Taxing Cap-and-Trade Environmental Regulation

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ABSTRACT

This paper examines the extent to which income taxation interferes with cap-and-trade environmental regulation and reaches two conclusions. First, within a single tax period, imposing an income tax will not undermine the cost-effectiveness of cap-and-trade regulation. Second, taxes may distort cost-effective allocation of permits and abatement through time when the permit market is dominated by permit owners with a tax basis of zero.

1. INTRODUCTION

In cap-and-trade environmental regulation, firms receive a fixed number of tradable permits to pollute. Each firm can either use or sell its permits. Over 3 decades ago, environmental economists showed that cap-and-trade regulation is more cost-effective than conventional command-and-control regulation in which the regulator specifies steps regulated firms must take to control pollution (the seminal paper is Montgomery 1972; see also Tietenberg 1985, chap. 2).[1] Although a voluminous and sophisticated literature addresses many aspects of cap-and-trade regulation, a critical question has not received significant attention to date: does the income tax interfere with the cost-effectiveness of cap-and-trade regulation? I analyze this question and reach two main conclusions.

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1. The conclusion that cap-and-trade regulation is economically efficient is not without its critics (see, for example, Cole and Grossman 1999).

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First, within a given time period, the income tax will not distort firms' incentives at the margin between using and selling permits. Second, the income tax can interfere with cost-effective allocation of permit use and, hence, pollution abatement over time. An income tax may distort decisions regarding whether and to what extent firms save permits for future use, a practice known as permit banking. Cost-effective intertemporal allocation occurs when permit use and abatement are scheduled to occur at the lowest present value cost to society. Firms, however, can be expected to minimize their private present value cost of abatement (including any tax cost), which can diverge from the least-cost solution for society. The circumstances that cause the tax system to interfere with a cost-effective intertemporal allocation of permit use and abatement exist under current law.

It is necessary at the outset to be more precise about the type of cap-and-trade regulation I will consider. I will assume the use of an undifferentiated discharge permit system, that is, a system in which each permit conveys an identical entitlement to every potential owner. This type of cap-and-trade regulation is appropriate for uniformly mixed pollution, such as greenhouse gases.[2]

I will also assume that the cap-and-trade regulation allows permit holders to emit a certain quantity of pollution, rather than a certain quantity per period (for example, tons rather than tons per year) and allows permit banking. A system with these features is appropriate if the pollution in question is accumulative rather than assimilative (Tietenberg 1985, p. 29).[3]

I proceed as follows. Section 2 explains why cap-and-trade regulation is thought to be cost-effective and why, in an efficient permit market, the cost of a permit will equal the marginal cost of abatement. Section 3 first describes the income tax rules that affect permit holders' choices

2. In contrast, the theoretically correct policy tool for nonuniformly mixed pollutants—known as an ambient permit system—involves permits that convey rights that vary depending on the environmental quality in the geographical area where the permit owner will emit, so trades among firms in different locations cause the pollution cap to fluctuate (Tietenberg 1985, pp. 16–30). The 1990 Clean Air Act Amendments, which established a permit-trading system for sulfur dioxide, the most significant such program now in place, effectively treat sulfur dioxide as though it is uniformly mixed, even though it is not. Tietenberg (1985, chap. 4) and Stavins (1998, p. 69) both note the theoretical advantages of an ambient system for nonuniformly mixed pollutants but conclude that ambient systems are unlikely to be adopted given their inherent complexity.

3. Accumulative pollutants (such as greenhouse gasses) are emitted faster than they can be absorbed by the environment. The opposite is true for assimilative pollutants, so the pollution level in each year is independent of that in all other years.

regarding whether to buy, sell, or use permits, then demonstrates that income taxation does not interfere with cost-effective permit allocation within a given tax period, and finally explains why the income tax does interfere with intertemporal allocation of permit use and abatement in certain circumstances. Section 4 concludes.

2. CONTROLLING SPILLOVERS WITH TRADABLE PERMITS

Cap-and-trade regulation is considered to be a more cost-effective solution for controlling the quantity of pollution than is command-and-control regulation because regulators do not know (and cannot determine without unreasonable expense) the marginal cost to each regulated firm of reducing pollution. Without this information, it is impossible for regulators to allocate pollution control responsibility among polluters at the lowest overall cost (Breyer 1982, pp. 171–74, 236–84).

Cap-and-trade regulation, in contrast, requires that regulators specify only the maximum quantity of pollution that all regulated firms may emit. Having determined this maximum quantity, or cap, the regulator then issues permits allowing their owners to emit some fraction of the cap. Regardless of how the regulator initially allocates these permits among firms, trading in permits will reduce pollution to the cap at the least total cost to society.

To illustrate, consider Figure 1, which assumes that there are only two sources of pollution, firm 1 and firm 2.[4] If neither firm were required to limit their pollution output, each firm would emit 15 units of pollution, and abatement costs would be zero. Suppose, however, the regulator determines that the combined emissions from the two firms should be cut in half, so that together the two firms must reduce emissions by 15 units. Firm 1's marginal abatement cost rises along curve m_1 up and to the right as it reduces emissions. Firm 2's marginal abatement cost rises up and to the left along curve m_2 as it reduces emissions. Every point on the horizontal axis represents a different allocation of pollution control responsibility between the firms.

If the goal is to reduce emissions at the lowest overall cost, firm 1 should reduce its emissions by 10 units and firm 2 should reduce its emissions by 5 units. The total cost of pollution control given this allocation will be the area A + B + C, where area A + B is the control

4. This illustration, including Figure 1 and the description thereof, draws on Tietenberg (1985, pp. 20–22).

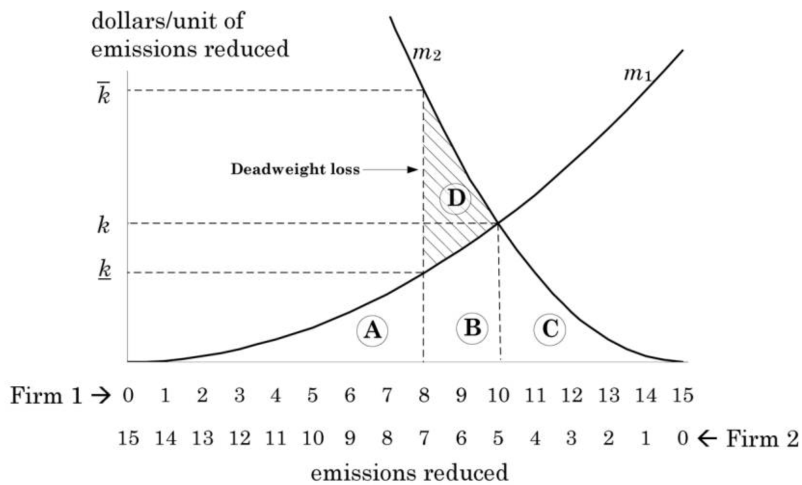

Figure 1. Cap-and-trade regulation is cost-effective

cost for firm 1, and area C is the control cost for firm 2. It would, therefore, be in both firms' best interests to exchange permits until firm 1 holds 5 permits and firm 2 holds the other 10 permits.

To illustrate further, suppose that the government allocates 7 permits to firm 1 and 8 permits to firm 2. Given this initial allocation, before any trading takes place, firm 1 must reduce its pollution output by 8 units and firm 2 must reduce its pollution output by 7 units.[5] From this starting point, a sale by firm 1 to firm 2 will leave both better off. If firm 2 is required to reduce pollution by 7 units (as would be the case if it has only 8 permits), its marginal cost of reducing emissions ($\overline{k}$) would be higher than firm 1's marginal cost ($\underline{k}$). Thus, firm 1 could profitably reduce its emissions by more than 8 units and sell its excess permits to firm 2. Firm 2 would be better off financially by paying for the right to pollute, as opposed to bearing its marginal cost of abatement. As long as firm 2's marginal cost of abatement exceeds firm 1's marginal cost of abatement, trading will be profitable for both. Trading will stop when the firms' marginal costs equalize at k.

5. If the firms do not trade permits, so that firm 1 and firm 2 reduce emissions in accordance with the initial permit allocation, the total cost will be area A + B + C + D. Area D represents the deadweight loss that results from a suboptimal allocation of pollution control responsibility between the two firms.

This example illustrates why cap-and-trade regulation is likely to produce the least-cost allocation of abatement responsibility (for a proof, see Montgomery 1972; Tietenberg 1985, pp. 17–18). A cost-effective outcome is (1) likely even if the government cannot accurately assess firms' relative costs of pollution control, provided that the firms themselves can assess accurately whether it is cheaper either to buy permits or to reduce emissions, and (2) independent of how the regulator initially distributes permits among firms, given the propensity of firms to trade in permits until their marginal costs equalize (Coase 1960). This example also illustrates that in an efficient market, the cost of a permit will equal the marginal cost of abatement. This equality plays an important role in the analysis that follows.

3. THE EFFECTS OF INCOME TAXATION

I begin with a summary of the doctrinal tax rules that apply to permit trades, then describe the within-period effects of applying these rules to permit trades, and finally turn to their intertemporal effects.

3.1. Tax Rules

Two features of the U.S. income tax system influence firms' incentives regarding the sale and use of permits: the tax imposed on the sale of permits and the cost-recovery deductions allowed when permits are used. The tax imposed on the sale is a percentage of the seller's gain. Gain is the excess of the sales proceeds over the seller's tax basis. The cost recovery deduction allowed on the use is equal to the user's tax basis. Thus, both the taxes on the sale and the tax deductions on the use are a function of tax basis.

Tax basis equals cost (I.R.C., sec. 1012). A permit holder's tax basis for its permits depends on two factors: how the permit is acquired and, if the permit is acquired free from the regulator (known as gratis allocation), whether the gratis receipt of permits is considered taxable income. There are three permutations. (1) If permits are purchased—either from the regulator (at auction or otherwise) or on the market—then the purchaser's tax basis equals its cost, and the effect of the tax rules on permits is essentially the same as that for all other assets. (2) If permits are allocated gratis and the recipient is taxed on the value of the permits received, then cost for the purposes of establishing tax basis equals the amount of income reported (Bittker and Lokken 2000, para. 41.2.5).

Again, in this case, the effect of the tax rules on permits is essentially the same as that for all other assets. (3) If, however, receipt of a gratis allocation is not considered taxable income, then cost and, hence, tax basis equal zero.[6]

The zero tax basis that follows nontaxable gratis receipt (case 3) has two implications, both of which are important in the analysis that follows. First, if the recipient chooses to sell, the firm will be taxed on the full amount of its sales proceeds with no tax basis offset. Second, if the recipient chooses to bank its permit for future use or sale, the usual effect of inflation on the time value of cost recovery deductions—specifically, degradation that increases with both time and the rate of discount—does not occur since the tax basis begins at zero and must always be nonnegative.

Case 3 describes how the tax law and environmental law currently interact. The Internal Revenue Service has ruled that the gratis receipt of permits is nontaxable (Revenue Ruling 92–16, 1992–1 C.B. 15). And "the federal government has distributed allowances for free in [all of] the environmental trading programs that it has implemented thus far, including ones to reduce the lead content of gasoline, phase out the use of ozone-depleting chemicals, and limit sulfur dioxide (SO_2) emissions in order to reduce acid rain" (Dinan and Rogers 2002, p. 201; see also Stavins 2003, p. 418).

3.2. Within-Period Tax Effects

Within a given tax year, firms will be indifferent toward the sale or use of permits, and, hence, arbitrage profits will be impossible, provided the marginal cost of permits for all firms in that year (m) equal one another and are equal to the market price of the permits (k) before tax.

Consider first the case of a firm that is deciding whether to use or sell a permit. If the firm uses the permit, the firm will not have to abate with respect to pollution covered by the permit. It will have an after-tax return equal to its avoided after-tax marginal cost of abatement plus basis recovery for the permit used less the opportunity cost of not selling its permit, or

$$m(1-t) + bt - k(1-t), \tag{1}$$

where t is the firm's marginal tax rate and b is the tax basis. If, instead,

6. A trivial permit basis (which I ignore) may result given the requirement that firms capitalize certain transaction costs relating to permit allocations, such as legal fees.

the firm sells its permit, it will have an after-tax return equal to the gross sale proceeds less the tax plus the value of basis recovery on sale less its after-tax cost of abatement, or

$$m(1-t)+bt-m(1-t). \qquad (2)$$

In equilibrium ($m = k$), expressions (1) and (2) both reduce to bt, and this result indicates that the after-tax return to the firm holding a permit (including opportunity costs) is the value of the firm's tax basis regardless of whether the firm uses or sells its permit.[7]

To illustrate, suppose a firm owns a permit worth \$100, which is the abatement cost that can be avoided by using the permit. Consider the choice between use and sale. Use obviates a \$100 cost and generates a deduction equal to the tax basis. For instance, if the firm's tax basis equals \$70, the firm would get a \$70 deduction. A sale, however, generates \$100 of proceeds that are offset by \$100 of abatement costs. The abatement deduction of \$100 is partially offset by a gain of \$30, for a net deduction of \$70. Use and sale thus produce the same after-tax outcome.

The result above holds regardless of the firm's tax basis for the permit. If the basis is \$100, use generates no cash and a \$100 cost recovery deduction; sale generates no net cash (sale proceeds fund abatement) and an abatement deduction of \$100. If the basis is \$0, use generates no cash and no cost recovery deduction; sale generates no net cash (here again, sale proceeds fund abatement), and gains would completely offset the abatement deduction.

For potential buyers—firms without (or with an insufficient number of) permits—things are slightly different analytically, but the conclusion is the same. If such a firm buys a permit, the cost gives rise to a deductible basis in the purchased permit. But the permit costs are in lieu of tax-deductible abatement costs. Thus, the cost recovery deduction allowed on the use of a purchased permit is not an added benefit to the buyer; rather, it is a substitute for the deduction the firm would have enjoyed even if it had not purchased the permit. Because a potential buyer will enjoy a tax deduction regardless of whether it purchases a permit, the tax deduction will not influence the choice between buying permits and abating.

7. If $m \neq k$, then arbitrage profits are possible. For instance, if $m > k$, then permit use dominates abatement by $(m-k)(1-t)$ for both permit holders and potential buyers. Prices will rise until the arbitrage is competed away. If $k > m$, the opposite is true.

This result is not surprising. As is well known, a pure, perfectly imposed income tax affects decisions to work and to save but not the choice between assets. Since the choice between buying permits and abating does not implicate work or savings decisions, income taxation does not distort the choice between the two alternatives.

Of course, in practice income taxation is imperfect. An implicit, simplifying assumption thus far has been that abatement generates deductions that are allowed in the current period. This is true for certain types of abatement costs such as the incremental cost to a coal-fired power plant of purchasing (more expensive, less toxic) low-sulfur coal rather than (cheaper, more toxic) high-sulfur coal. This expense may be deducted when incurred, just as the cost of a permit that is bought and used in the current period may be deducted when incurred. Not all abatement costs fit this pattern, however, and when the pattern is broken, things become more complicated.

Many abatement costs are capital expenditures that add to the taxpayer's basis in depreciable property. Under the current U.S. tax law, tax depreciation rules applicable to such property do not match true economic depreciation, defined as periodic change in value (Samuelson 1964). In most cases, the applicable depreciation rules are favorable to the taxpayer, providing some combination of an uneconomically short recovery period and an uneconomically fast schedule of deductions within that period. The consequence is to reduce the effective tax rate applicable to pollution control equipment vis-à-vis other assets (such as permits) that are not eligible for this tax benefit. Doing this, in turn, will trigger overinvestment in tax-preferred pollution control equipment when other options (low-sulfur coal in my example) would improve cost-effectiveness.

Note that interasset distortions of this type are not caused by the taxation of pollution permits. Even in the absence of cap-and-trade regulation, firms would enjoy a tax benefit by substituting high-sulfur coal for low-sulfur coal and investing the cost savings in pollution control equipment eligible for accelerated depreciation. Although cap-and-trade regulation is not the source of interasset distortions of this type, cap-and-trade regulation does nothing to alleviate such distortions.[8]

8. Sansing and Strauss (1998) model the interasset distortions caused by uneconomically rapid amortization of pollution control equipment.

3.3. Intertemporal Tax Effects

Not surprisingly, the dynamic case is far more complex. When permit banking is allowed, firms no longer simply choose between current use and sale; firms must also consider use or sale in the future as competing alternatives.[9] Likewise, polluters with insufficient permits must consider whether it is desirable to buy permits on the market for either current or future use (or both) or it is better to wait and purchase permits in the future. Taxes can distort choices along all of these margins and interfere with cost-effective environmental regulation.

The rate of return earned by firms that bank permits will depend on permit holders' tax bases. For holders with a zero basis in their permits—that is, for holders who received gratis allocations and excluded from income the value of the permits received—appreciation in the value of permits over time is effectively tax exempt. If most permit holders have zero bases, permit prices will rise so that the tax exemption is capitalized into the price of permits. Tax rules will warp the relative costs of abatement in present and future periods, causing the present cost of abatement to increase relative to future costs. In contrast, if permit holders' bases equal the acquisition date value, then permits are treated like all other assets, and cost-effective allocation through time will not be seriously affected.[10]

To understand the reason for these effects, consider a simple two-period model in which a firm owns a permit and can choose to use it in the current period or bank it for use in the next period. Assume that before-tax permit prices are equal to before-tax marginal abatement costs in both periods (in period 0, $k_0 = m_0$, and in period 1, $k_1 = m_1$).[11] At time 0, a permit is worth

$$k_0(1 - t) + bt \tag{3}$$

9. Significant banking occurs in practice. For example, as of March 2004, firms had yet to use 42 percent of all sulfur dioxide permits issued between 1995 and 2003, likely as a response to scheduled decreases in the cap (and, hence, permit allocations) set to occur in 2010 (Environmental Protection Agency 2004, p. 7).

10. My conclusions in this section are generally consistent with the view of some who have considered this question. For example, Sansing and Strauss (1998, pp. 56–57), Auten, Brashares, and Frisch (2000), and Fisher, Kerr, and Toman (1998, pp. 457–61) suggest there will be intertemporal distortions attributable to the lock-in effect, as is discussed later. My conclusions are inconsistent with the view of others. Parker and Kiefer (1993) and Gehring and Streck (2005) both conclude that the U.S. tax treatment of permits does not meaningfully interfere with cost-effectiveness.

11. Given the within-period equality of prices and costs, the firm can use its permit

to the holder. At time 1, a permit is worth

$$k_1(1 - t) + bt \tag{4}$$

to the holder. If the holder banks the permit, the after-tax return will equal the ratio of equation (4) to equation (3). If the holder's basis is zero, the after-tax return equals k_1/k_0. If, however, the holder's basis is equal to the time 0 value of the permit, then the return equals

$$k_1(1 - t)/k_0 + t. \tag{5}$$

The difference between the return to a zero-basis holder and the return to a cost-basis holder is thus

$$k_1/k_0 - [k_1(1 - t)/k_0 + t] = (k_1/k_0 - 1)t, \tag{6}$$

which is the tax on the yield between periods. Thus, for zero-basis permit holders, returns on permits are effectively tax exempt, but for cost-basis holders, returns are reduced by tax.

The tax exemption will induce zero-basis holders to bank permits. If the permit market is dominated by zero-basis holders, this situation will drive down the number of permits offered for sale and, thus, increase the price until permits are expected to rise in value at the after-tax rate of return on comparable investments.

There are a variety of ways to explain the result that the presence or absence of a tax preference, and, hence, the required rate of return to holding permits, turns on the holder's tax basis. Perhaps the simplest is by an analogy to the theorem that expensing is the present value equivalent of a yield exemption (Brown 1948). Excluding gratis receipt of permits from income is conceptually identical to including receipt in income and granting the recipient an expensing deduction for the permit's value, since the income and the deduction would be equal and offsetting.[12] If income exclusion is tantamount to expensing and ex-

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in either period by emitting the allowed amount of pollution or by selling the permit; the after-tax outcome will be the same in both alternatives, as is demonstrated in Section 3.2.

12. To see the identity between income exclusion and inclusion coupled with an expensing deduction, imagine that the regulator gives the taxpayer the cash value of the permit and requires the taxpayer to purchase a permit, instead of simply giving the taxpayer a permit. The taxpayer winds up with a zero tax basis in the permit regardless of whether (1) the cash transfer is excluded from income and the purchase transaction is ignored for tax purposes or (2) the cash is included in income and the taxpayer is allowed to expense the cost of the permit.

pensing is equivalent to a yield exemption, then exclusion is also equivalent to a yield exemption.[13]

To illustrate, suppose that two firms, one with a zero basis and the other with a cost basis, bank permits. Assume that the return on banking permits is equivalent to the after-tax return on other investments (including negative investments such as borrowing). The income tax exclusion saves the zero-basis holder k_0t dollars at time 0, which is equivalent to k_1t dollars at time 1 when inflated at the rate of return on permits (assumed to be the market rate). Basis recovery for the cost-basis holder also saves k_0t dollars but not until time 1, which is equivalent to a savings of $(k_0/k_1)k_0t$ dollars at time 0, again discounting at the market rate. The zero-basis holder's expensing deduction is therefore worth k_1/k_0 times the cost-basis holder's deduction regardless of whether the comparison reckons time 0 or time 1 values. After both firms use their permits in year 1, the zero-basis holder will be better off by an amount equal to tax on the permit's yield, $(k_1/k_0 - 1)t$, as is given in equation (6).[14]

To make this point concrete, imagine that in year 0 the regulator grants a permit with a fair-market value of $100 to one firm that is required to include the value of the permit in income and is allowed a cost recovery deduction in the year the permit is used or sold. The regulator also gives a permit to another firm that is allowed to exclude the permit's value from income (or, equivalently, is required to include the value in income but also is allowed to expense the permit's value). Assume that (1) both firms bank their permits and use them in year 1, when the (before-tax) marginal cost of abatement is $110, (2) the 10 percent increase in abatement costs is equivalent to the after-tax market rate of return, and (3) both taxpayers face a 30 percent marginal tax rate. The results of this example are given in Table 1.

Table 1 shows that the absence of a time-value adjustment for the deducting firm's cost recovery allowance increases the time 1 value of

13. The expensing-yield exemption equivalency depends on constant tax rates over time. Both rate graduation and rate changes between periods can undermine the equivalency (Weisbach 2006, pp. 5–8).

14. In this simple example, the treatment of the cost-basis holder accords with that in an ideal accretion income tax system under which cost recovery deductions (which might be negative) are allowed year by year as the value of the property declines (or rises). Such a tax system has no allocative effects because it does not alter relative asset prices (Samuelson 1964). If the model is extended to encompass more than two periods, however, the tax treatment of the cost-basis holder departs from the accretion ideal, and some allocative effects would result, as is described below.

Table 1. Expensing Is Equivalent to Yield Exemption

	Expensing Firm		Deducting Firm	
	Potential Value	Actual Value	Potential Value	Actual Value
Year 0:				
After-tax abatement savings	70	0	70	0
Cost recovery value	30	30	30	0
Year 0 net	100	30	100	0
Year 1:				
After-tax abatement savings		77		77
Cost recovery value		0		30
Year 1 value of year 0 net		33		0
Year 1 net		110		107
Yield (%)		10		7

the deducting firm's tax burden by $3, compared with that for the expensing firm, which is equivalent to a drop in the after-tax yield by the rate of tax. The absence of a time-value adjustment to the tax basis distinguishes tax systems that burden capital income from those that do not (Bradford 1998).[15]

The example suggests that if a zero-basis holder has title to permits and wishes to sell them to another firm for future use, the firms should enter into a forward contract for settlement in the year the buyer intends to use the permits. The tax exemption is available only to the firm that, for whatever reason (most commonly gratis receipt), has a zero basis. When a firm purchases in one period for use in a later period, any appreciation between purchase and use will be subject to tax because that buyer will take a cost basis. A forward contract allows the zero-basis holder to retain title and perpetuate the tax exemption. The forward market thus reduces a tax impediment to trade among firms, which would otherwise interfere with the efficient functioning of the permit

15. The analysis and example in the text abstract from risk by positing a single market rate of return. When risk is considered, the advantage to the expensing firm is the market rate of return on safe investments. It is appropriate to use a riskless discount rate when assessing the time value of cost recovery deductions because the taxpayer will enjoy the benefit of the deductions in all circumstances (in a tax system with full loss offsets, a cost recovery deduction has the same credit quality as a government bond). This reasoning accords with the view that the difference between income and consumption taxation is equal to the burden on the riskless rate of return (see, for example, Weisbach 2004; Kaplow 1994).

market. There is some evidence that this situation is in fact occurring in the permit-trading market.[16]

A second explanation for the tax preference for zero-basis holders, and the concomitant rise in prices that is likely if they dominate the market, is lock in. Lock in arises when the permit basis is less than the fair-market value (so there is an unrealized gain). In this situation, sale and reinvestment is tax disadvantaged compared with banking because banking defers (without interest) the tax on sale. Forsaking the tax deferral makes sense only if the return on whatever replacement asset would be purchased with the permit sale proceeds is high enough to compensate for the lost benefit. (When there is an unrealized loss, the opposite is true, so this circumstance is sometimes described as a negative lock in, connoting a tax inducement to sale.)

In the context of the two-period model, the expected after-tax return to the holder is given in equation (4). The value of sale (or use) at time 0, in contrast, is given in equation (3); if the sale proceeds (or cost savings) from a permit sale (use) at time 0 are invested until time 1 in another (taxable) asset, the year 1 after-tax value of that other asset will be

$$[k_0(1 - t) + bt][1 + x(1 - t)], \tag{7}$$

where x is the (before-tax) rate of return on the other asset, that is, the return to the reinvested permit sale proceeds between time 0 and time 1. The relevant question in assessing the importance of lock in is how the return to holding permits from time 0 to time 1 compares with liquidating a permit at time 0 and reinvesting. To determine this, set expressions (4) and (7) to be equal and solve for x:

$$x = (k_1 - k_0)/[k_0(1 - t) + bt]. \tag{8}$$

The two cases worth considering are the zero-basis holder and the cost-basis holder. First, for the zero-basis holder ($b = 0$), equation (8) reduces to $x(1 - t) = k_1/k_0 - 1$, which implies a significant lock-in effect. Unless the return for banking permits falls below the return that can be earned on other assets by more than the rate of the tax, there is a tax disincentive to selling. If zero-basis holders dominate the market, the number of permits offered for sale will drop, and the price will rise, until the return for permits is $x(1 - t)$ percent less than the expected

16. Permit brokers have reported that active markets for permit forwards, options, and swaps have developed (Joskow, Schmalensee, and Bailey 1998, pp. 677–78 n. 29, p. 684).

value of k_1, that is, until the tax exemption is impounded into the price of permits.

Second, consider the cost-basis holder. When the basis equals the time 0 market value ($b = k_0$), as when permits are purchased or when gratis receipt is treated as taxable income, there is no lock in. Equation (8) reduces to $x = k_1/k_0 - 1$. If the before-tax return for banking permits matches other assets of comparable risk, the holder will be indifferent toward banking. Thus, taxes will not distort the intertemporal cost of permits or abatement.

The total absence of lock in for the cost-basis holder is an artifact of the two-period model. If the model is extended to include more periods, then as the permit appreciates, the cost basis will drop below the market value and the taxpayer will become locked in, as is generally true in a realization-based income tax. The magnitude of the lock-in effect increases with the unrealized gain and with the rate of inflation (Shuldiner 1993, pp. 559–62).

4. CONCLUSIONS

I reach two main conclusions regarding the impact of income taxation on the cost-effectiveness of cap-and-trade regulation:

1. Within a given tax period, imposing an income tax will not undermine the cost-effectiveness of cap-and-trade regulation.
2. An income tax can interfere with cost-effective allocation of permits and, hence, pollution abatement across time, particularly when permits are allocated gratis and excluded from income, as under current law and administrative practice.

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