CAP AND TRADE: A BEHAVIORAL ANALYSIS OF THE SULFUR DIOXIDE EMISSIONS MARKET

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INTRODUCTION

The cap and trade program established by Title IV of the Clean Air Act is intended to facilitate the efficient reduction of sulfur dioxide emissions.[1] Since power production inevitably creates some pollution, the program aims to (1) keep pollution to a reasonable level and (2) make sure that society extracts the most benefit possible from each ton of pollution emitted.[2] The overall cap on emissions ensures that the first condition will hold, while the efficient operation of the market is supposed to provide the second. Emission allowances are allocated through a nakedly political process;[3]

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1. For a discussion of the passage of the Clean Air Act, see generally Brian L. Ferrall, *The Clean Air Act Amendments of 1990 and the Use of Market Forces to Control Sulfur Dioxide Emissions*, 28 HARV. J. ON LEGIS. 235 (1991). For background on the theory underlying the market in sulfur dioxide emissions permits, see Jonathan Remy Nash & Richard L. Revesz, *Markets and Geography: Designing Marketable Permit Schemes to Control Local and Regional Pollutants*, 28 ECOLOGY L.Q. 569 (2001); Lisa Heinzerling, *Selling Pollution, Forcing Democracy*, 14 STAN. ENVTL. L.J. 300 (1995). For a critique of the previous regime, see Bruce A. Ackerman & Richard B. Stewart, *Reforming Environmental Law*, 37 STAN. L. REV. 1333 (1985). For a look at how utilities have responded to the Clean Air Act, see generally Byron Swift, *How Environmental Laws Work: An Analysis of the Utility Sector's Response to Regulation of Nitrogen Oxides and Sulfur Dioxide Under the Clean Air Act*, 14 TUL. ENVTL. L.J. 309 (2001). The market mechanism for environmental improvement has been successful enough that proposals have been made to extend the model to non-emissions contexts. *See* David Sohn & Madeline Cohen, *From Smokestacks to Species: Extending the Tradable Permit Approach from Air Pollution to Habitat Conservation*, 15 STAN. ENVTL. L.J. 405 (1996).

2. As a side benefit, a market in emissions allows observers to infer valuable information about the cost of emissions reduction.

3. *See* Ferrall, *supra* note 1, at 246–48.

however, according to Coase's theorem, they will still be put to an efficient use if transaction costs are sufficiently low.[4]

Much of the work in the field of behavioral economics has called into question the validity of Coase's theorem.[5] These studies undercut Coase's assumption that firms that have been allocated allowances behave as rational, profit-maximizing entities. If this assumption does not hold, then the initial allocation of allowances could lead to inefficient utilization of allowances, even in a market with low transaction costs.

An inefficient market imposes unnecessary compliance costs on the power industry. To the extent that environmental regulations are restrained by the costs that regulations impose on industry, this will lead to unnecessarily lax emissions restrictions. In addition, an inefficient market would not provide observers with accurate information about abatement costs, neutralizing one of the useful side effects of emissions allowance markets. Finding a way to counteract the biases identified by behavioral economics (and removing other obstacles to the efficient operation of the market) could thus allow the imposition of tighter standards and provide the public with more accurate information.

This Note provides an overview of the sulfur dioxide emissions permit market, with an eye for how it could be improved. This information can be used to improve the performance of the sulfur dioxide allowance market, or incorporated into new emissions allowance markets to improve their operation. Part I of this Note provides background information on the creation and operation of the sulfur dioxide emissions market. Part II engages in an economic analysis of the interaction between the emissions allowance market and the power industry. Part III then identifies and describes some barriers to efficient trading. Part IV reports and ana-

4. Ronald Coase developed his theorem in *The Problem of Social Cost*, 3 J.L. & ECON. 1 (1960).

5. The most notable problems being the endowment effect and its cousin, loss-aversion. For background information about the endowment effect, see Russell Korobkin, *The Endowment Effect and Legal Analysis*, 97 NW. U. L. REV. 1227 (2003); Daniel Kahneman et al., *Experimental Tests of the Endowment Effect and the Coase Theorem*, 98 J. POL. ECON. 1325 (1990).

Many areas have shown signs of loss-averse behavior. *See* Stephen McG. Bundy, *The Policy in Favor of Settlement in an Adversary System*, 44 HASTINGS L.J. 1, 13–14 (1992) (civil litigation decisions); Nicholas L. Georgakopoulos, *Frauds, Markets, and Fraud-on-the-Market: The Tortured Transition of Justifiable Reliance From Deceit to Securities Fraud*, 49 U. MIAMI L. REV. 671, 701 (1995) (investment decisions); Amos Tversky & Daniel Kahneman, *Loss Aversion in Riskless Choice: A Reference Dependent Model*, 106 Q.J. ECON. 1039, 1040–42 (1991) (consumers).

lyzes data regarding the actual behavior of the market from 1995 to 2003.

Finally, Part V will explore how auctioning allowances[6] instead of giving them away could alleviate many of the problems identified in Part III. While implementing such a system for the sulfur dioxide allowance market would represent a large welfare transfer, it is at least worth considering and represents a much more attractive system for allocating allowances in other markets created in the future.

I.
BACKGROUND INFORMATION ON THE SULFUR DIOXIDE MARKET

A. The Clean Air Act Amendments of 1990

Congress passed several major amendments to the Clean Air Act in 1990.[7] The most innovative and controversial of these amendments was Title IV, which introduced a market-based technique for controlling the pollutants that form the key components of acid rain: sulfur dioxide and nitrous oxide.[8] This Note will focus on the Act's treatment of sulfur dioxide and its consequences.

The key innovation of the sulfur dioxide program was that it created tradable emission allowances, subject to an overall cap.[9] This replaced the previous program, which mandated that all nongrandfathered utilities emit sulfur dioxide at a specified rate per million BTUs generated.[10] Under the system of emission al-

6. This would be roughly analogous to the spectrum auctions conducted in the nineties. For a historical background on the spectrum auctions, see John McMillan, *Selling Spectrum Rights*, J. ECON. PERSPECTIVES, Summer 1994, at 145; Ruth W. Pritchard-Kelly, *A Comparison Between Spectrum Auctions in the United States and New Zealand*, 20 MD. J. INT'L L. & TRADE 155 (1996). For theoretical background on the justifications for spectrum auctions, see R. H. Coase, *The Federal Communications Commission*, 2 J. L. & ECON. 1 (1959); Peter Cramton, *The Efficiency of the FCC Spectrum Auctions*, 41 J. L. & ECON. 727 (1998). *But see* Stuart Buck, *Replacing Spectrum Auctions with a Spectrum Commons*, 2002 STAN. TECH. L. REV. 2 (arguing that appropriate allocation of spectrum rights is common ownership).

7. *See generally* Ferrall, *supra* note 1.

8. 42 U.S.C. § 7651 (2000).

9. *See* Nash & Revesz, *supra* note 1, at 582 (discussing the sulfur dioxide trading market).

10. The program allowed producers to use an equivalent alternative prescribed technology. *See* Ackerman & Stewart, *supra* note 1, at 1335 (describing the then-existing regulatory regime).

lowances, a firm's only obligation is to have sufficient allowances to cover its total annual emissions.[11]

This change in focus gives firms an economic incentive to reduce emissions as far as is practical, instead of simply reducing them by the minimum amount necessary to comply with the law. Any reduction in emitted sulfur dioxide allows the abating firm to sell excess allowances or to avoid purchasing allowances in the first place.

Title IV implemented this cap and trade approach in two phases.[12] In Phase I, from 1995 to 2000, only certain targeted power plants were subject to the cap.[13] Under Phase II, the current regime, almost all power generating units must comply with the cap.[14]

Phase I was marked by significant over-compliance.[15] The amount of allowances issued each year varied significantly, as utilities received bonus allowances for installing scrubbers and non-targeted firms' voluntary participation in the program varied.[16] However, total emissions were well under the cap every year.[17] Firms anticipated that allowances would become much more valuable under Phase II, as the number of emissions sources regulated would dramatically increase while the cap remained constant. Accordingly, they responded by reducing emissions farther than the law mandated.[18]

By the time Phase II began, firms had banked more than ten million tons of sulfur dioxide emissions allowances.[19] They have drawn down on those savings in order to cushion the impact of the more stringent cap in Phase II.[20] This drawdown prevented the price of pollution allowances from increasing dramatically as the

11. 42 U.S.C. § 7651c–d (2000).

12. *See* 42 U.S.C. § 7651a(28) (2000) (defining the beginning of Phase II).

13. 42 U.S.C. § 7651c (2000). The list of targeted plants is in Table A of 42 U.S.C. § 7651c(e) (2000).

14. 42 U.S.C. § 7651d (2000).

15. EPA Clean Air Markets Division, 2004 EPA Retired Allowances Database (2004) [hereinafter EPA Retired Allowances Database] (on file with the *NYU Annual Survey of American Law*).

16. The rules regarding the variable credit allocations are specified in 42 U.S.C. § 7651c(b). The variable credit issuance itself is visible in the EPA Retired Allowances Database, *supra* note 15.

17. EPA Retired Allowances Database, *supra* note 15.

18. Swift, *supra* note 1, at 325.

19. EPA Retired Allowances Database, *supra* note 15.

20. 2002 EPA Acid Rain Program Progress Rep. 2, 5, *available at* http://www.epa.gov/airmarkets/cmprpt/arp02/2002report.pdf [hereinafter EPA Compliance Report 2002].

program transitioned from Phase I to Phase II.[21] Under Phase II the EPA allocates approximately 8.95 million tons of emission allowances to firms for each vintage year.[22] The EPA also issues special allowances for various reasons,[23] and the total amount of emission allowances issued for each year has been approximately 9.5 million tons.[24]

Firms are not limited to trading active (currently redeemable) allowances—they may trade future allowances as well. The EPA gives a firm that is allocated X tons of annual allowances X vintage-2000 allowances, X vintage-2001 allowances, X vintage-2002 allowances, and so forth.[25] Allowances can be retired to cover sulfur dioxide emitted in the year of their vintage or banked and later retired to cover emissions for any year afterwards.[26]

The mechanics of the allowance system are simple. The EPA maintains an Allowance Tracking System, which tracks the ownership of all existing sulfur dioxide allowances.[27] Firms are required to report all allowance transfers to the EPA, which then updates the Allowance Tracking System.[28] The EPA tracks firms' sulfur dioxide emissions over the course of the year, and firms are required to retire allowances equal to their total emissions at the end of the year.[29]

The Title IV cap and trade program has been a success by any measure. Sulfur dioxide emissions in 2002 were down more than 40 percent from their 1980 levels and down 35 percent and 14 percent from 1990 and 1995, respectively.[30] These reductions have

21. *Id.* at 5.

22. 42 U.S.C. § 7651b (2000). Exceptions to bonus allocations are discussed in 42 U.S.C. § 7651c(b) (2000).

23. 42 U.S.C. § 7651d(a)(2), (a)(3) (2000) provide for bonus allocations.

24. The existence of these excess allowances can again be seen in the EPA Retired Allowances Database, *supra* note 15.

25. 42 U.S.C. § 7651a(3) (2000) provides that allowances are tied to a particular calendar year.

26. 42 U.S.C. § 7651a(3) (2000) states that an allowance authorizes an emission "during or *after*" (emphasis added) a specified calendar year.

27. The Allowance Tracking System is mandated in 42 U.S.C. § 7651b(a)(1)(d) (2000).

28. 42 U.S.C. § 7651b(a)(1)(d)(1) specifies that allowance transfers are finalized *after* they are recorded in the Allowance Tracking System.

29. Pursuant to regulations passed by the Administrator under 42 U.S.C. § 7651b(d)(1).

30. EPA Compliance Report 2002, *supra* note 20, at 2.

been achieved at a surprisingly low cost.[31] Of course, the system could still be made to work more efficiently.

B. Market Participants

Power generating companies directly own 45 percent of the allowances that have been banked from previous years.[32] Allowance brokers hold the vast majority of the remaining credits. Some of these allowances are being held for individuals, while some are being held for power companies, as it is less costly for some firms to trade through brokers than to trade directly with other firms.[33] Power companies retired the vast majority of allowances that have been retired over the course of the emissions trading program, and power companies own almost all of the allowances for future vintage years.[34]

Accordingly, when this Note refers to participants in the sulfur dioxide allowances market, it is generally referring to power plants. While the behavior of outside investors and environmentalists is interesting, it does not have a noticeable effect on the market as a whole.

Power companies have been one of the most heavily regulated groups of companies in the United States ever since the collapse of several pyramid schemes involving power-generating companies in the 1930s.[35] Many plants' top levels of management are comprised

31. *See generally* A. DENNY ELLERMAN ET AL., MARKETS FOR CLEAN AIR: THE U.S. ACID RAIN PROGRAM (2000) (evaluating the impact of Title IV on sulfur dioxide emissions).

32. Telephone Interview with Alex Saltpeter, EPA (Jul. 12, 2004). This might appear to be a low percentage. However, most firms that trade allowances will trade them through a broker, in the same way that most individuals who trade stock holdings generally trade through a broker instead of actually attempting to sell physical copies of stock certificates to other investors.

In addition, it makes sense that most of the traded allowances remain banked, rather than being retired. This is because of the tax treatment of allowances; an allowance that has been sold has a cost basis of its sales price, so that future sales of that allowance will incur less of a tax liability than would selling an allowance that has never been traded. Accordingly, a firm with a choice between the two will choose to retire the allowance that has never been traded.

Also, keep in mind that the currently banked allowances represent less than 10 percent of all of the 2003 and earlier vintage year allowances issued.

33. Email from Harvey Reid, EPA, to Jacob Kreuzter, NYU (Jul. 8, 2004) (on file with the *NYU Annual Survey of American Law*).

34. EPA Retired Allowances Database, *supra* note 15.

35. For a historical examination of utility regulation, see 2 ALFRED E. KAHN, THE ECONOMICS OF REGULATION: PRINCIPLES AND INSTITUTIONS (1971).

of a publicly elected board.[36] States have recently started to move towards deregulating power generation, which should have interesting side effects on plant participation in the market for allowances, but a full survey of the current state of the power industry is beyond the scope of this Note.

C. *Summary of Available Pollution Reduction Methods*

This section provides a brief description of the methods available to power plants to reduce their sulfur dioxide emissions. It is easier to predict how firms will behave when we understand some of the physical constraints under which they operate.

1. Use of Low-Sulfur Coal

Most coal-fired plants can retrofit their boilers to handle bituminous low-sulfur coal for a very low cost, typically between $5 and $10 per kilowatt (kW) of capacity.[37] The main cost involved in switching to the lower sulfur coal is the increased cost of the coal itself.[38] Lower sulfur coals command a price premium because low-sulfur bituminous coal (mostly from the east coast) is less common than high-sulfur bituminous coal.[39]

Since the market in emissions allowances began operating, sulfur content has become a factor priced into the cost of coal.[40] Where the market was previously divided into "high sulfur" and "low sulfur" coal, the emphasis that the Clean Air Act put on making every ton of emissions count created a gradient of types of coals, with the price increasing as the sulfur content decreases.[41] Some plants were able to reduce sulfur dioxide emissions significantly simply by switching from high sulfur to medium sulfur coal.[42]

A switch to lower sulfur coal can also be implemented more quickly than other emission abatement methods. While installing scrubbers takes eighteen to thirty months from the time that the

36. *See* Heinzerling, *supra* note 1, at 333 (discussing some of the obstacles that this regulation can create for allowances transactions).

37. Swift, *supra* note 1, at 338.

38. For example, in 2003 Appalachian low-sulfur coal carried a premium over medium-sulfur coal of $.99 or $1.16 per ton of coal used for the Central and Southern Appalachian regions, respectively. ENERGY INFORMATION ADMINISTRATION ANNUAL ENERGY OUTLOOK REPORT, Supplemental Table 112, http://www.eia.doe.gov/oiaf/aeo/supplement/pdf/suptab_112.pdf [hereinafter Coal Price Report].

39. *Id.*

40. Swift, *supra* note 1, at 339.

41. *Id.*

42. *Id.* at 337.

installation decision is made,[43] firms can switch to lower sulfur coal as quickly as they can renegotiate their fuel supply contract.[44]

2. Use of Extra Low-Sulfur Subbituminous Coal

Subbituminous coal mined in the western United States has extremely low sulfuric content (at or below 0.6 lb/mmBtu (pounds per million British termal units), compared with 1.2 lb/mmBtu for Appalachian low-sulfur coal).[45] However, the nature of the coal makes it more difficult to burn than eastern bituminous coals, requiring more extensive retrofitting of existing plants (which typically costs between $50 to $75 per kW of capacity).[46] Subbituminous coal is mined in large quantities from Idaho and Montana, so once the retrofit is complete ongoing costs are relatively minor.[47] This makes using this type of coal a sort of halfway step between switching to low sulfur bituminous coal and installing scrubbers.

In addition, some firms have experimented with burning mixes of subbituminous and bituminous coals.[48] This requires less extensive capital investment and still results in lowered sulfur dioxide emissions.[49]

3. Installation of Flue Gas Scrubbers

Flue gas desulphurization, or "scrubbing," is a technology that uses chemical reactions to remove sulfur dioxide from the smoke produced by a power plant before releasing it into the environment.[50] Scrubbers are expensive to install but are cheap to operate once in place.[51] The low operating costs make scrubbers a good abatement solution for large plants, while the high installation costs make scrubbers impractical for smaller plants (unless the price of an allowance is very high).

Since the beginning of the cap and trade program, scrubber costs have been going down.[52] Improvements in scrubber technol-

43. *Id.* at 331.
44. *Id.* at 338.
45. *Id.* at 336–37.
46. *Id.* at 336, 338.
47. Subbituminous coal from the Powder Basin/Green River area cost only $7.12 per ton in 2004, compared with a price of $30 to $34 per ton for Eastern low sulfur coals. Coal Price Report, *supra* note 38.
48. Swift, *supra* note 1, at 392–93.
49. *Id.*
50. Ellerman et al., *supra* note 31, at 241–42.
51. *Id.*
52. Swift, *supra* note 1, at 332.

ogy have been driven by competition with other emission reduction methods and by the changed emphasis of the Clean Air Act.[53]

Under the previous regime, some firms were simply required to maintain a very low rate of emissions per unit of power generated.[54] The only way to meet this standard was by installing scrubbers. Accordingly, scrubber manufacturers did not have to worry about plants switching to an alternative method of emission reduction. Under the Clean Air Act today, this is no longer the case. The increased competition has given scrubber manufacturers more incentive to innovate.[55]

The pre-1995 Clean Air Act also enacted heavy fines for any violation of the rate restrictions.[56] This meant that scrubbers had to be extremely reliable, which led to excessive redundancy in design.[57] Under the cap and trade program, companies that build scrubbers focus on removing as much sulfur dioxide as possible as cheaply as possible.[58] Designing scrubbers to be reasonably reliable (rather than almost perfectly reliable) has helped to lower the installation and operating costs associated with scrubbers.[59]

4. Reduction in or Relocation of Electricity Generation

Firms can always reduce emissions by reducing the amount of electricity that they generate. This can be a very expensive proposition, especially for plants that are already using relatively clean power generation technology.

One cost effective way of reducing emissions is to relocate electricity generation. Several firms have reduced their total emissions by reducing the amount of electricity generated at smaller, dirtier plants and making up the difference at larger plants that use clean power generation technology, like scrubbers.[60]

53. *Id.* at 332–35.
54. *See id.* at 334.
55. *Id.* at 333–34.
56. *Id.*
57. *Id.*
58. *Id.* at 334–35.
59. *Id.* at 334.
60. *Id.* at 333.

II.
MODELING THE INTERACTION BETWEEN THE ALLOWANCE MARKET AND FIRM BEHAVIOR

The goal of this part of the Note is to describe how we would expect rational participants in the sulfur dioxide emissions market to behave. Though this is at best an approximate description of how real players in the market behave, it does provide an idea of what an efficient market would look like.

Given the overall cap on emissions, one might question the importance of an efficient market in emissions permits. Assuming the cap is enforced, emissions will not go over the preset level no matter how inefficiently the market behaves. However, an inefficient market could have a number of bad real world consequences, ultimately raising the total social cost of reducing emissions. To the extent that lowering the cap on emissions is constrained by the cost of compliance, such costs could prevent Congress from enacting more stringent environmental safeguards in the future.

The first section discusses the ways that the market can affect the emissions behavior of power plants. The price of an allowance can have a strong effect on the amount that firms spend on abatement, and on the overall level of electricity generated. If the price is set incorrectly, from the point of view of an actor not subject to any of the behavioral biases discussed in Part III, firms could waste a lot of money.

The next section examines the way that the real world affects the market price of allowances. In a cap and trade regulatory regime, the price of an allowance is set by the supply and demand for the allowances on the market. Supply and demand are affected by advances in abatement technology, demand for electricity, and market players' cognitive biases.

A. Market Effects on Power Plant Behavior

Many articles have been written about the effect that the Clean Air Act has had on polluter behavior. The Act achieves these results through the market's influence on firms. This section will attempt to explain how rational firms would react to changes in market prices.

1. Allowance Prices and Abatement Costs Drive Abatement Expenditures

Each firm on the market should abate emissions until the cost of abating another ton of sulfur dioxide is equal to the market price for a one-ton emission allowance. If the cost of the next ton of abatement is higher than the market price, then the firm should purchase an additional allowance instead of abating the emission. Conversely, if the cost of the next ton of abatement is lower than the market price, then the firm with the low abatement costs should continue to abate pollution until its marginal costs for each ton of abatement is equal to its marginal benefit.

This relationship is complicated by administrative issues associated with the use of an allowance. Since the firm does not have to settle its account with the EPA until the end of the year, it has to guess what the future value of an allowance will be when making its decisions regarding emissions. Although the current price would reflect the best estimate of the future price in an efficient market, the market price of allowances has been quite volatile; so, even a good estimate could still prove to be far off the mark in a relatively short period of time.

Additionally, firms are not able to change their sulfur dioxide emissions instantly in response to changes in market price. Switching to lower sulfur coal may be delayed by the existence of a long term supply contract, while other methods of emission abatement, such as the installation of scrubbers, require long term capital improvements to the plant.[61]

The other factor that could cause firms to fail to comply with this principle is that some of them simply might not be rational profit-maximizers. Part III will examine this issue in more detail.

2. Allowance Prices and Profits Derived From Emissions Drive Emissions Decisions

Another way of expressing the relationship above is that firms should continue emitting sulfur dioxide until the profit they gain from emitting another ton is less than the market price for an allowance. If the market price is below the value of the next ton of emissions, the firm should emit sulfur dioxide until the marginal cost matches the marginal benefit. If the price is above the value of the next ton of emissions, then the firm should refrain from emitting the previous ton of sulfur dioxide and instead should sell (or refrain from purchasing) the associated allowance.

This reframing is most useful when considering the options facing a new firm. A modern, clean power plant can generate a lot

61. *Id.* at 331.

of electricity for each ton of sulfur dioxide that it emits.[62] This would lead the owners of the firm to place a very high value on emission allowances. This helps to explain why new plants have not had as much trouble obtaining allowances as some predicted.[63] They naturally place a higher value on the allowances than do firms that own older plants, which means that they would be willing to pay the market price for allowances.

3. All Firms Should Emit Until They Reach the Same Marginal Cost of Reduction

All firms should continue to emit until they reach the point at which the marginal cost of reduction is equal to the marginal price of an allowance. Implicit in this statement is the fact that in an efficient market all firms should have the same marginal price for their next ton of emission reduction. An example will serve to illustrate why this is so.

Consider Albert's coal-fired power plant. This plant has some unusual characteristics. When it is running flat out it generates one thousand tons of sulfur dioxide emissions per year. Albert can reduce these emissions, but at a gradually increasing marginal cost. Reducing emissions by one ton would cost him one dollar. Reducing emissions by another ton would cost him two dollars. In general, abating the Nth ton of emissions would cost Albert N dollars. Albert's friend Bert owns an identical power plant.

Albert and Bert differ, however, in the number of tons by which they decide to reduce their emissions. Albert decides to reduce emissions until the marginal cost of reduction reaches $43, while Bert decides to reduce emissions until the marginal cost of reduction is $51. Thus, Albert abates forty-two tons of sulfur dioxide emissions, while Bert abates fifty tons.

62. Among other things, a new plant faces a lower marginal cost to install clean technology when compared to an old plant that has to pay for a retrofitting, just as it is cheaper for the car manufacturer to install a more powerful engine than it is for you to replace the original engine with a more powerful one. *See* Robert N. Stavins, *Vintage-Differentiated Environmental Regulation*, 25 STAN. ENVTL. L.J. 29, 30 (2006) ("[I]t is frequently more cost-effective—in the short term—to introduce new pollution-abatement technologies at the time that new plants are constructed than to retrofit older facilities with such technologies.").

63. See Heinzerling, *supra* note 1, at 331, for an example of concerns about the effects of allowance allocation on new entrants into the market. An unpublished paper by EPA employees Reid Harvey, Joe Kruger, and Bill Irving, U.S. Experience with SO_2 and NO_X Allowance Allocations 9–11 (Sept. 12, 2003) (on file with the *NYU Annual Survey of American Law*), documents the lack of an observed barrier to new entrants.

When different market participants do not all reach the same marginal costs of abatement, money is being wasted. In the previous scenario, a total of ninety-two tons of emissions have been abated. The efficient way to do this would have been for both Albert and Bert to abate forty-six tons.[64] Instead, Albert only abated forty-two tons, and Bert spent $47, $48, $49, and $50 to abate an extra four tons (instead of Albert spending $43, $44, $45, and $46). Society as a whole is worse off by $16.

The preceding analysis posits a world in which each market participant operates a single power plant. In the real world, many participants own multiple power plants, but this does not change the analysis. Since intra-firm trading is free, it is reasonable to think of a multi-plant firm as simply operating one very large plant, and to aggregate the abatement costs of all of the plants owned by a firm.[65]

4. Options Availability Gives Firms More Choices

Several brokerages offer derivative contracts, such as options, on pollution allowances.[66] These options' prices generally conform to the Black Scholes formula[67] for valuing options. This allows power plants to specify an exercise deadline and strike price to a broker who will then figure out the appropriate price to charge for the option.

The existence of the options market gives firms an alternative method to limit their future allowance costs. For example, a firm that usually emits—and is allocated allowances to cover—one thou-

64. Note that the efficiency springs from equalizing the marginal costs, rather than equalizing the amount abated. The two are only equivalent here because by hypothesis both of the plants involved are identical.

65. Imagine Albert owned two plants: one can abate one ton of emissions for $2 and two tons for $5; the other can abate one ton of emissions for $3 and two tons for $7. From an abatement perspective, we can treat this situation as if Albert owned one plant that can abate one ton of emissions for $2, two tons for $5, three tons for $8, and four tons for $12.

66. *See, e.g.*, Amerex – Energy: Emissions, http://www.amerexenergy.com/emissions.aspx (last visited April 12, 2006) (advertising the availability of forward contracts on allowances).

67. Modern financial tools allow brokers to price the right to purchase a given asset on some future date. The factors affecting this calculation are the current price of an asset, the asset's volatility, the exercise price of the option, the date on which the option expires, and the prevailing interest rate. A higher current price, more distant exercise date, higher volatility, or lower exercise price will all lead to a more expensive option. The exact calculation involved was first set out in Fischer Black & Myron Scholes, *The Pricing of Options and Corporate Liabilities*, 81 J. POL. ECON. 637 (1973).

sand tons of sulfur dioxide per year could buy one thousand call options with a strike price $10 above the market price and an expiration date one year in the future. The firm could then sell the one thousand emission allowances that it was allocated for that year. The firm can then use the money from this transaction to benefit the firm for a year before re-purchasing the allowances. The call options guarantee that they will not have to pay more than $10 above the current market price when the time comes to cover their emissions obligation.

We would expect to see firms take advantage of options contracts if they were to treat emissions allowances the same way that they treat other power plant consumables, like coal. Power plants do not stockpile a yearly supply of coal every January; rather, they contract out to have coal delivered as they need it. Similarly, it does not make sense for them to hold on to emissions allowances for the whole year when they do not need them until it comes time to settle their account with the EPA. An options contract allows them to get rid of their allowance stockpile, and have the allowances delivered to them at the end of the year when it is time for them to be retired.

5. Non-Polluters Participate for Investment or Idiosyncratic Reasons

A small portion of market activity comes from individuals and firms that do not emit sulfur dioxide. These individuals can generally be divided into two groups: environmentalists and speculators.

Environmentalists purchase allowances in order to retire them without emitting any corresponding sulfur dioxide. By doing so, they reduce the total amount of sulfur dioxide that can ever be emitted under the cap and trade program. They also have the effect of reducing the supply of allowances available to the rest of the market, which in theory would result in higher prices and immediately lower the amount of sulfur dioxide emitted. However, the relatively tiny volume of such purchases renders any such effect practically invisible.[68]

The other group consists of outside investors who buy allowances when they perceive them to be undervalued, and sell when they perceive them to be overvalued. In sufficient volume, these investors could act as an important source of efficiency by making the market more liquid and by keeping power companies in check by providing an independent source of estimates about the future value of allowances. However, outside investors also par-

68. Email from Harvey Reid, EPA, to Jacob Kreuzter, NYU (Jul. 8, 2004) (on file with the *NYU Annual Survey of American Law*).

ticipate in the market at such low volumes that their participation has had only negligible effects.

6. Drawing Conclusions

The relationships discussed in subparts one and two are useful but limited. Given the cost of the last ton of pollution abated, we can determine the correct price of a pollution allowance. Conversely, given the price of a pollution allowance, we can deduce the cost of the last ton of pollution abated. However, this does not tell us what the price of an allowance should be (or, equivalently, at what price per ton companies should stop paying for pollution abatement). In order to determine the correct price to put on a one-ton emission allowance, we must turn to an analysis of the supply of and demand for emission allowances.

B. Technology and Expectations Affect the Market

Since we know the real world constraints that power companies operate under, we can estimate the supply and demand for emissions allowances. However, the market for allowances is different from a normal market in goods. The government introduces 9.5 million tons worth of credits into the market every year, regardless of the existing market conditions.[69] Since we know that not all outstanding allowances are retired each year,[70] the supply curve must be generated by something besides the total existing number of allowances.

The best way to model the market for pollution allowances is to treat power plants as both suppliers and consumers of allowances. We can think of a plant as having a separate “allowance holding” division and “sulfur dioxide emission” division. Presumably firms would only decide to transfer allowances between divisions when it is worth more to emit sulfur dioxide and retire the allowances than it is to continue to hold on to the allowances. Accordingly, we will treat “demand” as the demand for allowances to retire by the “sulfur dioxide emission” division, and supply as the willingness of the “allowance holding” division to give up allowances.

69. 8.9 million tons are mandated to be allocated by 42 U.S.C. § 7651b(a) (2000), and the various bonus allowances (whose issuance also does not depend on market conditions) are described in 42 U.S.C. § 7651d(a)(2) (2000) and § 7651d(a)(3) (2000).

70. This is visible in the EPA Retired Allowances Database, *supra* note 15, as well as in Table 1.

1. Demand

The demand for pollution allowances to be retired to cover the year's emissions corresponds to the marginal abatement costs at various price points. That is, the demand for emission allowances at a price of $700 is equal to the amount of emission that costs more than $700 to abate. Equivalently, the demand for emission allowances at a price of $300 is equal to the total amount of emissions such that each ton emitted brings in more than $300.

We know the cost and effectiveness of various forms of pollution abatement. With this knowledge, we may draw some conclusions about the shape of the demand curve for allowances.

At low prices demand should be very flexible. The curve starts at the point on the graph representing the quantity of sulfur dioxide that companies would emit if there were no restraints on emissions. Once the cost of emission is above zero, companies will take simple measures to reduce pollution. These measures can include routine maintenance or switching to lower sulfur coals.

At moderate prices, the curve should be less flexible. At this point companies will begin to make capital improvements in order to reduce pollution. Capital improvements can include modifying boilers to accommodate subbituminous coal or installing pollution scrubbers.[71] Such modifications typically cost $50 and $250 per kW of capacity to install,[72] and become cost effective at prices between $250 and $300 per allowance.[73]

At high prices the demand curve becomes very inflexible. At these price points, all of the technological measures for reducing emissions have been exhausted. The only way to reduce emissions further is to reduce energy generation. This is very costly since plants would have already installed emission reduction technology; they would have to drastically reduce electricity generation to appreciably reduce sulfur dioxide emissions.

2. Supply

The supply curve represents allowance holders' willingness to sell (or to retire) emission credits. It essentially represents a composite of all market participants' guesses as to what the price of an allowance should be, based primarily on what they think allowances

71. *See* Swift, *supra* note 1, at 332, 336–37 (discussing scrubber costs and boiler modifications).

72. *See id.* at 338.

73. *See id.* at 332 (describing the average cost of reduction through scrubbers as $282 per ton of reduction).

will be worth in the future. The slope of the supply curve depends on the differences between different participants' estimates of the proper value. If the estimates are close together, then the curve will be very inflexible. If the estimates are far apart, then the curve will be flexible.[74]

In any event, the supply curve will move around a lot, since it depends so heavily on predictions about the future. There are many potential new events that can significantly change investors' outlooks on the future.[75] These can cause significant changes in the price of allowances.

3. Demand Outlook

The future outlook for demand for allowances depends on how much sulfur dioxide firms will choose to emit in the future at various price points. The main factors affecting their choices are (1) how much they can earn for each unit of electricity produced; and (2) the costs of technological methods of emissions reduction.

a. Technological Improvements in Abatement Methods

As abatement technology improves, the cost of reducing pollution will go down. This would cause the entire demand curve to shift down and to the left, reducing both the price of pollution allowances and the amount of pollution emitted (assuming the supply curve is held constant).

Technological advances can be difficult to predict. We have already seen some emission reducing methods come into being that were not predicted before the program began. The reduction in scrubber costs was unexpected,[76] as was the extensive use of subbituminous coal.[77]

74. The basic intuition behind this is that if people's guesses are all very close together, small shifts in price will not change the amount supplied, since there will not be too many people who will not sell at P1 but will sell at P2. If guesses are different, there is an increase in the number of people whose decision would be affected by the same change in price. This makes the supply curve more flexible.

75. One example is the rules change promoted by the EPA that would devalue future allowances. Interstate Air Quality Rule, 69 Fed. Reg. 4566, 4630 (proposed Jan. 30, 2004) (to be codified at 40 C.F.R. pts. 51, 72, 75, and 96). The more likely such a change appears to be, the more dearly suppliers will hold on to existing allowances.

76. Swift, *supra* note 1, at 332.

77. *Id.* at 392–93.

b. Increased Demand for Coal-Produced Electricity

Increased demand for coal-produced electricity would make producers want to generate more electricity at any given cost. This would shift the demand curve up and to the right. This would make pollution allowances more expensive and lead to more sulfur dioxide emissions. As the population increases and the economy grows, demand for electricity as a whole will increase, naturally increasing the demand for coal-produced electricity as well.

A relative increase in the price of inputs for other methods of producing electricity, such as oil, will lead to additional demand for electricity from coal-fired generators and an associated increase in allowance price and emissions. A shift in relative prices could cause demand for emission allowances to change more quickly than overall demand for electricity.

c. Future Direction for Demand

It is hard to assess which force will be dominant in the long run. The key issue is whether increasing demand will move the curve until the inflexible portion is above the annual cap. Is this were to happen, the price of allowances would rise significantly.

While we do not know which force, technology or increasing demand, will win out, there are reasons to believe that industry participants may overestimate the chances of a demand crunch. The pressure of increased demand for electricity is easy to see and predict, while technological progress is always difficult to anticipate. Combined with the inherent conservatism of power plant management, this could lead to a systematic overvaluation of allowances.

4. Supply Outlook

a. Recent Price History

Recently, the price of sulfur dioxide emission allowances has jumped significantly. The price of an emission allowance on April 1, 2004 was $272.[78] By June 2nd the price was $375,[79] and by July 1st the price was $425.[80] Since it seems unlikely that the demand for emissions moved so dramatically over a four-month span, something probably happened to change suppliers' outlook on the future value of emissions allowances.

78. Cantor-Fitzgerald Environmental Brokerage, http://www.emissionstrading.com.

79. *Id.*

80. *Id.*

Two factors stand out as contributing to this change in price. First, increases in oil prices make coal power more attractive. When investors see or fear rising oil prices, they would become much less willing to part with emissions allowances. The other factor affecting the price of emissions allowances springs from a rule proposed by the EPA in January of 2004.[81]

b. The Unintended Consequence of Devaluing Future Allowances

The Clean Air Interstate Rule calls for a dramatic reduction in the sulfur dioxide emissions cap starting in 2010.[82] The basic proposal is to require firms to use more than one allowance for each ton of sulfur dioxide emitted.[83] The devaluation would not apply to allowances that have a vintage year prior to 2010.[84]

Devaluing future allowances while leaving current allowances untouched makes current allowances more valuable. In a manner similar to firms' behavior under Phase I of the program, firms may start hoarding Phase II credits for use or sale when they are more valuable under the more stringent regime. The current market price for allowances may reflect the market's guess as to the likelihood of the Interstate Air Quality Rule's enactment as much as it represents anything else.

C. Summary

In a perfectly rational market, the price of an allowance would reflect a valuation based on consensus estimates about the future availability of allowances and the future performance of abatement

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81. Interstate Air Quality Rule, 69 Fed. Reg. 4566, 4630 (proposed Jan. 30, 2004) (to be codified at 40 C.F.R. pts. 51, 72, 75, and 96). The comment period for the law ended on March 30, 2004. *Id.* at 4566. Hearings have been held on supplemental proposals to the rule. Clean Air Interstate Rule, 69 Fed. Reg. 28874 (proposed May 19, 2004) (to be codified at 40 C.F.R. pts. 51, 72, 75, and 96). Final action on the rule was scheduled for November 2004. Unified Agenda, 69 Fed. Reg. 38197 (June 28, 2004). The Clear Skies Act in Congress was the first attempt to implement this standard—since it stalled, the EPA enacted administratively what the Administration failed to achieve legislatively. *See id.* The final rule, passed in May 2005, intends to reduce sulfur dioxide allowances starting in 2009. Clean Air Interstate Rule (CAIR) 70 Fed. Reg. 25162 (May 12, 2005).

82. Clean Air Interstate Rule (CAIR), 70 Fed. Reg. 25162, 25195 (May 12, 2005).

83. *Id.* at 25201. Specifically, the proposal is that (1) pre-2010 allowances may be used at a one-to-one ratio; (2) 2010 to 2014 allowances may be used at a two-to-one ratio; and (3) post-2015 allowances may be used at a three-to-one-ratio.

84. *Id.*

technology. In addition, power plants would buy allowances until, and only until, the gain that they expect to reap from emitting an additional ton of sulfur dioxide is equal to the market price. Plants with extra allowances would sell allowances until, and only until, the amount that they get from the sale of the allowance is equal to the cost of abating another ton of pollution.

Of course, most markets are not perfectly rational. The next section will explore particular reasons that we might not expect the market in sulfur dioxide allowances to conform to the prediction of Coase's Theorem.

III. OBSTACLES TO THE EFFICIENT OPERATION OF THE MARKET

This section explores some features of the existing market in sulfur dioxide allowance that impede efficient trading. The first two potential obstacles, the endowment effect and loss aversion, are common problems identified by the field of behavioral economics. The third potential obstacle originates in the tax code. Though the tax problem can be eliminated or ameliorated fairly simply, getting rid of the two behavioral problems will require drastic changes in the structure of the emissions trading market, a topic that will be explored in more depth in Part V.

A. *Endowment Effect*

1. Endowment Effect Defined

The endowment effect is the name given to the observed phenomenon that people who are allocated a right place a higher value on that right than they would have placed had they not received it in the initial allocation.[85] In other words, people require a higher price to part with an item than they would be willing to pay to acquire the same item. A concrete example should help to convey the basic idea.

The most well known illustration of this effect involves coffee mugs.[86] A group of students in an advanced undergraduate law and economics class took part in the study. A third of them were chosen at random and given coffee mugs.[87] They were then asked to put a dollar value on the mugs. Those who had received the mugs gave a considerably higher average value than did those who

85. Kahneman et al., *supra* note 5, at 1326.
86. *Id.* at 1330.
87. *Id.* at 1332.

did not.[88] This effect has been shown to be consistent across multiple trials, and across different groups (even law students are not immune).[89]

The endowment effect has been used to explain why parties so rarely bargain away rights received by injunction. In a Coaseian world of purely rational economic actors, we would expect to see injunctive rights sold with some regularity, since there is no reason to think that least cost avoiders always win in cases where injunctions are sought. However, injunctions are, in fact, very rarely bargained away,[90] which makes perfect sense if those who receive rights tend to place a higher value on them than do those who do not.

2. Reasons Why Power Companies Would Be Affected by the Endowment Effect

Some power companies are explicitly assigned emissions allowances as part of the Clear Skies Act.[91] If people who are assigned rights put a higher value on them, we would expect these power companies to put a higher value on emissions allowances than do the power companies that did not receive them. Power companies, of course, are not people, and may institute some sort of internal controls to attempt to counteract the endowment effect. We would expect varying levels of success in this endeavor, depending on how well they are able to overcome their own internal biases.[92]

If firms are unsuccessful in overcoming these biases, we would see inefficiently low levels of trading between companies that received allowances and those that did not, but efficient levels of trading between companies that received allowances.

88. $5.25 vs. $2.25 in three of the four times the experiment was run. *Id.*

89. *Id.* at 1342.

90. *See* Ward Farnsworth, *Do Parties to Nuisance Cases Bargain After Judgment? A Glimpse Inside the Cathedral*, *in* BEHAVIORAL LAW AND ECONOMICS 302, 304–05 (Cass R. Sunstein ed., 2000).

91. 42 U.S.C. 7651c(e) Table A (2000).

92. Firms represent an aggregation of individual foibles, and have their own social norms and cultures. *See* Reza Dibadj, *Reconceiving the Firm*, 26 CARDOZO L. REV. 1459, 1498 (2005). It is difficult to say exactly how they make decisions. *Id.* Happily, as the next section explains, we at least should not have to worry much about the endowment effect.

3. Why the Endowment Effect Is Probably Not a Problem

One case where the endowment effect does not appear is with goods that are held solely for resale.[93] Thus, in experiments where students were given tokens that would be exchanged for cash at the end of the experiment, rather than something tangible like mugs that they would keep, the students did not show any signs of the endowment effect.[94]

An emissions allowance is not held solely for resale. However, the existence of reasonably active spot markets for allowances means that it can easily be converted into cash at any time. This easy conversion into cash probably makes the sulfur dioxide market look more like the token experiments than like the coffee mug experiments.

Also, most participants are allocated at least some credits,[95] suggesting that their perceptions would at least be similar, even if they were all biased from an objective point of view. While new entrants would not experience the prevailing bias, they would presumably place a higher value on the allowances because of the superior technology available to them.[96]

B. Loss Aversion

1. Loss Aversion Defined

Loss aversion is the term describing the behavior of people who assign a loss a negative value that is greater than the positive value that they place on an objectively equivalent gain.[97] Thus, given a game where there is a 50 percent chance of winning $100, and a 50 percent chance of losing $99, many people will refuse to play, despite the game's positive expected value. This result is consistent with the standard economics theory stating that for most people the marginal utility of a dollar decreases as wealth increases.

Another result that follows from this is that most people consider opportunity costs to be less important than objectively equivalent costs. This is because the opportunity cost is a foregone gain, while other costs are direct losses.

93. Kahneman et al., *supra* note 5, at 1328.

94. *Id.*

95. *See* 42 U.S.C. § 7651d(a)(1) (2000) (subjecting most utilities to the requirements of the Act and issuing allowances to those utilities).

96. As explained *supra* note 63 and accompanying text.

97. Tversky & Kahneman, *supra* note 5, at 1039.

2. Why Power Companies Would Be Affected by Loss Aversion

A company that sells allowances when it should not do so will experience a loss, as it is forced to buy back more expensive allowances in order to satisfy the EPA. A company that does not sell allowances when it should foregoes a gain, as it missed a chance to sell expensive allowances and then buy cheap ones to cover its obligations to the EPA. A company that buys allowances when it should not do so experiences a loss, as does a company that does not buy allowances when it should.

Since people value losses higher than they value equivalent foregone gains, sellers will err on the side of too few sales. Since there is no counterbalancing bias on the part of the buyers, there will be too few transactions in the market overall.

3. Why Power Companies Cannot Avoid Problems Created by Loss Aversion

The problem of loss aversion comes from studies in behavioral economics, which focus on cognitive errors committed by individuals. But in the sulfur dioxide emissions permit market, the vast majority of trades are conducted by large firms. Thus, a natural response to the foregoing analysis is to suggest that large firms will be able to overcome individual biases and engage in rational trading by delegating decision making to committees and standardizing trading formulas and other procedures.

However, even if power plants made decisions through a fully rational process, they would still behave as if they were subject to the loss aversion cognitive bias. This is because of the regulatory structure that has been built up around the power industry.[98] Power companies are not publicly traded firms that eventually return excess profit to shareholders. Most power plants are locally regulated monopolies, and most local regulations classify costs associated with emission allowances as fuel costs.[99] This means that any profits or losses incurred as a result of allowance trading must be passed on to consumers.[100] Power plants are run to maximize consumer happiness, not shareholder returns.

Since individual consumers do not filter their actions through decision-making committees, they will be loss averse—they will be more angered by an increase in power rates than they will be pleased by a similarly sized decrease in rates. Thus, a diligent power plant manager who is attempting to maximize consumer

98. S*ee generally* KAHN, *supra* note 35.
99. ELLERMAN et al., *supra* note 31, at 193–94.
100. *Id.*

happiness will trade as if he were subject to the loss aversion bias. It is unreasonable to expect anybody whose job depends on the will of voters to behave in a manner steadfastly inconsistent with voters' desires.

4. Loss Aversion Is Exacerbated by the Uncertainty Created by Political Interference in the Operation of the Market

As mentioned earlier, the Interstate Air Quality Rule proposed by the EPA calls for devaluing future emissions allowances (every two tons of 2010–2014 vintage allowances and every three tons of post-2015 vintage allowances will only allow firms to emit one ton of sulfur dioxide). If this rule were enacted, it would cause current allowances, which would not be devalued, to become much more valuable. In an environment of less secure property rights, participants are more likely to behave cautiously. One reason that power companies may hoard allowances is to protect themselves against a sudden devaluation in the allowances by the government.

5. Conclusion

A perfectly rational power plant manager attempting to maximize consumer happiness will trade in a loss averse manner. The potential for interference by political actors looking to reduce overall emissions provides another incentive to trade conservatively. The combination of these effects would lead us to expect to see an inefficiently low level of allowance trading on the market.

C. Tax Created Incentive Distortions

1. The Problem

The capital gains tax distorts market incentives.[101] While the behavioral issues identified above explain why actors in the market may choose not to make economically beneficial transactions, the capital gains tax actually renders some otherwise economically beneficial transactions worthless.

Because emission allowances are given to firms for free, they are recorded as assets with a cost (or basis) of $0.[102] This means that when a firm sells part of its initial allocation of credits, the entire proceeds of the sale count as capital gains (presumably long-term capital gains, as all allowances of all vintages should have been

101. *See* Rev. Rul. 92-16, 1992-1 C.B. 15 (describing the tax status of allowances). Allowances do not create taxable income when they are first given to firms, but they have a zero cost basis for the purpose of the capital gains tax when sold.

102. *Id.*

deposited in their owner's accounts by 2000). So a firm that sells part of its initial allocation of allowances receives only 85 percent of its value, as the other 15 percent goes to the IRS.

This means that firms that are allocated allowances will abate until the marginal cost of abatement is equal to 85 percent of the market value of an allowance, while firms that are not allocated allowances will abate until the marginal cost of abatement is equal to the entire market value of an allowance. This state of affairs is inefficient, as described supra at Part II.A.3.

2. A Potential Solution

One way to cancel out the problem identified above without repealing the capital gains tax is to charge a fee for redeeming allowances that have never been traded. Suppose we charge firms 15 percent of the market value of the autarchic allowances, or allowances redeemed by the firm to which they were allocated, that they redeem. We will again use Albert and Bert, from supra II.A.3, to illustrate the resulting behavior.

Albert's response will now vary precisely with the market price for allowances. No matter what the market price is, the amount that Albert receives for selling an allowance will be equal to 85 percent of the market price due to the capital gains tax. He will also save an amount equal to 15 percent of the market price by avoiding the fee. This means that his gain from abatement, ignoring the costs of abating, will be equal to .85 times the market price plus .15 times the market price; that is, his gain will exactly equal the market price for an allowance. This means that he will abate pollution until the marginal cost of abatement is equal to the market price.

Bert, who is not allocated any allowances, is not affected by the fee. The only incentive he faces is the market price, which means that he will also abate until the marginal cost of further abatement is equal to the market price for an allowance.

Charging a percentage fee for autarchic redemption will equalize the emission incentives facing firms that are allocated free allowances and firms that are not. Since they would be trading on an equal footing, allowances would wind up with the firms that value them the highest.[103] This in turn would mean that we as a society are getting the maximum value possible for each ton of sulfur dioxide emitted. The incentive distortion problem has disappeared.

However, as industry lobbyists would be quick to point out, a new problem has taken its place. Specifically, the power industry

103. This is an application of Coase's Theorem.

will be experiencing a direct loss of wealth to the tune of $360 billion a year.[104] The power industry's loss would be the EPA's gain, and since revenues on that scale would represent about 4 percent of the agency's budget,[105] we would probably want to pre-allocate the funds somewhere even if we were not concerned with canceling out the distributional effects of the proposal.

Fortunately, it is relatively simple to neutralize the loss suffered by the industry because of the autarky fee. The EPA can simply distribute the fee income out to participants in the market based on their relative level of power production. This would not introduce any inefficient incentives.

This solution is not free of political drawbacks, of course. It would represent a redistribution of wealth from firms that were allocated allowances by the government to firms that were not. This reallocation is not unfair in any subjective sense in light of the fact that the original allocation of allowances represented a wealth transfer from firms that were not allocated any allowances to firms that were. To the extent that firms receiving allowances oppose this proposal, the combined efforts of firms not receiving allowances (the would-be distributional winners) and environmental groups should be effective counterweights.

D. Conclusion

There are several reasons to expect an inefficiently low level of trading in the market for sulfur dioxide allowances. Firms may avoid profitable transactions because they are risk averse, or may have profitable transactions rendered unprofitable by the capital gains tax. Though we have no way of establishing a priori what the level of emissions trading ought to be, we can at least look at the data to see if the amounts traded seem unusually low. The next section examines data on emissions allowances collected by the EPA.

104. Assuming a 15 percent fee, the current market price of $600, and that autarchic retirement is reduced to 4 million tons from the current level of 6.3 million tons.

105. Approximately 3.9% of the 2003 budget of 7.7 billion. EPA Budget, *available at* http://www.epa.gov/ocfo/budget/2003/2003bib.pdf.

IV. OBSERVED BEHAVIOR IN THE PRIVATE ALLOWANCE MARKET

The data sets in this section come from an electronic database maintained by the EPA that tracks allowance retirement. I have used standard database tools to aggregate and separate out useful information.

Caution must be exercised when drawing conclusions from this data. Because the market in Phase I was so different from the market in Phase II, we really have two separate data sets of five years and four years, respectively. While we can observe trends and make broad generalizations about how the market acts, we will not be able to produce formulas to define these actions with any precision.[106] This Part will only use the data as a guide in developing theories about how the market works, or in rejecting theories that are clearly contradicted by the observed data.

A. *Price and Emission History*

1. Phase I

a. Tracking Total Emissions

The first four years of the sulfur dioxide market system were marked by reduction far beyond the minimum cap requirements. The following table describes the number of allowances available and the number of allowances retired each year:[107]

Table 1

	1995	**1996**	**1997**	**1998**	**1999**
Issued	8,772,768	8,265,104	7,101,605	6,952,813	6,148,527
Previously Banked	0	3,844,456	6,808,699	8,468,757	9,968,627
Total Available	8,772,768	12,109,560	13,910,304	15,421,570	16,117,154
Total Retired	4,928,312	5,300,861	5,441,547	5,452,943	5,359,147

After a slight jump from 1995 to 1996 the number of allowances being retired each year remained fairly constant at a level well below the number of allowances issued each year. Because of this, a large number of allowances built up in the bank. We can see

106. That is to say, we may be able to tell that when prices go up, emissions tend to go down, but we will not be able to say that "for every $5 increase in allowance prices, emissions tend to fall by X number of tons."

107. EPA Retired Allowances Database, *supra* note 15.

from the table that the large number of allowances in the bank did not lead to more sulfur dioxide being emitted. Instead, firms kept their total emissions well below the overall limit and saved their extra allowances.

The following table compares the prices of emission allowances, in nominal dollars, from year to year:[108]

Table 2

	1995	**1996**	**1997**	**1998**	**1999**
January Price	140	100	100	100	210
July Price	135	75	90	200	190
December Price	100	100	100	210	130
Allowances Retired	4,928,312	5,300,861	5,441,547	5,452,943	5,359,147

As Part II explains, economic theory would predict an inverse relationship between the price of an allowance and the amount of sulfur dioxide emitted. This table provides some support for such a theory, or at least does not contradict it. As prices declined slightly in real value due to inflation, emissions showed only a slight increase, while the year after the prices went up, less sulfur dioxide was emitted. The abnormally low amount emitted in 1995 is probably due to the fact that the consensus estimate before the start of the cap and trade program for the price of a one ton emission allowance was between $300 and $700.[109] Firms had made plans and installed equipment based on that number that led to low emissions in 1995 and, to a lesser extent, in 1996.[110]

Table 2 also suggests that firms do not react quickly to changes in price. While prices shot up in 1998, sulfur dioxide emissions didn't start to go down until 1999. This delay could be attributed to the number of physical factors that must be altered in order to reduce emissions. Clearly, any economic model of the market that assumes perfectly flexible demand is missing part of the story.

b. Tracking Autarchic Behavior

Phase I was also marked by heavily autarchic behavior. Firms met most of their emissions obligations by retiring allowances that

108. Retirement volume is from the EPA Retired Allowances Database, *supra* note 15. Market prices are drawn from the EPA Compliance Report 2002, *supra* note 20.

109. Swift, *supra* note 1, at 331.

110. *See id.*

had originally been allocated to them, rather than by retiring allowances that they bought from a different firm. The following table measures such behavior:[111]

Table 3

	1995	1996	1997	1998	1999
Total Retired	5,359,147	5,452,943	5,441,547	5,300,861	4,928,312
Autarchic Allowances	4,190,664	4,054,370	3,720,455	3,709,535	3,499,133
Autarchic Percentage	78.2	74.4	68.4	70	71

Table 3 shows, for example, that in 1995, of the 5.36 million allowances retired, 4.19 million were retired by the same firm to which the government initially allocated them. The percentage of allowances retired in this manner went down over time, but never dropped much below 70 percent. This means that 70 percent of the allowances used each year were never traded on the open market. In turn, this means that the price generated by the market was based on trades involving the other 30 percent of allowances.[112]

This very low level of trading activity could be attributed to two different, though not mutually exclusive, factors—incredibly efficient government allocation or excessive reluctance to trade. It is possible that the government simply allocated 70 percent of all allowances to the power plants that could make the best possible use of them. However, given the usual imperfections of administrative planning, this seems unlikely. The other potential explanation is that private parties are kept from making trades that would make both parties better off by artificial barriers to trade introduced by cognitive failures or by capital gains taxes.

c. Tracking Retirement by Vintage

Emission allowances are issued with a particular vintage year.[113] Allowances with a vintage of year N can be used to cover

111. EPA Retired Allowances Database, *supra* note 15.

112. Alternatively, the price change was generated by trades involving allowances that were banked for future use. Unfortunately, data on the ownership of banked allowances is not readily available. This is ameliorated to a certain extent by the fact that banked allowances are counted (as either autarchic or non-autarchic) when they are eventually retired—the current total of 7.7 million banked allowances represent only 10% of 2003 and earlier vintage allowances. EPA Retired Allowances Database, *supra* note 15.

113. 42 U.S.C. § 7651a(3) (2000).

emissions for year N or for any year afterwards, but they cannot be used to cover emissions liability for years before N.[114]

This table tracks vintage retirement rates by year:[115]

Table 4

		Retirement Year				
Vintage	**Issued**	**1999**	**1998**	**1997**	**1996**	**1995**
1995	8,772,768	65,719	209,298	619,389	1,486,242	5,359,147
1996	8,265,104	306,111	963,555	1,882,966	3,966,701	
1997	7,101,605	698,802	1,359,827	2,939,192		
1998	6,952,813	1,212,504	2,768,181			
1999	6,148,527	2,645,176				

Table 4 shows, for example, that of the 8,772,768 vintage-1995 allowances that were issued, 1,486,242 were retired in 1996.

There is a consistent pattern of firms redeeming banked allowances from past years even as they are banking allowances from the current year at a tremendous rate. This probably results from firms treating allowances as interchangeable once they can be retired to cover emissions obligations.[116] Because of the interchangeable nature of the allowances, breaking down redemption by year does not provide any additional information that is not available by simply looking at overall redemption rates.

2. Phase II

a. Tracking Total Emissions

Phase II of the sulfur dioxide trading program involved many more sources of pollution, while the cap on the number of allowances issued each year remained about the same.[117] In addition, there was no longer any reason to hoard credits—firms did not expect a dramatic increase in future demand in the way that they expected demand to increase from Phase I to Phase II.[118] As

114. *Id.*

115. EPA Retired Allowances Database, *supra* note 15.

116. As, in fact, they are, per 42 U.S.C. § 7651a(3) (2000).

117. 42 U.S.C. § 7651d details the additional utilities covered under Phase II (compared with the table of affected units in Phase I in Table A at 42 U.S.C. § 7651c(e)). The constant level of allowance issuance can be seen in the EPA Compliance Report for 2002, *supra* note 20.

118. This may change, if the Clear Skies Act, S.1844, 108th Cong. (2003) passes, as it would dramatically reduce the number of available allowances.

one might expect, companies began to retire some of their banked credits:[119]

Table 5

	2000	2001	2002	2003
Issued	9,879,565	9,547,229	9,535,636	9,535,906
Previously Banked	10,758,007	9,595,332	8,512,731	7,855,376
Total Available	20,637,572	19,142,561	18,048,367	17,391,282
Total Retired	11,042,240	10,629,830	10,192,991	10,577,783

Again, we can see that the number of allowances retired each year do not correlate well with the total number of allowances available to be retired. If there were a strong relationship between existing allowances and total emissions then we would not see emissions change in different directions from year to year (down from 2000–01 and 2001–02, and up from 2002–03) while the number of available allowances steadily decreased. We must look elsewhere for an explanation of firms' behavior.

The table comparing emission allowance prices, in nominal dollars, with total emissions shows some correlation:[120]

Table 6

	2000	2001	2002	2003
January Price	$130	$160	$170	$140
July Price	$150	$200	$150	$170
December Price	$160	$170	$140	$210
Total Retired	11,042,240	10,629,830	10,192,991	10,577,783

We see again that lower allowance prices at the beginning of year leads to lower overall emissions. We also again see a delayed reaction to price inputs; although allowance prices were falling throughout 2002, firms did not start emitting more sulfur dioxide until 2003.[121]

119. EPA Retired Allowances Database, *supra* note 15.
120. *Id.*
121. EPA Compliance Report 2002, *supra* note 20, at 6.

b. Tracking Autarchic Behavior

Autarchic behavior was less prevalent in Phase II than it was in Phase I, but remained common:[122]

Table 7

	2000	2001	2002	2003
Total Retired	11,042,240	10,629,830	10,192,991	10,577,783
Autarchic Allowances	6,485,185	6,465,461	6,272,849	6,293,865
Autarchic Percentage	58.7	60.8	61.5	59.5

The proportion of allowances retired by their original owners has remained fairly close to 60 percent throughout Phase II. This is 10 percentage points lower than the autarchy rate observed during Phase I. This is probably due to some change in the makeup of the market from Phase I to Phase II. It is possible that the larger number of participating firms led to a more efficient market, leading to less hoarding and more use of externally acquired credits.

Another explanation focuses on the existence of intra-firm trading. Allowances are allocated on a plant-by-plant basis. Since many firms own multiple plants, they may choose to move allowances from a clean plant, or a plant that is easier to make clean, to a dirty plant. Taking advantage of these sorts of opportunities allows firms to avoid using the market without sacrificing too much efficiency.

Small firms do not have this option. Firms that own only one or two plants must use the market. If their plants are clean, they have to use the market in order to get any benefit from their excess allowances. If their plants are dirty, they have to use the market in order to obtain allowances to cover their emissions obligations. Since Phase I only involved certain targeted plants,[123] while Phase II covers all coal-fired power producers,[124] it seems reasonable to believe that Phase II simply includes more small firms that do not have the option of autarchic compliance.

c. Tracking Retirement by Vintage

It can also be helpful to break down each year's retired allowances by their original vintage, to get some idea of the magni-

122. EPA Retired Allowances Database, *supra* note 15.

123. As enumerated in 42 U.S.C. § 7651c(e) Table A.

124. As described in 42 U.S.C. § 7651d(a)(1), and elaborated upon at great length in § 7651d(b), (c), (d), (e), (f), (g), and (h).

tude of the inter-temporal trading[125] occurring. Remember, an allowance may be retired to cover an emission obligation at any point after its vintage year, but not before.[126] Here is the table:[127]

Table 8

		Retirement Year			
Vintage	**Issued**	**2003**	**2002**	**2001**	**2000**
1995	8,772,768	66,055	143,697	109,105	470,358
1996	8,265,104	99,958	220,855	308,151	387,309
1997	7,101,605	176,799	307,517	552,628	838,757
1998	6,952,813	174,192	460,568	708,858	1,152,455
1999	6,148,527	366,770	682,957	782,897	1,915,984
2000	9,879,565	389,769	595,248	1,746,575	6,277,377
2001	9,547,229	727,742	1,404,220	6,421,616	
2002	9,535,636	1,754,162	6,377,929		
2003	9,535,906	6,822,336			

Table 8 shows that throughout Phase II firms have banked allowances from the current year while retiring allowances from previous years. This provides more documentation for the tendency we saw in Phase I for firms to treat retireable allowances of different vintages as interchangeable.

B. Autarchic Behavior

1. Breakdown of Sources of Retired Credits

This section will examine the sources from which firms obtained allowances to cover their emissions liabilities. This analysis does not consider the total trading volume in the market; it considers the number of unique allowances that were ever traded on the market. The year-by-year results are in the following table:[128]

125. Economists often refer to banking as intertemporal trading, as in the working article by A. Denny Ellerman & Juan-Pablo Montero, The Temporal Efficiency of SO2 Emissions Trading, *available at* http://www.mit.edu/afs/athena/org/c/ceepr/www/2002-003.pdf. The idea is that a firm is essentially trading an allowance from its past self to its future self. The lay person might refer to this as "saving," which simply shows a lack of appreciation for the insight that one acquires with a Ph.D. in Economics.

126. *See* 42 U.S.C. § 7651a(3) (2000).

127. EPA Retired Allowances Database, *supra* note 15.

128. *Id.*

Table 9

Year	Credits Retired	% Autarchic	% Aut. Same Yr.	% Aut. Prev Yr.
1995	5,359,147	78.2	78.2	0.00
1996	5,452,943	74.4	55.5	18.9
1997	5,441,547	68.4	45.4	23.0
1998	5,300,861	70.0	43.0	27.0
1999	4,928,312	71.0	46.3	24.7
2000	11,042,240	58.7	46.0	12.8
2001	10,629,830	60.8	47.3	13.5
2002	10,192,991	61.5	48.8	12.8
2003	10,577,783	59.5	47.1	12.4

Table 9 gives the total number of allowances retired each year, and the percentage of them that were redeemed by the firm to which they were originally allocated. It then breaks the autarchic allowances into two categories: allowances with a vintage year the same as the year that they were redeemed, and allowances from a previous vintage.

A certain amount of autarchic behavior is inevitable. After all, the firms that have had credits allocated to them will continue to produce power, and will emit a certain amount of sulfur dioxide. It is perfectly reasonable for them to hold back a certain amount of allowances to cover those emissions.[129]

However, we should still look for systemic incentives that prevent firms from selling all of the allowances that they would sell in an efficient market. Under ideal conditions, the initial allocation would be irrelevant; given low transaction costs, emission allowances would find their way to the high cost avoiders.[130] However, as was discussed in Part III, there are several reasons to believe that conditions are not ideal and that firms are not reducing emissions in the most efficient possible manner.

For now it is worth noting that a significant amount of allowances are never available on the market (although it is possible that some of the credits marked as autarchic within the table above had actually been sold and then purchased back by the original firm, it is unlikely given the capital gains tax that would be incurred

129. In addition, we would expect firms to favor retiring untraded allowances over traded allowances, for tax reasons. *See generally* Swift, *supra* note 1.

130. This is a fairly straightforward application of Coase's Theorem, as developed in Coase, *supra* note 4.

by such a transaction). Apparently, while annual trading volumes were high,[131] that volume consisted of a relatively small number of allowances being traded back and forth.[132]

2. Strange Banking Behavior

Another fact apparent in the table above is that a significant number of the never-traded allowances that firms retired had been carried over from the previous year. This is counterintuitive. If a firm reduced its emissions sufficiently to carry some of its allotment over into the next year, it would be a little surprising to see them have to tap into that bank the next year. However, we saw from Table 8 that firms do not collectively retire all of the current year's allowances before beginning to retire allowances from previous years. Accordingly, some firms were probably just retiring allowances from the previous year while banking allowances from this year.

What is odd is that firms keep these excess allowances in the bank in the first place. Once a firm has reduced its annual emission total below its annual allowance allocation, it does not have any pressing business need to keep the extra allowances. Even if the cap were overly lenient, leading to excess allowances, it does not make sense for power generating firms to be the ones holding on to the extra allowances. Holding on to them is pure financial speculation.

This behavior could be motivated either by a widespread belief within the industry that prices are going up or by inefficiencies within the market. The idea of widespread belief in a price increase does not make sense; if everybody thought prices should be higher, then prices would be higher. Earlier sections examined the market to identify factors that could be creating inefficiencies. The next section offers a proposal that would remove many of the inefficiencies plaguing the market.

131. 30.8 million allowances were traded between unrelated entities. *See* Swift, *supra* note 1, at 341.

132. Again, the unique credits being traded around could include those that were banked at the end of each year. However, such allowances must eventually be retired and thus recorded as either autarchic or non-autarchic. The number of currently outstanding banked and non-classified allowances represents only 10 percent of the total number of 2003 and earlier vintage allowances issued.

V.
AUCTIONING ALLOWANCES

One way to solve the problems created by an inefficient allocation of credits by the government is to go to an auction system. In an auction, allowances would simply go to the highest bidder. This means that the government does not have to attempt to determine who "deserves" to get sulfur dioxide allowances, but only has to focus on running the most efficient auction possible.[133]

A. *Behavioral and Tax Issues*

1. Endowment Effect

To the extent that the endowment effect distorts trading, an auction system will remove the distortion. Since nobody receives the initial right to emit sulfur dioxide, nobody has an irrational attachment to the right, and everybody should bid a rational amount.

Firms' bids might be affected by the extent to which they are already committed to producing power; that is, a plant might bid more to avoid being shut down than a group would pay in order to found a plant.[134] However, this situation looks like the sort of rational difference in valuation that we want to bring out in an auction setting, since the party with a power plant in place is presumably more committed to producing power.

2. Loss Aversion

An auction setting will eliminate the effects of loss aversion. It does this by converting opportunity costs into actual losses. Thus, participants in the auction are comparing losses against losses, rather than comparing losses against foregone gains.

In the current system, a firm that is allocated an allowance and does not sell it will at worst see the price go down, reducing the amount of the windfall received from the government. With an auction, firms will only get extra allowances if they pay for them. A firm that pays for an allowance that it does not need and fails to sell it at an opportune time will experience a loss, just as does the firm that fails to buy an allowance that it should buy. This symmetry will cause firms to behave rationally by removing the current bias against selling.

133. For one possible auction design, see Motty Perry & Philip J. Reny, *An Efficient Auction*, 70 ECONOMETRICA 1199 (2002).

134. *But see id.* and accompanying text (II.A.2).

3. Capital Gains

Because firms pay for allowances that they receive from auctions, the capital gains tax will not distort their behavior. Their basis in the allowances will be set at the price paid, which will greatly reduce the amount of capital gains resulting from the sale of an allowance, assuming that the purchase price of an allowance is much larger than the usual variation in allowance prices. While there might be some problems created by allowances that are held for a long time, the lock-in effects will be no more significant than what currently exists in the stock market.

B. Distributional Issues

Right now firms receive allowances for free. Under an auction system, they would have to pay fair market value for the allowances. Assuming current levels of approximately ten million allowances per year,[135] and that the price goes no lower than one hundred dollars per allowance, this will result in at least a one billion dollar annual loss to the industry compared to the current system.

This raises the issue of what to do with the money. One option would be to give it to power plants in proportion to the percentage of the national power generation that they supply. Alternatively, the government could simply apply the gain to the bottom line. A comparison of the potential emissions allowance auction with the spectrum auctions conducted throughout the nineties should prove helpful in determining which option is preferable.

C. Comparison with the Spectrum Auction

Between 1994 and 1996 the FCC switched from its previous policy of giving spectrum rights for free to what they considered the most worthy candidate to a policy of simply auctioning off large blocks of spectrum.[136] The FCC established a complicated set of rules designed to maximize the efficiency of the auction,[137] and all revenue generated went directly to the general budget.[138] The auctions were a tremendous success, raising about $20 billion for the

135. *See* 42 U.S.C. § 7651b(a) (2000).
136. *See* Pritchard-Kelly, *supra* note 6, at 155–56, 161.
137. *Id.* at 167–69.
138. Omnibus Budget Reconciliation Act of 1993, § 6002, amending 47 U.S.C. § 309(j)(3)(C) (1993). The original report calling for the switch to auctions cited this as a benefit of the auction model. National Telecomm. and Info. Agency, U. S. Dept of Commerce, *U.S. Spectrum Management Policy: An Agenda for the Future* (1991) at 115.

U.S. Treasury,[139] and opening up a wide range of spectrum for innovative use.

While auctioning off spectrum and pocketing the money was successful, there are differences between spectrum and sulfur dioxide that may make auctioning off emission allowances less successful. In particular, the electromagnetic spectrum is a tool that can be used in many different ways to make money. This means that an auction will allow the company that can put the spectrum to the best use to get the right to do so. Sulfur dioxide, on the other hand, is an unfortunate but inevitable product of power generation. Firms that win the auction for emissions allowances will not be able to use the allowances to create new businesses; rather, the allowances will simply allow them to continue in their old businesses, but with lower profits due to the expense of the allowances. Redistributing the proceeds of the auction to power companies will not prevent any innovators from coming up with new ways to use the allowances, since the allowances are only useful to the power industry. In any event, redistributing the proceeds of the auction to the power companies may be necessary in order to get support for the move to an auction, with its other attendant benefits.

CONCLUSION

The sulfur dioxide emissions allowances market responds to supply and demand just like any other market. Power companies respond to the price signals by abating pollution.

Some firms do not appear to be responding appropriately to these price signals. Some of this happens because of agency problems created by the interest that power plant managers have in keeping their jobs. However, a large part of it is created by loss aversion effects that can be eliminated by moving from a free allocation system to an auction-based system.

139. Cramton, *supra* note 6, at 727.