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Commodifying and Banking Pollution Rights, Reducing Innovation

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Abstract

This Article represents an attempt to fill a gap in the existing environmental law and policy literature by exploring the interplay between the extent to which, and the conditions under which, polluting firms are allowed to bank excess pollution credits and the strength of the incentives for polluting firms to invest in the development of new pollution reduction and control technologies. The central argument in the Article is this: permitting the banking of pollution credits has both a pro-innovation and anti-innovation incentive effect, and the anti-innovation effect for each firm is a function both of how many credits that firm has in the bank and of how many credits it knows that its competitors have in their banks. Although my analysis does not point to any particular rule regarding banking, it does provide some support for limits on the banking of credits. The intuition behind the analysis is simple: once firms have banked pollution credits, they are in the position of both a prospective buyer and a prospective seller of pollution credits. As prospective buyers of credits, firms have an incentive to further the development of pollution reduction and control technology that will (in addition to other things) reduce the prevailing market price for credits. As prospective sellers of pollution credits, by contrast, firms have an incentive to deter, or at least not further, the development of pollution reduction and control technology that will reduce the prevailing price for credits.

Commodifying and Banking Pollution Rights, Reducing Innovation

David A. Dana, Northwestern University School of Law

In tradable pollution credit regimes, existing firms are typically allocated a certain number of pollution credits commensurate to their historical pollution outputs. Firms are then free to comply with (typically) gradually-tightening standards either by buying pollution credits from other firms, or by making changes in their production processes (such as switching from high to low sulfur coal) or some combination of measures. Firms that over-comply with applicable standards generate excess pollution credits, which they can either sell on the marketplace or bank for future use or future sale. In the largest experiment with tradable credits to date, the Clean Air Act SO2 Acid Rain program, firms have banked a large percentage of their allocated credits, and the number of trades between firms has been far fewer than was originally anticipated by policymakers.[2]

There is a very sophisticated literature exploring, in almost exclusively theoretical/modeling terms, the level of incentives for technological innovation in pollution control and reduction under tradable credit, pollution tax, and traditional command and control regulation. In practical policy terms, however, these comparisons arguably are beside the point. There is no political will behind, and hence no political success with respect to, meaningfully-tailored pollution taxes,[4] and almost everyone in

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[4] For an interesting discussion of why , as a matter of political economy, this might be so, see Thomas Merrill, Explaining Market Mechanisms,

the relevant policymaking, non-profit-organization and industry communities now accepts that tradable permits offer distinct advantages, at least with respect to pollutants that lack strong localized effects.[5] This is as true in Europe (and more broadly, internationally) as in the United States, as witnessed by the centrality of trading in the EU emerging regime aimed at reduction in CO_2/greenhouse gases emissions.[6]

The true debate in policymaking is, what kind, what form, what particulars of tradable credit systems would produce the "best" results according to the relevant social metrics. By and large, the theoretical literature has not yet addressed these questions. Indeed, the only particular of tradable credit regimes that has received much attention is whether the initial allocation of credits should be by "free" allocation (typically based on past pollution outputs) or by open auction.[7] As a matter of political economy, free initial allocations appear to be inevitable,[8] so the important question, practically, is what happens *after* the initial allocation of credits: that is, what post-initial-allocation rules for the operation of the pollution credit market best effectuate the stated goals of the regulatory regime: improving environmental quality, limiting the costs of pollution control and abatement, and (to both those ends) increasing the pace and scope of technological innovation in pollution reduction and control.[9]

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9 I mean the term technological innovation to be broadly inclusive, so as to encompass not just smokestack scrubbers and other end-of-the-line treatment devices but also product input and end-product redesigns, manufacturing process modifications, and even the development of entirely new, substitute products.

Not all innovation in reduction and pollution control is efficient in the sense that the costs of the control outweigh the benefits, and there is some level or rate of aggregate innovation that is super-optimal, in the sense that the aggregate costs outweigh the aggregate benefits. But there seems to be a widely-shared empirical assumption that under the traditional command-and-control regime of environmental regulation, aggregate levels or rates of innovation have been sub-optimal, and that marked increases in

This Article represents an attempt to fill the gap in the existing literature in part by exploring the interplay between the extent to which, and the conditions under which, polluting firms are allowed to bank excess pollution credits and the strength of the incentives for polluting firms to invest in the development of new pollution reduction and control technologies.[10] The central argument in the Article is this: permitting the banking of pollution credits has both a pro-innovation and anti-innovation incentive effect, and the anti-innovation effect for each firm is a function both of how many credits that firm has in the bank and of how many credits it knows that its competitors have in their banks. Although my analysis does not point to any particular rule regarding banking, it does provide some support for limits on the banking of credits.

The intuition behind the analysis is simple: once firms have banked pollution credits, they are in the position of both a prospective buyer and a prospective seller of pollution credits. As prospective buyers of credits, firms have an incentive to further the development of pollution reduction and control technology that will (in addition to other things) reduce the prevailing market price for credits. As prospective sellers of pollution credits, by contrast, firms have an incentive to deter, or at least not further, the development of pollution reduction and control technology that will reduce the prevailing price for credits.

I. How Banking Affects the Political Posture of an Industry

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innovation would be consistent with a goal of efficiency as that term is generally understood. This Article proceeds on that assumption.

[10] There is some literature addressing the economics of banking in tradable credit regimes, see , but this literature either ignores the possible effects in technological change in pollution control technology., see , or treats technological innovation as an exogenous variable that is unaffected by the decisions of the regulated, polluting firms, see. My basic point is that technological innovation must be considered as an endogenous variable.

To the extent an industry operates as an unified or semi-unified actor, it may be possible to make predictions regarding the political posture of the industry under different regulatory regimes. Under traditional command and control regimes, the predicted political posture of an industry toward the enactment and maintenance of strict aggregate limits per industry or per-facility on pollution would be one of hostility. Strict regulation, all else being equal, means high compliance costs. By the same token, we would expect industry opposition to rigorous enforcement of pollution limits on the books (however strict those limits may be), since such enforcement, all else being equal, also means high compliance costs. In a command and control industry, strict pollution limits and rigorous enforcement of those limits has no upside for an industry (except perhaps to serve as a barrier to entry for prospective competitors).

We would expect that the switch from a command and control regime to a tradable credit regime would make a polluting industry more supportive of the maintenance of strict pollution limits as a matter of formal law, and more supportive of the rigorous enforcement of those limits.[11] There are two reasons this is so. First, all else being equal, a trading regime means lower compliance costs for the industry since high-marginal-abatement-costs firms can comply by means of the purchase of credits from low-marginal-abatement-costs firms.

Second, to the extent the firms within the industry have banked pollution credits, the maintenance of a strict enforcement of pollution limits preserves the value of the credit asset. The weakening of pollution limits de jure or de facto (as through the weakening of enforcement) would erode the value of that asset, because te price and

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hence the economic value of pollution credits is a function of the strictness of the formal limits on pollution and the rigor with which those limits is enforced. Where strict limits are formally in place, and rigorously enforced, the right to pollute an additional (for example) ton of sulfur dioxide is worth a good deal more than where there are no limits with respect to sulfur dioxide emissions and/or spotty, weak enforcement of strict formal limits.

The same reasoning can and should be extended (but has not yet been extended) to government efforts to foster the development of technology that reduces the amount or toxicity of pollution emitted into the environment per a given amount of industry output. The proponents of tradable credit regimes have long argued trading regimes create better incentives for technological innovation than command and control regimes. These proponents argue that, in command and control regimes, a polluting firm gains nothing (economically) from over-complying with pollution limits whereas, in a trading regime, an overcomplying firm generates excess pollution credits that can then be sold.[14] At the same time, the inertia in pollution control bureaucracy means that pollution limits are rarely changed, such that there is no ongoing pressure on industry to innovate.[15] This argument has merit to be sure, but proponents of market trading regimes ignore the relationship between credit price and the development of new pollution reduction and control technology.

When a firm in an industry develops a new technology that allows industrial production to proceed as before but with (for example) half the attendant pollution, and that technology is suitable for use by other firms at their production sites, the ultimate effect on the price of pollution credits is highly negative. If firms can do their productive

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business with half the pollution, they need a great deal fewer pollution credits, and the market price of the pollution credits will fall. New, non-site-specific pollution reduction and control technology thus translates into a reduction in the asset value of existing pollution credits, and to the extent polluting firms are the entities holding those credits, they lose asset value with the development and dissemination of the new technology.

A graphic depiction of the loss in asset value may be useful. On Figure One, the x axis represents the quantity of credits sold, and the y-axis represents their price of sale. Before the development and diffusion of a new pollution reduction and control technology, the demand for credits is that represented by line D. With the development of new technology, demand for credits drops, such that the demand is now represented by line D'. Both the quantity and price of permits drops, from (P,Q) to (P',Q'). The shaded area on Figure One represents the savings by the industry in terms of the production input of pollution credits. The supply curves upward because, with price increases, more pollution credits that would otherwise have been used or banked (by polluting firm or others) will be placed on the market, but much finite natural resources, there is a point at which the supply curve would be vertical, inasmuch as, at some point, in theory, there would be no additional credits that could be placed on the market.

On Figure Two, the x axis again represents the quantity of credits, and the y-axis represents the price. The line V represents the market value of all permits at a given quantity and price. With (once again) the shift from (P,Q) to (P', Q'), there is a loss in the value of the credit asset that is represented by the shaded are on Figure Two.

FIGURE ONE: Industry Savings

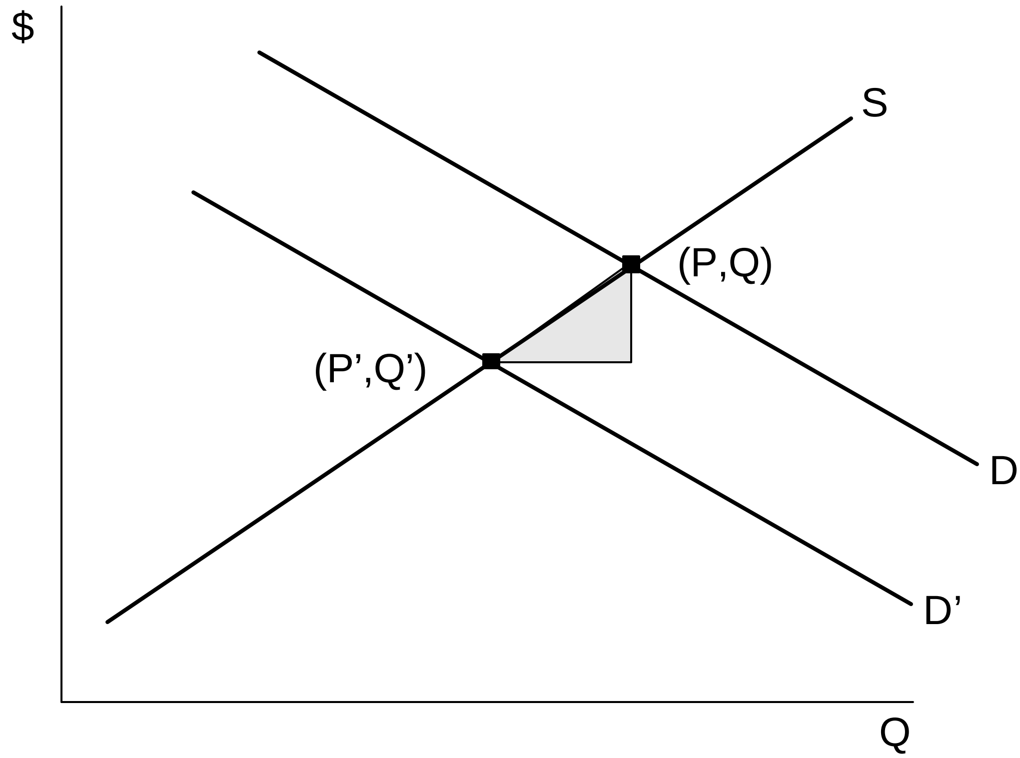
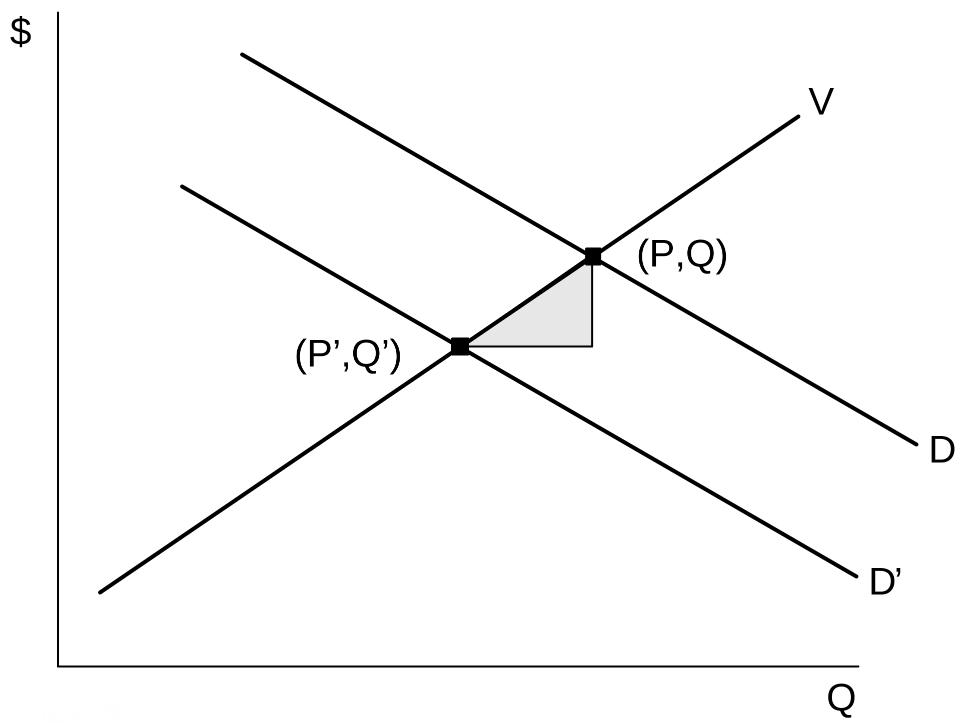


FIGURE TWO: Loss in Asset Value



If the polluting firms in the industry do not bank any excess pollution credits but rather sell their excess credits each year (or some other relatively short time period) and buy any credits that they need each year (or some other relatively short time period) from each other or from non-industry, non-polluter entities (e.g., broker/investors or a government agency, if an agency has ongoing authority to buy, sell, and/or generate credits, as the EPA does to a limited extent in the SO2 program[16]), the firms in the industry will reap the cost savings represented on Figure One without bearing any or any significant portion of the loss in asset value represented on Figure Two. By contrast, if the firms in the industry hold *all* the credits that predictably might be needed under current technology for many years, then the firms, as a group, will reap the savings represented on Figure One but also will suffer the loss in asset value represented on Figure Two. The more credits the firms in the industry have banked, the more the loss in asset value will, in effect, "eat up" the cost savings from the drop in credit prices that flows from the development and diffusion of the new technology.

In addition to affecting the research and development investment decisions of individual firms vis-à-vis new pollution reduction and control technology, as explored below, the ownership of a large stock of pollution credits by the firms in the industry should have some effect on the political posture of the industry. For example, we might expect that a trade association representing the industry would become *less* supportive of federal efforts to fund or otherwise support (e.g., through tax incentives) the development of new, diffusible pollution control and reduction technology once the firms in the industry, as a group, have built up a large stock of pollution credits. Similarly, the industry, again operating perhaps through its trade association, might shift from support to indifference or even opposition to legislation that would authorize regulators to waive formally applicable pollution control requirements in lieu of a firm's agreement to invest

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in experimental pollution prevention technology, as in EPA's controversial Project XL program.[17]

Figure Three summarizes the shifts we would expect to observe with the move from command and control regulation to a tradable credit regime.

FIGURE THREE

	Enactment and Maintenance of Strict Pollution Limits	Rigorous Enforcement of Limits	Programs to Foster Development of Pollution Reduction and Control Technology
Command and Control	Less Supportive	Less Supportive	More Supportive
Tradable Credits, With Banking	More Supportive	More Supportive	Less Supportive

Of course, the political posture of the industry as a unified or semi-unified political actor notwithstanding, there may be significant variation in the political strategies and efforts of the individual firms within the industry. Indeed, there may be certain firms even in a tradable credit regime characterized by substantial banking that assume a political posture in favor of lowering pollution limits and/or lax enforcement of the limits and/or greater federal support and regulatory emphasis upon technological innovation in pollution reduction and control. It also bears emphasis that we would not expect to observe any loss in support by the industry with respect to any governmental efforts that might support the development of *non-diffusible,* site or firm-specific innovations in pollution reduction and control. The loss in asset value depicted in Figure Two is the product of a decline in the market price of credits, and a significant decline is

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likely to follow only the development of technology that is capable of being adopted by the major firms in the industry.

II. How Banking Affects the Research and Development Decisions of Individual Firms

Individual firms in a tradable credit regime are (all else being equal) likely to invest less in research and development aimed at the production of potentially diffusible new pollution reduction and control technology if they have banked a substantial stockpile of credits than if they have not done so. This is true whether or not such banking is widespread within the industry. Even if a firm itself has not banked any credits, it will invest less in research and development if the other firms in the industry have banked credits (at least if that fact is transparent). Banking may be consistent with very large investments in research and development, however. My point here is entirely a comparative one: there will be less investment in a trading regime as a result of the fact that there has been substantial, widespread banking within the industry.[18]

A. No banking by Firm X or other firms in the industry

In order to understand the possible effect of banking on the incentives of individual firms, it is helpful, as a preliminary matter, to consider how the management of a polluting firm might go about deciding whether or not to invest in the development

[18] Strictly speaking this statement is true notwithstanding the discussion of the pro-innovation effect of banking in Part IV because the anti-innovation effect of banking results from the fact that substantial banking *has occurred* while the pro-innovation effect results from the prospect or option that banking *will occur* – or at least will be permitted to occur – in the future. But it is true that, in thinking in general terms about the relative advantage and disadvantage of trading regimes with and without banking, the pro- and anti-innovation effects both warrant consideration.

It also bears noting that firms within the industry are not the only possible sources of new pollution control and reduction technology. In some instances new technology could be developed by firms devoted solely to developing new pollution technology, and that are unaffiliated with particular polluting industries or polluting firms. But because the development of new technology will typically require intimate knowledge of the operations of the polluting industry, involvement of the industry or particular firms in the industry typically will be necessary. Major innovation in pollution control technology in (to pick one well-studied example) the car industry came from within the firms in the industry, acting under regulatory pressure.

of new pollution reduction and control technology in a regime in which such firms are *not* allowed to bank pollution credits. For simplicity of exposition, I will assume that the investment decision is a stark binary one – the firm, Firm X, either invests a certain fixed some or instead invests nothing at all.

In making that decision, managers presumably would consider possible outcomes if they were to choose to make the investment, and if they were choose not to do so. Figure Three represents a simplified version of the possible outcomes that might flow from Firm X making the investment. If the investment is made, then there are four possible outcomes, listed in order of their desirability (from most to least) – the new technology will be developed first by Firm X, the new technology will be developed by Firm X at the same time that other firm(s) develop it, no new technology will be developed by Firm X or by the other firms in the industry, and (notwithstanding Firm X's investment) the new technology will be developed first by firm(s) other than Firm X.

For each of the three outcomes that entail the development of new technology, there are two possible second-order outcomes – that the new technology will diffuse through the industry (through unlicensed copying, legal or illegal, or licensing) or the technology, for whatever reason, will remain in use only by the firm(s) that developed it. (For the purpose of assessing the effect of the absence or presence of banked credits, it is not important what percentage of the gains from innovation are reaped by the innovating firms(s), since we are concerned not with the total expected gain from innovation (and by extension, the expected gain from investing in innovation) but rather with the difference between the expected gain with out banking and with banking.)

The total expected value for the investment equals the sum of the expected values of the four outcomes. Each outcome's expected value is the product of the probability of it occurring and the anticipated economic impact of the outcome on Firm X. We will assume that the economic impact of the two preferred outcomes would be positive (a gain, at least if the fixed investment cost is not considered), the economic impact of no new technology presumably would be zero, and the economic impact of other firm(s) developing the technology first would be negative (a loss). Thus, the no-new-technology outcome is zeroed out of the equation, and the relevant variables in estimating the expected value of the investment are: (1) p1, the probability that Firm X will develop the technology first; (2) v1, the gain to Firm X if it develops the technology first; (3) p2, the probability that the Firm will develop the new technology concurrently with other firms in the industry; (4) v2, the gain to Firm X if it develops the new technology concurrently with other firms in the industry; (5) p3, the probability that another firm or firms will develop the technology first notwithstanding Firm X's investment, and (6) v3, the loss to Firm X if another firm or firms were to develop the technology first notwithstanding Firm X's investment. The expected value of the investment, therefore, equals: (p1)(v1) + (p2)(v2) + (p3)(v3) or, alternatively, [(p1)(v1) + (p2)(v)] – l (p3)(v) l.

Anything that *raises* the probability that Firm X will develop the technology first or concurrently with other firms, or that *lowers* the probability that another firm(s) will develop the technology first, *increases* the expected value of the investment. Anything that *raises* the gain to Firm X from developing the technology first or concurrently with other firms also *increases* the expected value of the investment. Finally, the expected value of the investment is increased by anything that reduces the loss Firm X will suffer if another firm or firms develop the new technology first notwithstanding Firm X' research investment.

The converse relationships hold. Anything that *lowers* the probability that Firm X will develop the technology first or concurrently with other firms, or that *raises* the probability that another firm(s) will develop the technology first, *decreases* the expected value of the investment. Anything that *lowers* the gain to Firm X from developing the technology first or concurrently with other firms also *decreases* the expected value of the investment. Finally, the expected value of the investment is *decreased* by anything that increases the loss Firm X will suffer if another firm or firms develop the new technology first notwithstanding Firm X' research investment.

In addition to considering the expected value of making the investment, Firm X's managers presumably will also consider the expected value of *not* making the investment – that is, what expected loss they will bear as a result of not entering the competition to develop the new technology. If Firm X does not invest, then there are (again, to simplify) two possible outcomes – no new technology will be developed, or other firms will develop the new technology first and that technology will either diffuse through the industry or not. We will assume that the first possible outcome would have zero economic impact on the firm, and that the second possible outcome will have a negative economic impact on the firm. P4 represents the probability that another firm will develop the technology first if Firm X makes no investment, and, as previously stated, v3 is the loss Firm X will suffer if another firm develops the technology first. Thus, the expected loss for Firm X as a result of not making an investment is (p4)(v3). Anything that raises (p4) or (v3) increases the expected loss, and anything that decreases (p4) or (v3) decreases the expected loss.

If we assume that the managers of Firm X are risk averse, which is a standard assumption regarding managers,[19] then (loosely speaking) the managers will be more concerned with avoiding the possibility of the worst possible outcome for the firm than they are concerned with pursuing the possibility of the best possible outcome, even if it has equal economic magnitude, in absolute terms, as the worst possible outcome. In our context, risk aversion might translate into managers paying particular to the possible downside associated with not making the investment in research, and other firms taking advantage of that decision by being able to develop the technology first. Thus, although all the variables discussed above will affect even highly risk averse managers, we make the following assumption: managers will place extra weight on any factor or development that raises or lowers p4.

B. Banking by Firm X, no banking by other firms

If Firm X has a substantial number of banked credits, it is going to experience a loss in credit asset value if new technology is developed and diffuses through the industry, and demand for credits and hence the market price for credits drops. As shown on Figure Four, this loss will be experienced whether Firm X develops the technology first, Firm X develops the technology concurrently with other firms, or another firm or firms develop the technology first. Therefore, when we move from the situation where none of the firms engage in banking to the situation where Firm X engages in banking (but other firms do not), Firm X's estimate of the economic gain to it from making the investment if it develops the technology first (v1) or develops it concurrently with others

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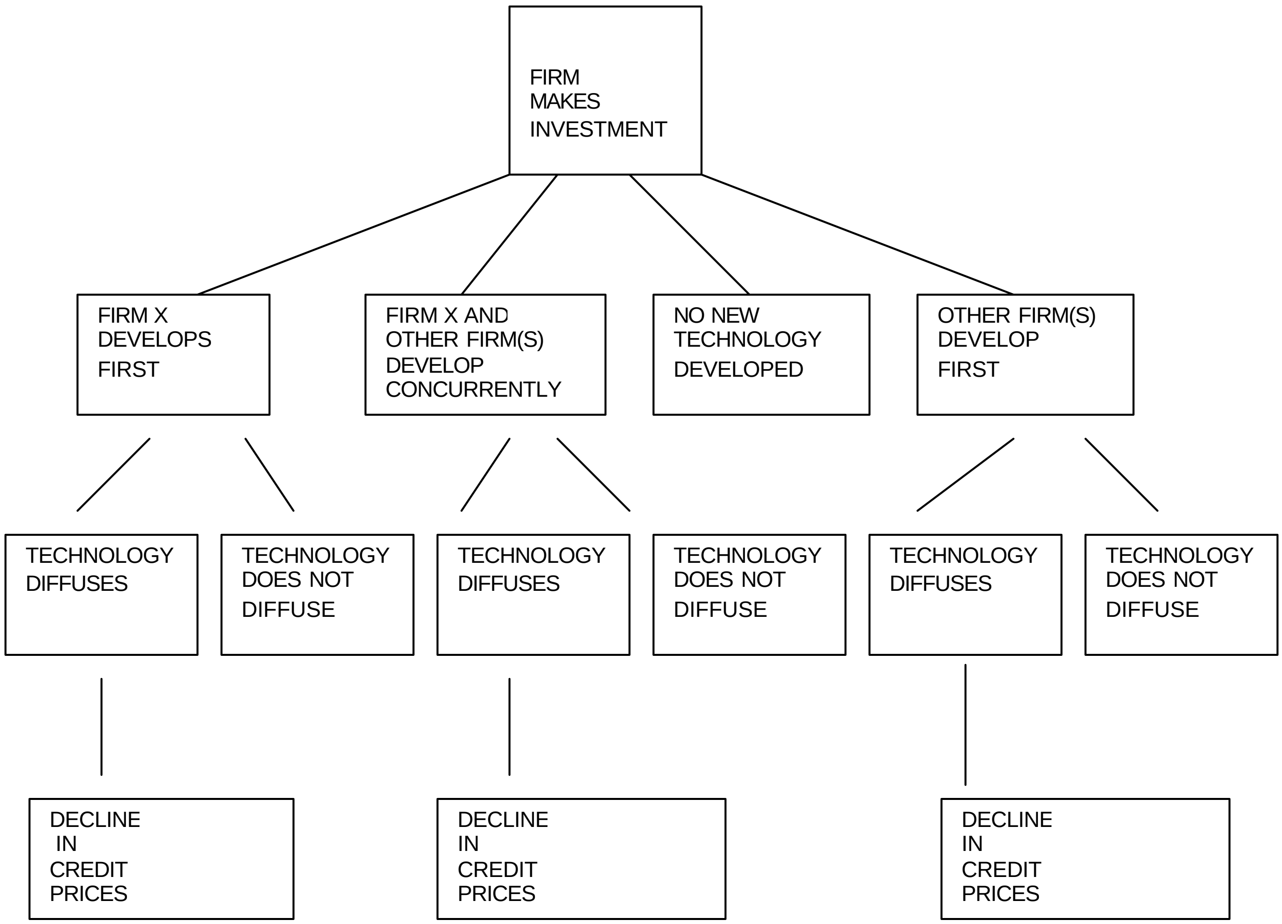
(v2) will decline, and its estimate of the expected loss if others develop the technology first will increase (v3). As a result, the expected value of making the research investment [(p1)(v1) + (p2)(v2) - l(p3)(v3)l] will decline. Relative to alternative possible investments, the research investment will become less attractive than it s in the no-banking-by-any-firm regime.

FIGURE THREE: Possible Outcomes from Firm X's Investment



C. Banking by Firm X and the other firms in the industry

If Firm X and other firms in the industry bank substantial number of credits the basic result is the same: there will be a lower incentive to make the research investment than in the no-banking-by-any-firm regime. Moreover, as explained below, there is a substantial basis for predicting that the incentive for Firm X to invest will be lower when Firm X *and* other firms have banked than when *only* Firm X has banked credits.

If Firm X has banked a substantial number of credits, the value to the firm if it makes the investment and then develops the technology first (v1), or if the firm develops the technology concurrently with others (v2), will be the same whether or not other firms in the industry have banked credits. Either way Firm X will lose some of the value of its banked credits if the new technology diffuses and credit prices fall as a result. By the same token, v3, the loss Firm X will bear if another firm or firms(s) develop the technology first, will be the same regardless of whether other firms have banked credits.

But the probabilities variables in the expected value equations will be affected by the fact other firms have banked credits. In the scenario in which all firms have banked credits, the probabilities that Firm X will develop the technology first (p1) or concurrently with other firms (p2), as well as the probability that other firms will develop the technology first (p3, if Firm X makes the investment, p4 if it does not), will be different than in the scenario in which only Firm X has banked credits. Specifically, Firm X will perceive a relative decline in both p3 and p4, and a relative increase in p1. As explained below, on balance these changes in probabilities – subjective probabilities, probabilities as perceived by Firm X managers – will reduce Firm X's managers' inclination to make the investment.

Firm X's managers will understand that other firms will perceive a lower economic return from investing in the new technology if those firms have banked substantial credits because, as discussed, the development of new technology, if it diffuses, will lower the market value of the banked credits. Thus, Firm X's managers will reason that the other firms will be *less* likely to invest in the development of new technology if they have banked credits than if they had not done so. In terms of Firm X's expected value calculation, this means that, if Firm X does go ahead and make the investment, it is more likely to develop the technology before other firms (p1 increases) and other firms are less likely to develop technology first (p3 declines). These changes in p1 and p3, by themselves, would translate into an increase in Firm X's expected value of making the research investment.

However, Firm X's managers' perception that other firms will be less likely to invest in research and development also means that Firm X's managers will perceive a decrease in the probability that other firms will develop the new technology in the scenario in which Firm X makes no investment in the research (p4). Thus, the downside of not making the investment will be reduced in proportion to the extent to which the upside of making the investment is increased. If we assume managerial risk aversion, such that changes in the downside matter more than comparable changes in the upside, the overall effect of the changes in the probabilities Firm X's managers perceive with respect to other firms will be a decrease in Firm X's inclination to make the research investment. Consequently, Firm X will be less disposed to make the investment in new technology where Firm X and other firms have banked credits than where only Firm X has banked credits.

Now suppose that Firm X's managers assume that, in deciding upon research investments, other firms will factor in their predictions as to what research investments Firm X will or will not make. Firm X managers will reason that (for the reasons stated above) other firms will (rightly) anticipate a lower likelihood of Firm X making the research investment because Firm X has banked credits and knows other firms have as well. Other firms will be less likely to invest as a result. This decline in other firms' willingness to invest, in turn, will lead Firm X to perceive an even lower p4 (probability other firms will invest if Firm X does not), and hence Firm X will be even less likely to invest.

The process can go on and on: for example, if firm X managers assume that the managers of other firms will predict the just-mentioned additional decline in the p4 perceived by Firm X, and hence predict a further decline in the likelihood that Firm X will invest in research, then Firm X may predict yet another decline in *other* firms' willingness to invest, and hence Firm X in turn may be even less willing to invest.

To state the point more generally, once we imagine that Firm X managers do not take a snapshot of other firms' likely investments, but rather think more dynamically as to how Firm X's and other firms' research decisions will be based on their mutual perceptions of and predictions about one another, then (assuming all the firms have risk averse managers, and assume as such about one another), then Firm X's managers' prediction of the decline in p4 triggered by a drop in credit prices – and hence the decline in their motivation to invest in research – will be lower, and perhaps substantially so, than when we assume a snapshot approach on the part of Firm X's managers.

D. No banking by Firm X, banking by other firms

In the final scenario, that in which Firm X has not banked credits but other firms have, Firm X will not suffer any losses in asset value if new technology is developed and diffuses inasmuch as Firm X has no banked credits to be devalued. In that sense, Firm X's calculations where it has not banked credits but other firms have done so are the same as where neither Firm X nor the other firms have banked credits. For the reasons explained above, however, Firm X's managers will perceive p1 as higher and both p3 and p4 as lower when other firms have banked credits than when they have not done so. If the managers of Firm X are risk averse, such that the decline in p4 dominates their assessment, then Firm X's managers will be less likely to make the research investment when they have not banked credits but other firms have done so than when neither Firm X nor any of the other firms have banked credits.

III. How Banking Facilitates Innovation

So far we have explored role of banking by polluting firms as a disincentive to innovation in the development of pollution control and reduction technology. But banking also has a role in facilitating innovation, and that pro-innovation effect must be balanced against the anti-innovation effect in any overall assessment of banking and in the formation of any policy as what restrictions, if any, should be placed on banking.

In certain instances, the option of banking by polluting firms may be the necessary precondition for those firms to make changes in their operation that result in over-compliance with legal limits. Such changes in operation sometimes may facilitate or even represent advances in new or refined pollution control and reduction technologies, and in the absence of the option of banking and hence the changes in operation, the new or refined technologies might never develop or might be developed only later.

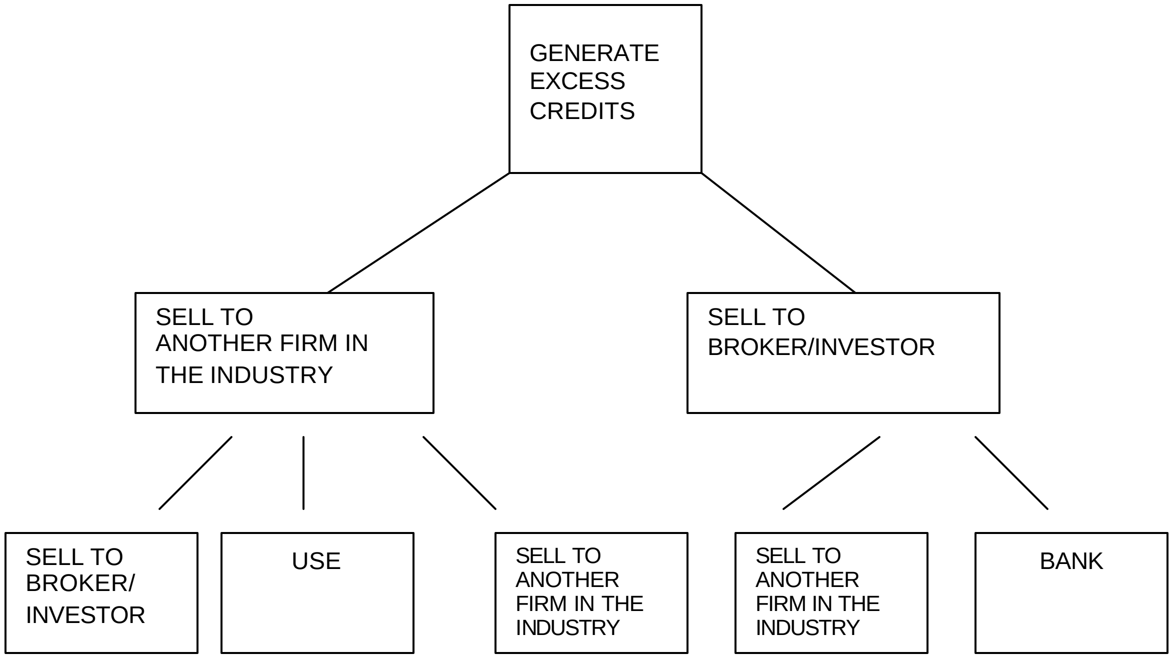
Why would a polluting firm ever choose to bank a credit rather than sell it? One way to approach that questions is to compare a world where banking by polluting firms is prohibited and one in which it is permitted, and then to ask how the latter offers more to polluting firms – enough "more" that, *ex ante*, firms in the world with banking by polluting firms may generate more excess credits than in the world without such banking.

Even where banking by polluting firms is prohibited, we should assume, if the credit market is efficient, the credit price will reflect not only demand for relatively immediate use of credits by other firms but all the available information regarding the likely future demand and other factors that would affect the value of credits in the future. The reason this is so is that the market would contain non-polluting-firm broker/investors that would buy up credits if they foresaw a sufficient prospect of appreciation and who therefore would ensure both depth in the buying market and a prevailing credit price that factored in the prospect of appreciation.

In this sense, polluting firms that sold to broker/investors would receive some of the expected value of price appreciation in the future. They would also bear less of the downside risk (if the predicted appreciation did not materialize) in return for giving up some share of the upside reward (if the price appreciation does materialize). If we (again) assume managerial risk aversion, the avoidance of downside risk through sales to brokers may hold considerable appeal for managers.[20] Figure Four depicts the options for a polluting firm that generates excess credits where banking by polluting firms is prohibited.

[20] Managerial risk aversion thus may push managers to avoid building large stocks of credits, but if we focus on the risk to managers of being caught with an inadequate number of pollution credits in the future at a time when credits are difficult to obtain at all in a quick turnaround or at least very costly to obtain, then we might conceive of managerial risk aversion as a force favoring the building of large stock of credits. It is hard to say, in the abstract, whether managerial risk aversion on net favors or dis-favors banking.

FIGURE FOUR: Firm Options In No-Banking Regime



Banking, however, offers some possible advantages to polluting firms. Where a polluting firm sells excess credits to a broker/investor at time 1 and the broker/investor then sells them at time 2 at the higher price that both the polluting firm and the broker/investor had guessed (in time 1) would prevail at time 2, the polluting firm does receive some of the value of the price appreciation in the sense that the broker/investor paid more for the credits precisely because it anticipated the appreciation. But if the market is not yet efficient, the price the broker is willing to pay may not fully reflect the likelihood of appreciation. And even if the market is efficient, the facts that two sales instead of one must be negotiated for the credits to be sold at the higher, time 2 price[21] means that the net return from the expected appreciation of the credits in the future (however it is split between the polluting firm with the excess credits and the broker/investor) will be less when the excess credits are banked by the polluting firm at time 1 and later sold at time 2.

Moreover, the polluting firm saves in transaction costs if it banks credits in time 1 and then decides to use them in time 2 because of (for example) the imposition of stricter legal limits or because of an uptick in the economy and hence in production and production-related pollution. If the firm had not banked the credits but instead sold them in time 1, the firm would have had to purchase additional credits in time 2 (from another firm in the industry or an investor/broker). The negotiation and consummation of that purchase in time 2 would entail some transaction costs.

There also may be tax advantages to credit banking. Government-allocated credits are presumed to have a zero basis for federal income tax purposes, such that firms that sell them must pay capital gains tax on the full sales proceeds (absent costs of selling itself).[22] When a firm sells credits in time 1, and then needs credits in time 2 and buys them, it must pay income tax on a gain in time 1, and then can take a business expense deduction in time 2. But if the firm banks the credits in time 1, and then uses them in time 2, there is no tax consequence, which, all in all, may be preferable (in tax terms) to paying tax in time 1, and having to wait until time 2 to incur and record a business

[21] That is, the sale in time 1 from the polluting firm to the broker, and the sale of the credits by the investor/broker in time 2.

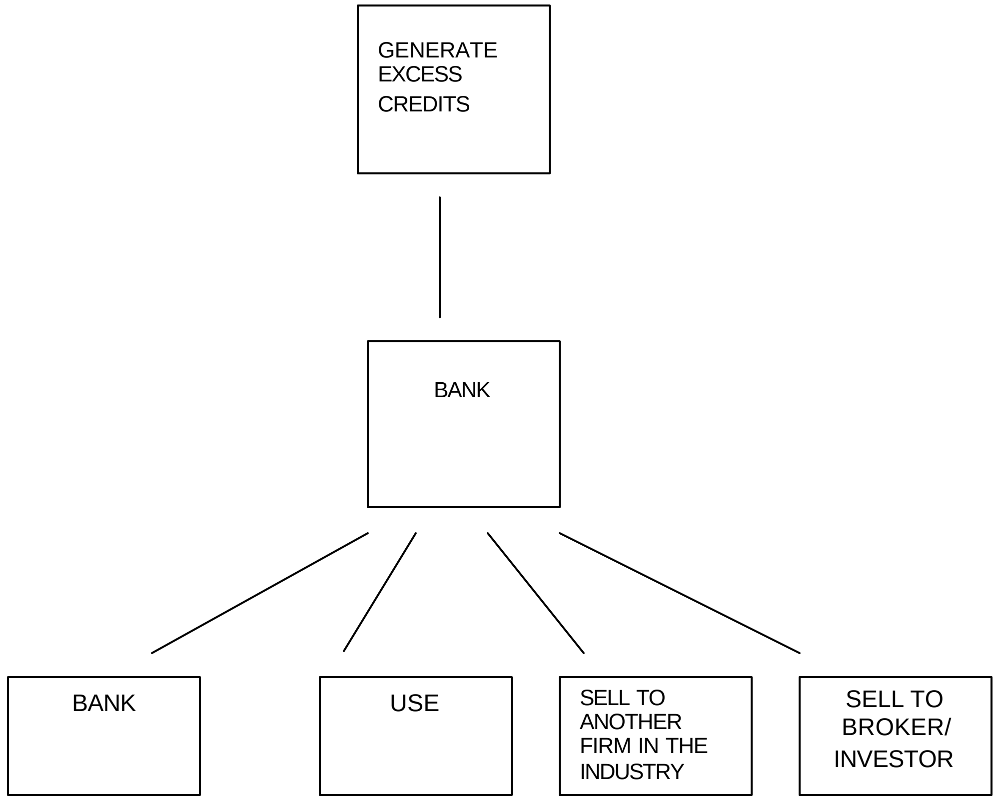
[22] For statements of the Internal Revenue Service's tax treatment of emissions credits, see Rev. Ruling 92-16, Internal Revenue Bulletin No. 1992-12, Mar. 23, 1992, p.6; Rev. Proc. 92-91, Internal Revenue Bulletin No. 1992-46, Nov. 16, 1992, pp.32-33.

expense. Moreover, if it turns out that the firm does not need the credits in time 2, and instead can sell them then, the firm will have deferred taxable gain from time 1 to time 2.

Since the advantages of banking are related to the extent of market failure to reflect all available information and to the magnitude of transaction costs, and both of these correlate with the thinness or immaturity of the market in credits, we should expect the advantages from banking to drop as a credit market develops. Unless there are other dynamics driving banking (which is certainly possible), the extent of banking therefore should drop, although the amount of banking in absolute terms may still be enough to raise concerns regarding the anti-innovation effect associated with banking.

Figure Five depicts the options for polluting firms that has banked excess credits.

FIGURE FIVE: Banking Option



IV. Quantity versus Timing Restrictions on Banking and Credit Duration

If a regime of unrestricted banking by polluting firms does not strike the best balance between the anti- and pro- innovation effects of banking, then what kinds of restrictions might make sense?

One category of possible restrictions would be quantitative restrictions on the number of credits that individual polluting firms can bank. Quantitative restrictions could be structured in absolute terms or in terms of the size of the firm or of its legally-permitted amount of pollution. Quantitative restrictions might be the easiest to implement but they run the risk of discouraging big changes in operation that generate a large number of excess credits at once, and it is precisely these sort of big changes that may be most important in the development of new, potentially diffusible pollution control and reduction technology.

Time restrictions on how long credits can be kept in the bank, by contrast, would not discriminate as much against big changes in operation. Such restrictions, if moderate, also would avoid the transaction cost waste associated with compelling firms to sell excess credits that they can *reliably* anticipate they will need or at least want to use in the near term. The appropriate criteria for reliable prediction of near-term future use would presumably vary by industry.

As an alternative to restrictions on how long a particular credit can be banked, the length of the validity period of all credits could be limited such that (for example) any credit must be used within two years of issuance. At the present time, credits do not have any automatic expiration date, although the federal Clean Air Act contains language reserving to the federal government the right to modify or cancel credits. The length of validity of credits remains an open issue in emerging credit markets such as the market in

CO2 credits now being constructed by the EU as part of its implementation of the Kyoto Protocol.

Another possible approach – and one that might be easier to realize as a political matter, since it entails essentially a carrot for industry – would be to alter the tax treatment of credit sales in such a way as to discourage banking. For example, firms could be allowed to defer for some time tax recognition of income from sales of credits such that there would not be any significant possible tax advantages associated with banking.

One might object that none of these policy recommendations may make sense until we have a better sense of the magnitude of the anti-innovation effect of banking relative to the pro-innovation. The best response to this study would be comparative studies examining rates of innovation in pollution control technologies in industries or sectors with different rules regarding the permissibility of banking. Such studies will not necessarily yield definitive results about the effect of banking as a general matter since comparative studies of this sort typically will involve a great deal of "noise" – factors unrelated to banking that might affect innovation levels. Perhaps the most revealing, least noise-burdened study would be one that examined innovation rates in a trading regime before and after banking was permitted or before and after banking was prohibited. But such a study is impossible at present since (to my knowledge) there have been no trading regimes which have operated for a substantial period of time both before and after banking rules were significantly altered.

V. Conclusion

In the construction of a regime of pollution control based on tradable pollution rights, an important consideration is the extent to which polluting firms will be allowed to bank pollution credits. There are legitimate, socially-beneficial effects of banking, but banking also can operate so as to reduce the incentive for the polluting industry as a whole and or for individual forms to invest in new, potentially diffusible technologies that are capable of reducing or controlling pollution. In deciding upon the particulars of a tradable pollution credit regime, the anti-innovation effect of banking warrants consideration it has not yet received.