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Analysis of the Bush Proposal to Reduce the SO_2 Cap

by
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Introduction

On February 14, 2002, President Bush announced a Clear Skies Initiative that proposes, among other things, to reduce the existing cap on total SO_2 emissions from approximately 8.9 million tons under the existing provisions of Title IV of the 1990 Clean Air Act Amendments to 4.5 million tons starting in 2010 and to 3.0 million tons starting in 2018. The proposed reductions in the SO_2 cap are similar to that facing the 263 generating units that were mandated to be subject to Phase I under Title IV and which occasioned a significant amount of early over-control and consequent banking of allowances for later use. If enacted, there is every reason to believe that electric utilities would similarly engage in banking behavior prior to the reductions in the cap. Accordingly, any evaluation of the costs and economic effects of this proposal must make some assumption about banking.

The first section of this paper briefly describes banking and summarizes the grounds for concluding that banking behavior under Title IV has been largely rational, and therefore nearly optimal. This conclusion is the subject of another paper now being written by Juan Pablo Montero and myself and the most that can be done here is to adumbrate the argument. In the following section, the simple model that closely tracks observed banking behavior under Title IV is used to simulate the response to the proposed further reductions in the SO_2 cap. The results reported concern marginal and total costs of abatement, emission levels, allowance prices, and the value of the existing endowment of allowances. This section is then following by one presenting a sensitivity analysis in which the three principal uncertainties—the timing and levels of the reduced caps, the discount rate, and the predicted rate of growth in counterfactual emissions—are varied; and a final section concludes.

Banking in Theory and under Title IV

The basic theory of emissions banking is well developed and can be quickly summarized.[1] If emissions banking is allowed, agents will over-control in the current period and bank allowances for later use whenever they expect future marginal abatement cost discounted to the present to be greater than current marginal cost. Doing so causes marginal costs in the current period to rise and the discounted, expected future marginal costs to fall. And, when the opposite

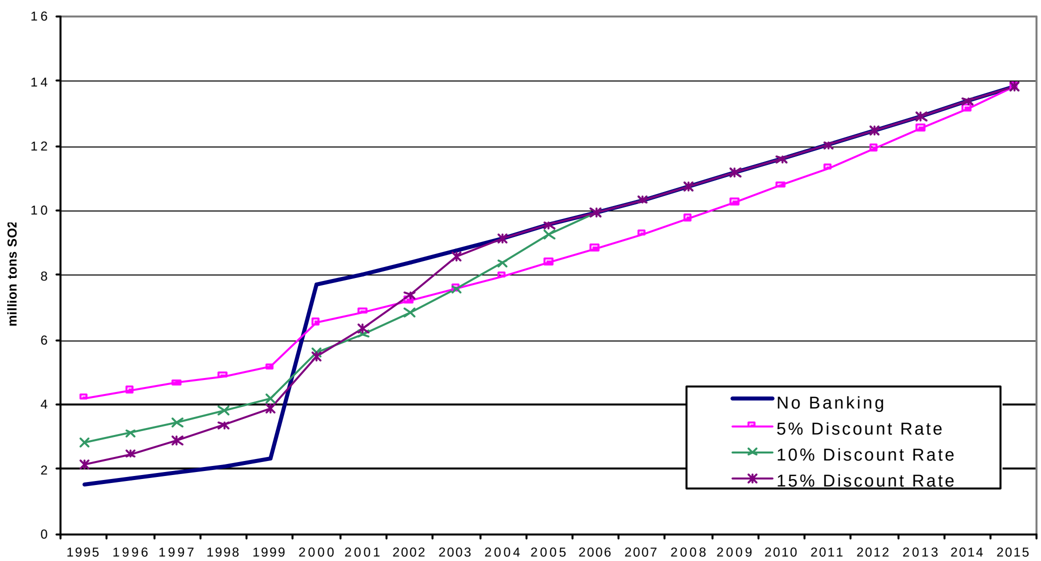
[1] See Rubin (1996), Kling and Rubin (1997), Cronshaw and Kruse (1996), and Schennach (2000). The latter two address Title IV explicitly.

condition obtains, namely, discounted expected marginal costs are lower than current marginal costs, agents will draw down the accumulated allowance bank until the temporal equality of discounted marginal abatement cost is established. The result is that allowance prices rise at the discount rate over the banking period, which can be defined as a complete cycle of accumulation and draw down.

Emissions banking is identical in all essential characteristics to the accumulation and draw down of inventory for any commodity.[2] Emissions and allowances may differ for any given sub-period, but over the complete cycle of accumulation and draw-down, the cumulative totals will be equal, just as cumulative production and cumulative consumption will be equal over any standard inventory cycle. The chief difference between the two is that allowance banking, as least as observed in Title IV, occurs over a much longer cycle because the reduction of the cap that distinguishes Phase II from Phase I creates a much greater difference in marginal cost than is ever true of the stochastic variation in production and consumption from year to year that rules inventory behavior for more standard commodities.

The general banking problem and how it might be solved under Title IV is illustrated in Figure 1.

Figure 1: Optimal Abatement Programs
(by discount rate, g = 2.0%)



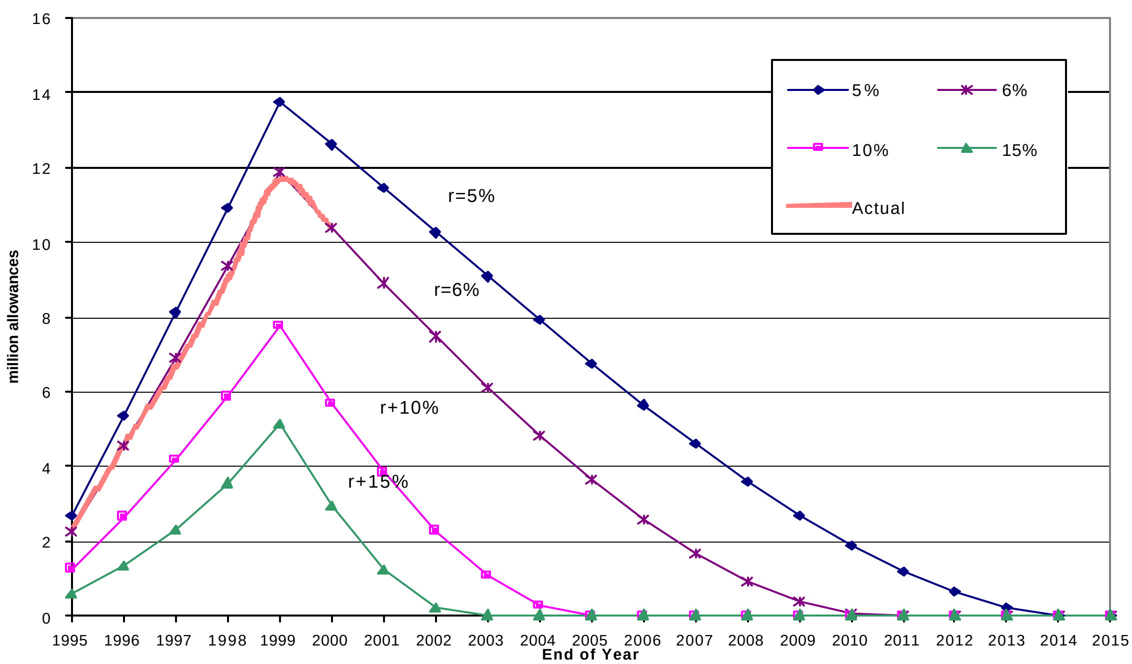
The bold line indicates the amount of abatement that would have been required in each year without banking, that is, if units had emitted in the aggregate in each year as much as allowed by the allowances issued for use in each of those

[2] The classic treatment of inventory behavior provided by Williams and Wright (1991) can be readily adapted to emissions banking.

years.[3] Since marginal abatement cost increases with the quantity of abatement, the reduction of the cap in 2000 occasions a sharp increase in marginal cost that will cause rational agents to over-control in Phase I and to bank the unused allowances for later use in smoothing the transition to the Phase II cap. Three examples of optimal banking programs and the resulting emissions paths—corresponding to nominal discount rates of 5%, 10% and 15%—are illustrated in Figure 1. Lower discount rates place a higher present value on future costs and therefore call forth more early abatement, a larger bank at the end of Phase I, and a longer period of drawing down the accumulated bank.

Another way to illustrate the problem and to compare what has happened so far under Title IV is to plot the evolution of the bank over time, as is done in Figure 2.

Figure 2: Optimal Banking Programs
(expressed as end-of-year bank)



Each of the ascending and descending lines indicate the cumulative bank, or the difference between allowances available for use in each year and emissions under an optimal banking program for each of the indicated discount rates. The bold, broken line in Figure 2 indicates the actual development of the allowance bank through 2000 and it corresponds almost exactly with what would have been called for using a 6% discount rate. The clear inference, assuming electric utilities are acting rationally, is that the discount rate applied to the holding of allowances has been 6%.

The choice of an appropriate discount rate is always difficult, but it can be established independently, as is done for a variety of common inventory

[3] The amount of abatement required in each year during Phases I and II increases because counterfactual emissions, what would have been emitted but for Title IV, are assumed to increase at 2% annually.

problems, using standard techniques of financial economics, such as the capital asset pricing model (CAPM). The forthcoming paper by Montero and me applies this model and finds that allowance prices have zero correlation with equity returns, regardless of estimation technique or equity index, which implies in turn that the risk associated with holding SO_2 allowances can be completely diversified and that the appropriate discount to be applied to holding SO_2 allowances is the risk-free rate. This rate has averaged 6% from 1994 through 2000. Accordingly, we conclude that emissions banking under Title IV has been optimal.

Application of Optimal Banking to the Proposed Reduced Caps

The conclusion that Title IV banking has been optimal greatly simplifies evaluation of the effects of the reduction in the SO_2 cap proposed by the Bush Administration, assuming that the proposal survives the legislative and regulatory process in as pure a cap-and-trade form as was true for Title IV of the 1990 Clean Air Act Amendments. In particular, this assumption of rational behavior frees analysis of this proposal from the ad hoc institutionalism that so bedeviled early analysis of Title IV.[4]

The problem to be solved now is how to change an already existing banking program in mid-stream to incorporate the new constraints. Analysis of the change in banking program is simplified by assuming that the President's proposal is enacted now, or equivalently that agents assign a 100% probability to its enactment in identical or equivalent form and stringency. Such a high probability is unlikely, but that agents are incorporating a non-trivial probability is beyond question.[5] In actuality, varying levels of probability will be incorporated into allowance prices, and therefore into abatement decisions and the resulting emission levels, as the prospects for enactment wax and wane. The effects of the proposal can be understood best, not by attempting to simulate all the effects of the transition from proposal to enactment, but by ignoring the transition and simply assuming, for the sake of analysis, that the proposal has been instantly translated into reality.

The model to be applied to this mid-stream change is only slightly different from a standard banking problem. Agents start out with positive allowance holdings (instead of zero as at the beginning of 1995) and they now face additional, previously unexpected increases in marginal abatement cost as the cap is reduced from the Title IV level of 8.9 million tons to 4.5 million tons in 2010 and 3.0 million tons in 2018. Assuming all else is unchanged, agents will incorporate the new abatement requirements into their banking programs such that

[4] To some extent, the early, less rigorous analysis of Title IV was unavoidable since it had no precedent. For instance, the beta for allowances could not have been estimated since no markets for this or any similar asset had existed before. Still, it is surprising how little analysts attempted to treat banking rigorously even though virtually recognized that some banking would occur. Estimates for the end-of-Phase I bank ranged from two to fifteen million tons and the actual bank was 11.65 million tons.

[5] For instance, *Air Daily* reported, in its first weekly report on SO_2 prices after the President's announcement, that "Bush's proposal…has pushed SO_2 prices sharply higher (to) $169 on Friday, up $9 from the week before." Given a certainty equivalent increase in price (to be developed shortly), this increase can be seen as an instant handicapping of the probability of enactment.

discounted marginal costs are brought into equality over the appropriate banking period. With a significant reduction of the cap at about the time the existing bank of allowances would otherwise have been exhausted, agents will undertake additional control efforts before 2010 and extend the banking period for some years beyond 2010, and perhaps after 2018. Moreover, the effects will not be limited to the years surrounding 2010 or 2018. The effect will reach back to the present time and lead to an increase in current allowance prices and abatement effort.

The basic banking model is relatively simple although the equations may look forbidding. An abatement cost function must be assumed and the same form as that used in the forthcoming paper by Montero and me concerning Title IV banking behavior is used here to express marginal and total abatement cost.

1) $$mc_t = a\ q_t^b \qquad TC_t = \frac{a}{b+1} q_t^{b+1}$$

The respective costs in period t depend upon the quantity of abatement in that period, q_t, and two time-invariant parameters, a scaling parameter a, which relates the quantity and price metrics, and a convexity parameter b, which indicates the extent to which marginal abatement cost rises with the quantity of abatement. Several earlier studies and analysis by this author and colleagues at MIT suggest that aggregate abatement costs are linear (b=1.0) and this assumption leads to the expression in equation 2) for the equality of allowances and emissions over the banking period.

2) $$B_0 + \int_0^t a_t\, dt = u_0 \left[\frac{e^{gt}-1}{g}\right] - \left(u_0 e^{gt} - a_t\right)\left(\frac{1-e^{-rt}}{r}\right)$$

The left-hand-side of equation 2) states the number of allowances available during the banking period, which is the number of allowances held in the bank at the time it becomes certain that the cap will be reduced, B_0, plus all the allowances that will become available for use in covering emissions with each succeeding year until τ, the end of the banking period. The right-hand-side of the equation expresses cumulative emissions over the banking period, which is the difference between cumulative counterfactual emissions (u_0 at $t = 0$, growing at the annual rate of g) and cumulative abatement over the same period. The last term, cumulative abatement, is the product of the abatement required at the end of the banking period, t, and the integral expressing the accumulation over the banking period which depends on the discount rate, r.

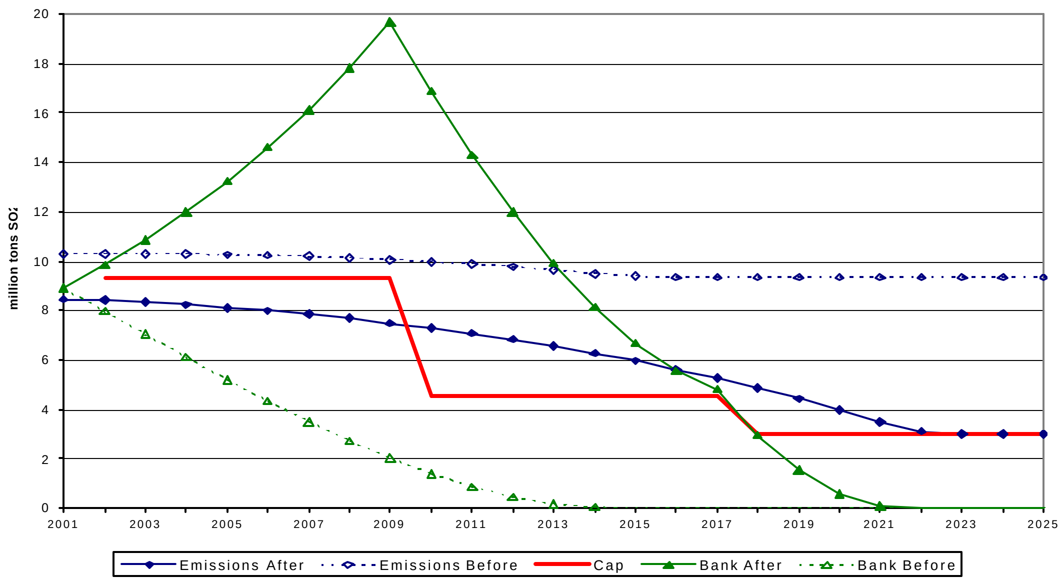
Equation (1) can be solved for t using known or reasonable values for all the parameters and variables in the equation. A reasonable estimate of the size of the bank at the end of 2001 is 8.9 million allowances. The number of tons allowed during 2002-2009 will be 9.35 million tons annually;[6] during 2010-2017,

6 This amount is slightly higher than the 8.9 million ton cap frequently cited because of additional bonus allowances made available during the early years of Phase II. In 2000, the number of allowances issued was

4.5 million tons annually; and thereafter, 3.0 million tons annually. Counterfactual emissions at the end of 2001 are estimated at 18.16 million tons and the growth rate in these emissions is assumed to be 2.0% per annum indefinitely. Finally, the dramatic reduction of interest rates in the course of 2001 has rendered a discount rate of 6.0% too high for the present. An appropriate risk-free rate would be that on a five- or ten-year Treasury note, which can be taken to reflect the average holding period for a banked allowance, and that rate is about 4.5%.

Figure 3 shows the results for emissions and the bank using these assumptions.

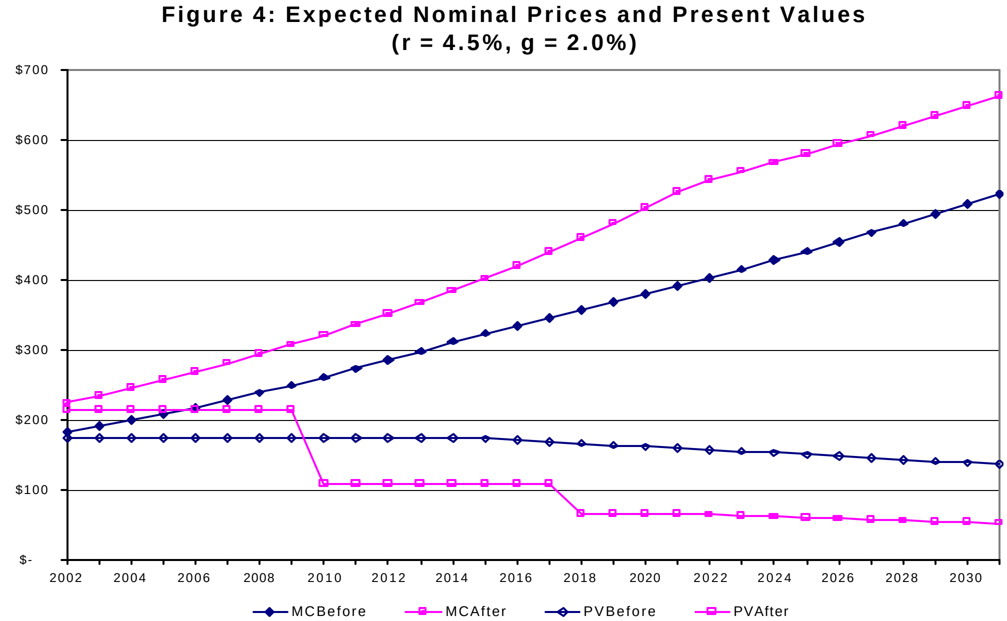
Figure 3: Emissions, Caps, and the Bank (4.5%, 2%)



The bold line with three descending steps is the proposed cap and the dashed lines indicate the paths of emissions and of the cumulative bank as each would be if the cap remained at the level of the first step. The solid lines indicate what will occur with the reduction of the cap. Without a reduction in the cap and with a 4.5% discount rate, the cumulative bank would have been drawn down slowly and it would have been exhausted around 2013. The reductions in the cap justify considerably more abatement prior to 2010 and a much longer banking period that would now extend to 2022. Abatement in the current period increases by about 1.75 million tons and the entire emissions path throughout the banking period shifts downward in a manner than smoothes the transition to the eventual 6 million ton reduction in emissions. Holders of allowances also resume the accumulation of a bank that will increase to almost 20 million tons before the draw down phase begins in 2010.

Figure 4 shows the same effect in the domain of prices.

9.94 million. 9.35 million is the average annual amount assuming that the amount available declines linearly from 9.9 in 2000 to 8.9 in 2009.



The two lines rising steadily from around $200 in 2002 represent the marginal cost of abatement before and after the reductions in the cap. The immediate increase in nominal prices is about $44, or 24%,[7] and the difference in the marginal cost of abatement increases steadily until it reaches about $140/ton or about 34% at the end of the banking period in 2021.

The two declining lines in Figure 4 indicate the present value of an allowance of the vintages corresponding to the years along the horizontal axis before and after enactment. Since allowances are distributed for thirty years forward, the allowances that will be used from 2002 through 2031 are already in compliance accounts and the sum of these present values represents the endowment value of each thirty-year, one-allowance stream. The President's proposal is silent on how allowances of vintages 2010 through 2031 would be handled, but the presumption must be that the legislation would declare allowances of vintages 2010 through 2017 valid for covering half a ton instead of a full ton, and those for vintages after 2017 valid for one-third of a ton.[8] Doing so would mean that the allocations for these years had been reduced from approximately 9 million tons to 4.5 and 3.0 million tons. Doing so would also create three classes of allowances: Class 1 consisting of allowances of vintages 2009 and earlier; Class 2 consisting of allowances of vintages 2010 through 2017; and Class 3 consisting of allowances of vintages 2018 and later. A Class 1 allowance would always be equal to the marginal cost of abatement and worth two Class 2 allowances or

[7] Assuming certainty of enactment as proposed. The $9 increase in allowance prices observed after the President's announcement suggests that the instant handicappers were placing a 20% probability on enactment of legislation having equivalent effect.

[8] It is worth noting perhaps that any attempt to apply the reduced coverage ratio to banked allowances will lead to the use of all allowances before their devaluation. This would imply not only no banking but also the use of the entire existing bank prior to 2010 and considerably higher emissions between now and 2010.

three Class 3 allowances, since these latter would be worth only that fraction of the marginal cost of abatement for which they can be used.

Under the current law and assuming that the current price reflects an equilibrium value, allowances of vintages out to the end of the banking period have a present value equal to their current price and later vintages have a lower present value since marginal cost does not rise at the discount rate after the end of the banking period in 2014. The effect of reducing the cap is to increase the value of the Class 1 allowances by $44 each, while the value of Class 2 and Class 3 allowances is reduced, as indicated, by the product of the changes in the coverage fraction and in marginal abatement cost. Table 1 summarizes the changes in the value of the allowances in each class and as a whole.

Table 1: SO_2 Allowance Endowment Value

(30-year stream of one allowance as of 1/1/02, 4.5% discount)

	Class 1 (2002 – 2009)	Class 2 (2010 – 17)	Class 3 (2018 - 31)	Total (2002 – 31)
After	$1,709	$ 855	$ 911	$ 3,475
Before	$1,387	$ 1,376	$ 2,108	$4,871
Difference	+ $ 322	- $ 521	- $ 1,197	-$ 1,396
% Change	+ 23%	- 38%	- 57%	- 29%

The total present value of each endowed 30-year, one-allowance stream is reduced by 29%, from almost $5,000 to about $3,500 per stream, but this outcome is the net effect of the 23% increase in the present value of Class 1 allowances and the 38% and 57% reductions in the present value of Class 2 and Class 3 allowances, respectively.

If marginal costs can be simulated, the total abatement costs can also be estimated, as indicated by equation 1). For this purpose, a value of 22 is given to the scaling parameter, α, to scale the early 2002 “before” price to approximately $175. Table 2 presents the estimated annual total costs for the current year 2002; for 2015, the year after the bank would have been drawn down without the proposed reductions of the cap; and for 2025, a year after the extended bank will have been exhausted.

Table 2: Total SO_2 Abatement Costs, (undiscounted millions of nominal 2002$)			
	2002	2015	2025
Total Cost After	$1,085	$3,471	$7,470
Total Cost Before	$747	$2,371	$4,400
Difference	+ $338	+ $1,126	+ $3,070
% Increase	+ 45%	+ 47%	+ 70%

The "before" costs for 2002 are approximately what others have projected without consideration of the lower cap (Ellerman et al., 2000; Carlson et al., 1998). Since it is not completely certain that the proposed legislation will be enacted, the 45% increase in costs for 2002 will not occur, although some portion of it may to the extent that the proposed higher costs are incorporated into the expectations that determine current allowance prices. Nevertheless, the magnitudes are indicative. In general, and assuming passage of the legislation as proposed, annual costs for abating SO_2 emissions would increase by about half in the early years, including years before 2010, and by about 70% after the 3.0 million ton cap has been fully achieved.

Sensitivity Cases

The results reported above provide a good indication of the direction and general magnitude of the effects of reducing the SO_2 cap. Changing the assumptions behind this illustrative but realistic model will lead to different results of course but the basic result will remain. The cost incurred by reducing the SO_2 cap will not be restricted to those future years when the cap is actually reduced. Banking will redistribute those costs over the years surrounding the time when the cap is reduced, including the present, in a manner that will be cost-reducing.

In this section, three variations are discussed briefly: changing the timing and levels of the reduced cap, a higher discount rate, and a lower rate of growth in counterfactual emissions. The effects of these variations, as well as of the base case, are most easily comprehended if the reader keeps in mind that what counts, when banking is allowed and used by affected parties, is the cumulative required reduction in emissions over a relevant economic horizon that is defined by the discount rate and the expected increase in marginal abatement cost.

Changes in the Level and Timing of the Reduced Caps

The importance of the cumulative required reduction in emissions can be illustrated by varying the timing and level of the reduced cap in a manner that is offsetting, for instance, by moving the proposed 2010 reduction of the cap forward one year but raising the level of the new 2009-2017 cap by an amount that would equal, over the eight years 2010-2018, the reduction in allowed emissions in 2009. The effects of this offsetting variation are shown in the second data row of Table 3.

Table 3: Variations in the Level and Timing of Reduced Caps

	Initial Emissions (million tons)	Maximum Bank (million tons)	End of Banking (years)
Base Case	8.45	19.66	20.39
2009 Reduction to 5.04	8.45	17.79	20.39
2009 Reduction to 4.50	8.30	19.02	19.71
2011 Reduction to 4.50	8.59	20.15	21.04
2018 Cap at 2.0 vice 3.0	8.31	21.03	21.49

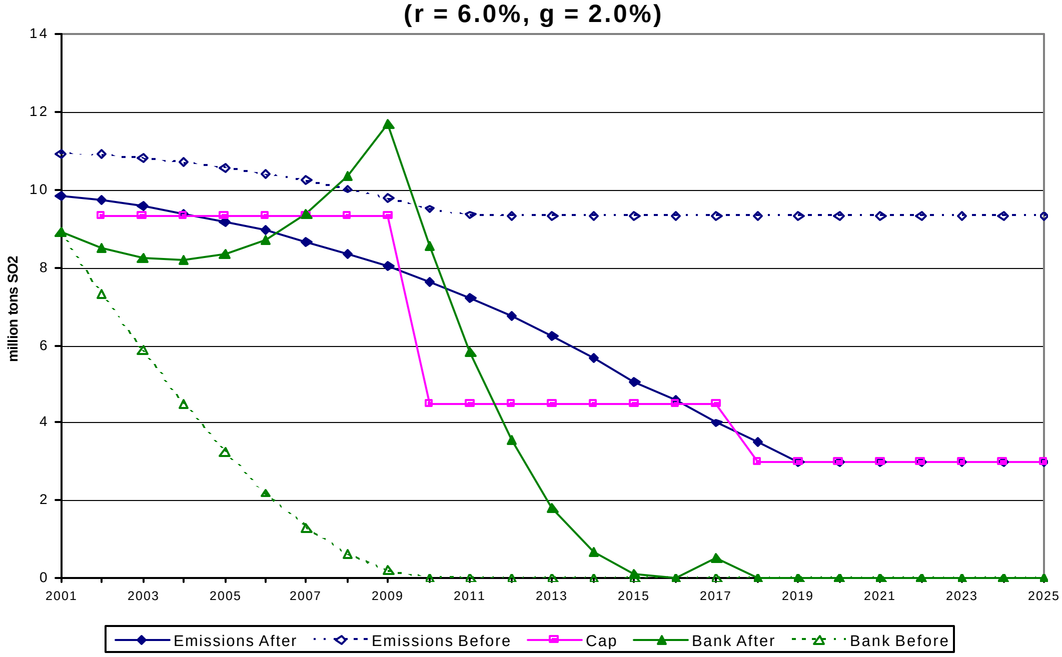
The path of emissions (and of marginal costs) is unchanged: it starts at 8.45 million tons and falls steadily to the eventual cap of 3.0 million tons, which is reached in 2022, exactly as in the base case. All that is different is that the maximum level of the bank is less, although it is exactly what it is in the base case at the end of 2008, because there is one less year to build up the bank. The draw down starts a year earlier, but the amount drawn down in 2009 is exactly offset by the smaller amounts that need to be drawn down in the years 2010 through 2017 because of the higher cap.

The other variations in Table 3 illustrate the same basic result. Moving the 2010 reduction in the cap forward one year (without an offsetting increase in the 2010-17 cap) increases the required cumulative emission reduction and thereby calls forth more abatement at the beginning, which leads to lower emissions and higher costs throughout the banking period. The maximum bank is less and the banking period is shorter because there is less time to over-control and accumulate allowances. Conversely, deferring the 2010 cap reduction by one year requires less cumulative abatement and therefore leads to higher initial emissions, lower costs throughout the banking period, a larger peak bank, and a longer banking period. Finally, reducing the 2018 cap to 2.0 million tons instead of 3.0 million tons increases required abatement during the banking period, as well as ever after, and leads to lower emissions, higher costs, a larger bank, and a longer banking period than in the base case.

A Higher Discount Rate

By any comparison with the past thirty years, current interest rates are low and it could be argued reasonably that a more appropriate discount rate, representing what might be applied on average throughout the future banking period, would be higher. Accordingly, the only sensitivity case tested for the discount rate is a higher one, of 6.0%, one-third higher than today's risk-free rate for a five-year holding, but one closer to the norm during the 1990s. The effect on emissions and banking is shown on Figure 5.

Figure 5: Emissions, Caps, and the Bank
(r = 6.0%, g = 2.0%)



Unlike changes in the level and timing of the reduced caps, a change in the discount rate affects the base case or what would occur without any reduction in the cap. Since a higher discount rate gives more weight to near costs and less to distant costs, less will be abated currently, the inherited bank will be drawn down more quickly, and the banking period will end sooner, even though the required reduction remains unchanged. Thus, as indicated by the before cases in Figures 3 and 5, initial emissions would be 10.95 million tons with a 6.0% discount rate instead of 10.28 million tons with 4.5% and the banking period would end in 2010 instead of 2014.

The proposed reduction of the cap will still lead to more abatement currently and throughout the banking period, but not as much will be banked in the period through 2009 and the banking period will be shorter. As illustrated by Figure 5, the increase in initial abatement, and corresponding reduction in initial emissions, is 1.1 million tons instead of the 1.8 million tons that occurs with the lower 4.5%

discount rate. The banking period is extended to 2016 and then there is a small second banking period surrounding the 2018 reduction in the cap.[9] Moreover, the bank will continue to be drawn down for several more years, albeit at a slower rate. When the new accumulation phase begins in a few years, the bank is built up roughly to its end-of-Phase I level of almost 12 million tons before then being rapidly depleted beginning in 2010.

A higher discount rate has two opposing effects on the value of the existing allowance endowment. Because not as much current abatement is warranted, the marginal cost of abatement and the value of each Class 1 allowance is less than when the discount rate is 4.5%. However, the share of the Class 1 allowances in the total value of the endowment is greater so that the smaller increase in value of a larger share leads to less of a loss in total endowment value, 27%, instead of 29% as occurs with a 4.5% discount rate.

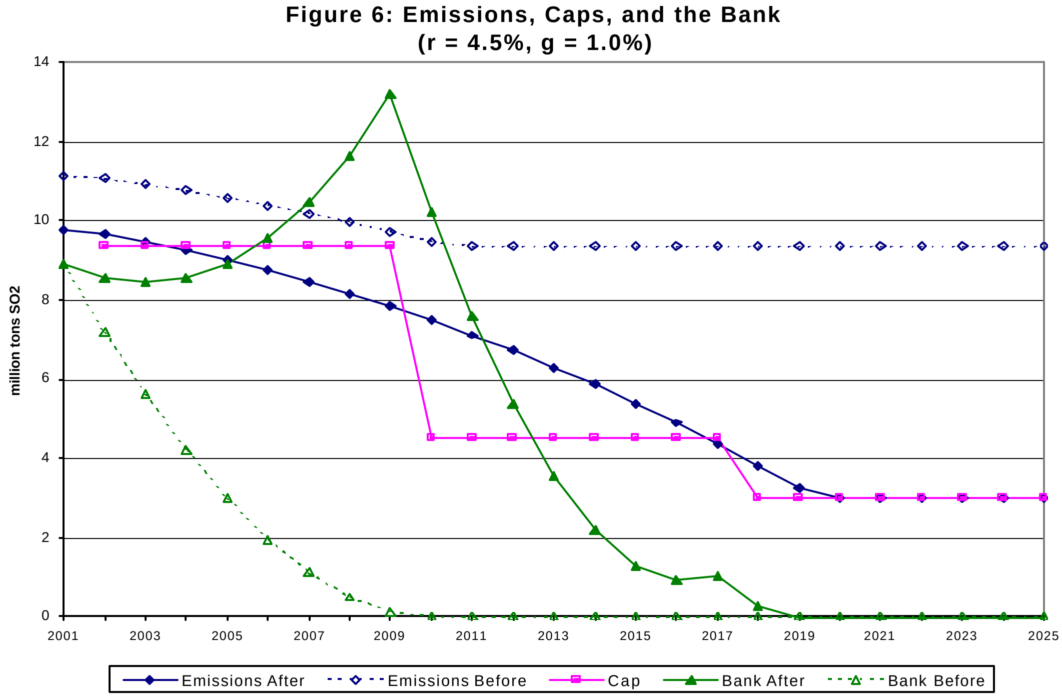
Lower Growth in Counterfactual Emissions

One of the most difficult parameters to estimate is the rate of growth in counterfactual emissions, or what emissions would be if the Title IV and the proposed reduced caps were not in place. This rate reflects assumptions about growth in the American economy, the role of electricity in that growth, and the share of coal-fired electricity, which depends heavily upon relative price comparisons between coal and natural gas, as well as the competitiveness of coals of differing sulfur content in coal markets independently of sulfur content.[10] The rate used in the base case, 2.0%, is in fact less than has occurred since the year before Title IV went into effect. As of 2000, heat input at Title IV affected units has increased at a rate of 3.2% per annum and, based upon the emission rates prevailing before these units became subject to Title IV, counterfactual emissions would have increased by 2.5% per annum.[11] Still, this may seem to many to be a high rate of growth and Figure 6 illustrates the effect of a 1.0% rate of growth in counterfactual emissions as might be the case with relatively low natural gas prices, marked improvements in the efficiency of power plants, or less growth in the demand for electricity.

[9] This mini-banking period around 2018 deserves some note. It occurs because of two conditions. First, the 6% discount rate is not low enough to extend the banking period occasioned by the 2010 reduction of the cap beyond 2017. Second, the 6% discount rate is lower than the 7% difference in marginal costs in 2018 between the 4.5 million ton and the 3.0 million ton caps.

[10] As discussed in Ellerman and Montero (1998), SO_2 emission declined considerably in the years before Phase I began because reductions in rail rates made low sulfur coal from the Powder River Basin economically competitive in the Midwest on the basis of its Btu value alone.

[11] The rate of increase in counterfactual emissions is less than the rate of increase in heat input because generation has shifted to lower emitting units. Some of this shift may be due to Title IV.



The primary effect of a lower rate of growth in counterfactual emissions is to reduce the required abatement over all time periods. Less abatement will be required at the end of the banking period and that in turn implies less abatement and lower costs over all time periods. Less required abatement also implies a shorter banking period and less of a re-accumulation of allowances in anticipation of the 2010 reduction in the cap. When compared with the 2.0%-growth case, the end-of-2009 bank is 13 million tons instead of 20 million tons and the existing bank will be drawn down some more before re-accumulation starts. The initial increases in abatement and in marginal abatement cost due to the proposed reduction in the SO_2 cap are less than if counterfactual emissions were growing at 2% per annum: 1.25 million tons of abatement instead of 1.75 million tons, and a 19% increase in marginal abatement cost instead of 26%.

Finally, the loss in the value of the allowance endowment is less in percentage terms: 24% in the 1.0%-growth case instead of 29% in the base case. The endowment is worth less when counterfactual emissions are growing at 1%, and the loss of value due to a reduction of the cap is less due to an effect similar to that of a higher discount rate. Because marginal costs are not increasing as rapidly in the far years (while still being discounted at the same discount rate), Class 2 and Class 3 allowances account for less of total endowment value in the 1%-growth case. Thus, even though the increase in the price of each Class 1 allowance is less, the loss in total endowment value is not as great because the classes losing value constitute a smaller share of total value.

Conclusion

The most important result emerging from this analysis is not that costs will increase with a reduction of the SO_2 cap. This is obvious. The main lesson is that banking will distribute the costs of a reduction in the cap over many years beginning in the present, including before the reduction is enacted, and extending to several years after the last reduction of the cap. Even so, and with all the uncertainties about discount rates, rates of growth in counterfactual emissions, and the level and timing of the reduced caps, several robust conclusions emerge. The banking period will certainly be extended and a new phase of accumulation will begin, if not immediately, then in a few years. Although some of the emission reduction and the resulting cost increase will occur immediately, most of these effects will be felt in the later years. The exact balance between near and far abatement and cost will depend upon the discount rate whose main role is to determine the rate at which the economy absorbs the higher cost implied by the reduced cap.

This redistribution of the cost burden through banking will be efficient from an economic point of view; and it will be advantageous from an environmental point of view in that the required emission reduction will take place sooner than it would without banking. The introduction of this proposal does however introduce a new element of volatility into SO_2 allowance markets as expectations of enactment enter into the formation of current prices. It is possible that the prospects of enactment will grow steadily stronger over time so that the incorporation of these expectations into current prices will create an efficient transition, but it is at least as likely that those prospects will wax and wane as the legislative process is engaged with resultant effects on allowance prices and abatement effort.

The President's proposal also introduces a new wrinkle in emissions trading, namely, the effect on the value of the SO_2 allowances that have already been distributed under the existing provisions of Title IV. The value of the existing endowment will be reduced by 25% to 30%, but the important issue is how the final legislation will deal with the coverage ratios of the allowances already distributed. Nothing in the law prohibits Congress from revising, or even revoking, these quasi-property rights, but how the revision is handled will make a large difference in emission outcomes, especially over the next few years. Title IV continues, of course, and the existing allowances will be required for coverage of SO_2 emissions with each succeeding year; but there should be no doubt that, if the ability to cover emissions of currently banked allowances, or those that would be banked prior to the proposed reduction in the emissions cap, is threatened, currently banked allowances will be used and little banking would occur between the present and the time of the first reduction in the cap. The consequences would to increase emissions in the near term and to lose the economc advantages of banking both prospectively and as has occurred to date under Title IV.

Finally, lest any reader give too much importance to the numbers provided here, which are intended to be both indicative and realistic, mention must be made of two important considerations that have not been included. First, the extent to which abatement technology may change over the economically relevant horizon has not been incorporated into the analysis. These changes can be expected to be cost-reducing; and to the extent that they are, future costs will not be as great is indicated in the preceding analysis. Moreover, if these changes in technology are correctly anticipated and incorporated into price expectations, current costs will be lower, and emissions higher, than they would otherwise be.

The second excluded factor is the effect of the NO_x and mercury caps that would accompany the proposed reduction in the SO_2 cap. On the one hand, the caps on these other two pollutants will surely add to the total costs facing electric utilities and consumers. On the other hand, the sources are the same industrial processes and actions to abate one pollutant will often reduce emissions of the other so that the cost will not be as great as it would be if each cap were considered independently. Even without inter-pollutant trading, there is every reason to believe that agents will take all interaction effects into account in deciding how to attain the three caps jointly and that these actions will depend on the value of allowances in the three independent but related markets. No attempt has been made here to consider these interaction effects, but they promise to be important and to offer a rich field for analysis.

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