realistic to assume that agents face idiosyncratic and transitory shocks to their nontradable income, so that agents would hold multiple assets and follow a richer set of trading sequences, alternating between purchases and sales.

IV. Production Economy

Since the above analysis assumes an exchange economy, it is of interest to consider the extension to a production economy. Although the exact solution of a production-economy model is quite difficult, particularly with multiple assets, some general conclusions can be stated. Under the exchange-economy assumption, I derived the asset-pricing equations (10) and (15) by imposing the condition that aggregate consumption and assets’ dividend yields are fixed. In a production economy, however, changes may occur in these quantities in addition to (or instead of) changes in prices. With production, a λ-weighted sum of (9) and (14) yields general forms of the asset-pricing equations,

\[ (10') \quad \frac{dP}{P} = \sum_{i=1}^{\infty} \lambda E \left[ \sum \lambda \frac{dP}{P} (P_i - P_{i-1}) + dD_{nx} + \gamma D_{nx} \left( \frac{dC_x}{C_i - M_x} - \frac{dC_x}{C_i - M_x} \right) \right] \forall n \]

\[ dP = \sum_{i=1}^{\infty} \lambda \left( \frac{P - \frac{dB}{B}}{B} \right) S_{nx} dr_{nx} + \]

\[ (15') \quad \sum_{i=1}^{\infty} \beta E \left[ \sum \lambda \frac{dP}{P} S_{nx} \sum \frac{dB}{B} + dD_{nx} + \gamma D_{nx} \left( \frac{dC_x}{C_i - M_x} - \frac{dC_x}{C_i - M_x} \right) \right] \forall n \]

Events that increase an asset’s price in an exchange economy will generally cause a smaller price increase in a production economy, because the price increase will be accompanied by increased production. The increased production generally reduces the current market value of the asset’s future cash flows (by increasing consumption and reducing marginal utility in the states with such cash flows) and, with declining returns, may reduce the asset’s dividend yield. This intuition is verified by earlier theoretical analyses of realization taxes in simple production economies. Auerbach (1992, p. 266), using a three-period model with one safe and one risky asset, finds that
realization taxes result in higher savings than accrual taxes, because the tax discourages asset liquidation for purposes of consumption. This quantity response is the counterpart to the price response identified in this paper.

This discussion rests, however, on an implicit assumption about how the capital-gains tax treats production, an assumption that is only partly valid for the United States. The application of the budget constraint (12) is valid only if the tax system treats investment expenditures that produce new assets identically to purchases of existing assets. In other words, agents whose investment produces a new asset and sell it must receive a basis deduction for their production costs. This is how the United States taxes investment by individuals and sole proprietors and the tax treatment of investments by partnerships and the small ("S") corporations that are taxed as pass-through entities is economically similar, since sections 705 and 1367 of the Internal Revenue Code provide partners and S shareholders a basis deduction for their pro-rata shares of the partnership's or corporation's reinvested earnings.

However, the tax treatment of reinvested earnings by corporations subject to the corporate income tax ("C" corporations) is quite different, as noted by Gravelle (1994, p. 126) and other authors. The reinvestment increases the value of the existing shares, but shareholders are not allowed a basis deduction for the reinvested amounts. Accordingly, investment is penalized by any future realization taxes that will apply to these gains. Capital gains taxes are then likely to reduce asset prices (and investment).

This analysis is consistent with empirical results, such as those of Bolster and Janjigian (1991), indicating that announcements of capital gains taxes tends to reduce corporate equity prices, with larger reductions for low-dividend stocks that have larger expected capital gains. However, my analysis suggests that different results would be found in empirical studies of asset prices in the non-corporate sector. Although assets other than corporate equity generate three-quarters of realized capital gains in the United States, Gravelle (1994, pp. 129-130), little or no empirical work has been done on how capital gains taxes affect their prices.

V. Other Extensions

My crucial methodological assumption is that all agents are at an interior optimum in all periods and all states, along the no-tax equilibrium path (and after small taxes are introduced). The marginal opportunity cost of
acquiring an asset then always equals the infinite-horizon present discounted value of its expected marginal cash flows. Several changes to the model's assumptions would negate this feature.

For example, transaction costs would induce some individuals to choose corner solutions in the no-tax equilibrium. Kiefer (1990) considers a model in which investors hold only a single stock at a time and are at corner solutions with respect to other stocks. Cook and O'Hare (1992) also consider a model in which the choice variable is how often to transact. Although transaction costs would complicate the analysis, they are unlikely to alter the qualitative properties of the solution. Englund (1986) considers a model with transaction costs, where the choice variable is how often to transact, with two-period lives and a deterministic economy, and finds that realization-based capital gains taxes generally increase asset prices.

I assumed that living individuals are altruistically linked to an infinite sequence of descendants simplifies the analysis by permitting the use of an infinite-horizon first-order condition. The qualitative results would be similar if individuals had no bequest motives, but were uncertain about the date of death. In contrast, the results would change considerably if individuals knew their date of death with certainty and had no bequest motive. The first-order conditions (5), (8), and (13) would then be replaced by first-order conditions equating the asset's marginal cost to its marginal cash flows during the individual's lifetime plus the net-of-tax proceeds from selling the asset in the period of death. Future taxes would then generally reduce the asset's aftertax payoff, due to the tax at death. However, such assumptions would yield the strongly counterfactual conclusion that appreciated assets are never bequeathed. Empirically, the inheritance of appreciated assets is an important phenomenon. Both Auerbach (1989, p. 394) and Gravelle (1994, p. 293) estimated that half of all accrued gains ultimately escape taxation due to basis-stepup at death, while Kiefer (1990, p. 81), making a different comparison, estimated that the value of gains receiving basis-stepup in a typical year equals 30 percent of the value of the gains accruing during the year.

Similarly, future capital-gains taxes would be likely to reduce current asset prices, if unrealized gains on inherited assets are taxed at the time of death, as in Canada and some other countries. Of course, the taxation of unrealized gains at death constitutes a partial move to accrual taxation, so it is unsurprising that the asset-price effects would be similar to pure accrual taxes.
I assume that realization taxes cannot be avoided through strategies that do not require real changes in the allocation of consumption across periods and states of the world. As Stiglitz (1983, pp. 259-271) and Constantinides (1983, pp. 623-626) demonstrated, with perfect capital markets and a stylized tax code, utility-maximizing agents can use borrowing and short sales against the box to completely avoid capital gains taxes and obtain interest and capital-loss deductions offsetting taxes on their other income. In a short sale against the box, an investor, before selling shares of a security, borrows shares of the same security from her broker or another investor and uses specific-identification to designate the borrowed shares as the ones sold, avoiding tax until she closes the transaction by selling her own shares and delivering them to the lender as repayment for the borrowed shares. Similarly, if redundant assets exist, an individual can avoid tax on an appreciated asset by selling another asset with the same risk properties, but different tax basis. As Dammon and Spatt (1996, pp. 910, 928 n.10) noted, basis values have no impact on asset values in the extreme case in which all assets subject to capital gains tax have identical tax-exempt counterparts. Costless avoidance of capital gains tax requires the use of identical assets, but near-costless avoidance can be achieved with almost-identical assets, by writing deep-in-the-money calls, purchasing deep-in-the-money puts, or entering into equity-swap transactions, as described by Henriques and Norris (1996).

These strategies are generally permitted in the United States10 and have recently been used by some wealthy investors, as discussed by Kleinbard and Nijenhuis (1995), Bray (1996), and Henriques and Norris (1996). However, as noted by Stiglitz (1983), Poterba (1987, pp. 165-169), Balcer and Judd (1987, pp. 745-746), Auerbach (1989, p. 395), Kiefer (1990, p. 92 n.13), Haliassos and Lyon (1994, p. 283), and Mariger (1995, p. 448), most taxpayers do not exploit these strategies. Dammon and Spatt (1996, p. 948) similarly comment, "What is puzzling about investors' observed trading behavior is the relative infrequency of capital loss realizations." In 1994, individual taxpayers realized $142 billion of capital gains, net of capital losses, U.S. Internal Revenue Service

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10 On January 6, 1996, President Clinton proposed that short sales against the box, equity swaps, issuance of deep-in-the-money calls, and purchases of deep-in-the-money puts be taxed as "constructive sales" under a new section 1259 of the Internal Revenue Code. The President also included this proposal in his fiscal 1997 budget plan on March 21, 1996 and his fiscal 1998 budget plan on February 6, 1997, but it has not been adopted by Congress.
(1996, p. 179). Stiglitz concluded (pp. 258, 273) that capital market imperfections, such as transaction costs, prevent widespread use of these tax-avoidance strategies.\footnote{However, the use of these strategies is increasing, as discussed by Henriques and Norris (1996). Similarly, O'Connell (1997) noted that more than 12 "tax-managed" stock mutual funds existed in January 1997, up from about six in October 1996.}

I have abstracted from several features of the actual tax systems, such as rate differentials between long-term and short-term capital gains. Constantinides (1984) and Bossaerts and Dammon (1994) also discussed tax-avoidance strategies which exploit this differential. I have also ignored possibilities for transforming ordinary income into capital gains, as through the dividend-payment and capital-structure decisions considered by Balcer and Judd (1987). I also precluded wash sales; incorporating them in this model would add terms reflecting the savings from the resulting deductions, but would not otherwise affect the analysis since wash sales do not have real portfolio effects. The inclusion of short sales would pose more complex issues. Under section 1233 of the Internal Revenue Code, short sales are not taxed until repayment of the borrowed shares, implying that taxes are triggered when the individual purchases additional shares. Given the small volume of short sales, I disregard these issues.

Allowing incomplete markets or more general preferences would negate the aggregation results employed in the analysis. It would not be possible to take a weighted combination of the relevant Euler equations with the fixed weights given by $\lambda_i$, because the appropriate weights would be time-varying, stochastic, and endogenous. The introduction of a tax could itself induce a first-order change in the weights. With incomplete markets, the choice between accrual and realization taxes also has implications for risk-sharing, as in Haliassos and Lyon (1994). Without the aggregation conditions, however, it would be much harder to obtain a simple asset-pricing result, even for accrual taxes.

V. Conclusion

In this paper, I demonstrate that accrual and realization taxes on capital gains have dramatically different asset-pricing effects and incidence. The taxes are different because they imply different marginal effects on agents' payoffs. While asset prices decline in response to anticipated accrual taxes and are unaffected by current accrual
taxes, they rise in response to current realization taxes. While the incidence of accrual taxes falls upon those who hold the assets at the time the tax is announced, the incidence of realization taxes is largely divided between the buyers and sellers of the asset at the time the tax is levied, with each group's burden determined by an inverse-elasticity formula similar to the traditional public-finance analysis of excise tax incidence. The effects of anticipated realization taxes depend on agents' trading sequences and subtle aspects of tax rules.

One direction for further research is a welfare comparison of different designs of realization-based taxes. The model economy of section III and modifications thereof could be used to explore the degree of exchange inefficiency under different treatments of inherited assets and different basis-designation rules. It would also be possible to perform empirical tests of the model. For the reasons discussed in section IV, these tests should be done for non-corporate assets.

Since the effects of realization-based capital gains taxes are sensitive to the specification of the economic environment and tax rules, further theoretical and empirical research is necessary to clarify the impact of actual realization taxes. Nevertheless, my results cast serious doubt on the practice of assuming that realization and accrual taxes have fundamentally similar economic properties.
References


U.S. Internal Revenue Service, *Statistics of Income*, 16(2), Fall 1996
Life-Cycle Trading Sequence

Normalize the current-period endowment to unity. Then, the end-of-current-period wealth of the economy, i.e., the current-period present discounted value of the endowments in all subsequent periods is \( p \), the ratio of the (ex-dividend) price to the dividend. Let \( R \) denote the expected (gross-of-principal) return on equity and \( G \) denote the expected (gross-of-principal) capital gain. By construction, \( p = G/(R-G) \). The market value of equity is \((1-x)p\) and the aggregate nontradable wealth of the dynasties equal to \( xp \). Each of the cohorts aged 1 to \( L \) in the current period received nontradable income equal to \( x/L \).

For each infinite-lived dynasty, calculate its end-of-current-period nontradable wealth, i.e., the current-period present discounted value of the nontradable income that it will receive in future periods. With the endowment distributed lognormally, the expected growth rate of the endowment and of nontradable income \( G \) is \( \exp(\mu + (\sigma^2/2)) \), which is 1.0258 for \( \mu \) equal to .025 and \( \sigma \) equal to .03. The appropriate risk-adjusted discount rate for nontradable income is simply the required return on equity \( R \) (since the equity dividend and nontradable income are perfectly correlated). Therefore, each dynasty’s nontradable wealth is simply the summation of a geometric sequence with growth rate \( G/R \), omitting all terms for periods in which the dynasty representative is aged \( L+1 \) through \( N \). For the cohort aged \( i \) in the current period, nontradable wealth equals

\[
\frac{G}{R} \left[ 1 + \frac{G^N - G^{i+1}}{R^N - G^N} \left( \frac{R}{G} \right)^i \right], \quad i = 1..L \quad \text{and} \quad \frac{G}{R} \left[ 1 + \frac{G^N - G^{i}}{R^N - G^N} \left( \frac{R}{G} \right)^i \right], \quad i = L+1..N.
\]

Each cohort has equal total wealth of \( p/N \), or \( G/[(R-G)N] \), so the number of equity shares held by each cohort at the end of the period equals \( G/[(R-G)N] \) minus its end-of-current-period nontradable wealth, divided by the ex-dividend equity price \((1-x)G/[(R-G)N] \). The end-of-period equity holdings of the cohort aged \( i \) in the current period are

\[
\frac{1}{N(1-x)} + \frac{x}{(1-x)L} \left[ \frac{G^{N+1} R^{-i} - G^N}{R^N - G^N} \left( \frac{R}{G} \right)^i \right], \quad i = 1..L \quad \text{and} \quad \frac{1}{N(1-x)} + \frac{x}{(1-x)L} \left[ \frac{G^{N+1} R^{-i} - G^N}{R^N - G^N} \left( \frac{R}{G} \right)^i \right], \quad i = L+1..N. \]

It can be verified that aggregate equity holdings are unity and that holdings rise monotonically from 1 to \( L \) and fall monotonically from \( L+1 \) to \( N \). Also, calculating
each dynasty's consumption in each period, which is its nontradable income plus its equity dividends plus its proceeds from equity sales (or minus the cost of its equity purchases) verifies that each cohort has consumption equal to 1/$N$ of the endowment. Note that the age-$N$ holdings are the shares bequeathed each period.

Preferences and Rates of Return

Although safe assets (of any duration) are not traded in the no-tax equilibrium, it is necessary to calculate the shadow risk-free rate to evaluate some of the future tax effects. (Although I do not explicitly calculate the changes in trading patterns in response to the tax, it should be noted that agents will begin to trade safe assets of varying maturities in response to the tax, as they hedge their tax liabilities.)

As is well-known, the calibration of realistic values for equity returns, the risk-free rate, and the mean and variance of consumption growth requires extremely high risk aversion and a time-discount factor $\beta$ substantially greater than unity (negative pure time preference). Since this paper is not intended to resolve the long-standing equity-premium puzzle, I assume $\gamma$ equal to 40 and a time-discount factor that will yield a shadow safe rate of 1.4 percent, $F=1.014$. (With i.i.d. consumption growth and isoelastic utility, the term structure is flat and safe rates at all maturities are identical). Set $\pi=1.025$, so that (deterministic) annual inflation is 2.5 percent, yielding $F\pi=1.03935$, a safe nominal annual interest rate of 3.935 percent. With lognormally distributed consumption growth, the mean (gross-of-principal) return on equity $R$ equals $F \exp(\gamma \sigma^2)$, which is 1.0711 with $\sigma$ equal to .03.

Some changes in future basis deductions involve deductions for shares purchased prior to the current period. In this case, the present value of the change in deductions equals the known nominal change in deductions discounted back to the current period at the safe nominal interest rate. Other changes involve deductions of the stochastic (future) purchase price. The period-zero present value of a deduction in period $b$ equal to the stochastic nominal period-$a$ equity price, where $b\geq a\geq 0$ is $\left(\frac{R}{G}\right)^{\gamma \sigma^2} (F\pi)^{\gamma \sigma^2}$.  

FIFO Basis Effects

For buying cohorts, purchasing an additional share has no tax effect on the basis deductions associated with future sales until all previously purchased shares are deemed sold. A sequence of cascading effects arises thereafter. For illustrative purposes, consider the age-19 cohort. The purchase of an additional share has no
effects until age 34 years in the future, when the cohort will be age 53. In that period, the cohort will claim a basis
deduction for one more share purchased in the current period and one less share purchased at age 20, one year in
the future. The following year, the cohort receives a basis deduction for one more share purchased at age 20 and
one less share purchased at age 23. The following year, at age 55, the cohort receives a basis deduction for one
more share purchased at age 23 and one less share purchased at age 26. In each case, the cohort receives a
deduction of lower expected value, since an earlier purchase is displacing a later purchase. Therefore, the
realization taxes anticipated 34, 35, and 36 years in the future reduce this cohort's expected net payoff from equity.
The future-tax effects for the other 39 buying cohorts can be calculated in the same manner.

For the selling cohorts, the sale of one less share in the current period also changes basis deductions for
subsequent sales. For illustrative purposes, consider the age-49 cohort. The sale of one less share in the current
period removes the tax liability associated with one share purchased at age 5. In the following period, the cohort
receives a basis deduction for an additional share purchased at age 5 and one less share purchased at age 9.
Similarly, an age-9 purchase displaces an age-13 purchase at age 51, an age-13 purchase displaces an age-16
purchase at age 52, an age-16 purchase displaces an age-20 purchase at age 53, an age-20 purchase displaces an
age-23 purchase at age 54, and an age-23 purchase displaces an age-26 purchase at age 55. For sellers, the change
in these deductions can be calculated from historical equity prices. If nominal equity prices have steadily risen,
basis deductions are reduced. In the period after age 55, the cohort's descendants receive an additional inherited
share, creating a sequence of basis effects when they reach age 47, as described above. For this cohort, any
realization taxes anticipated during the next 6 years, and those anticipated 53 and more years in the future reduce
net equity payoffs. Similar effects can be calculated for the other 14 selling cohorts.

 Effects also occur for each living cohorts' descendants. For either current buyers or sellers, purchasing a
share in the current period and holding it causes the cohort's descendant to inherit an additional share, which will
induce a sequence of basis changes, beginning when the descendant reaches age 47 and receives a basis deduction
for one more inherited share and one less share purchased at age 1, and continuing throughout their subsequent
selling periods. This process is repeated for each subsequent generation.