THE CZECH REPUBLIC: POTENTIAL COST SAVINGS FROM USING ECONOMIC INSTRUMENTS

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B

I. Introduction

The Czech Republic will have numerous opportunities to consider the use of economic instruments for the regulation of environmental problems. These instruments may involve policy changes including increased flexibility in meeting required emission standards, implementing pollution charges in a different way or allowing broad based emissions trading. Whether economic instruments become implemented as policy will depend on many political, environmental and economic issues. For instance, although economic instruments can be used for any medium -- air, land disposal or water -- they tend to be easier to use with pollutants that are released from a number of sources and that cause approximately equal damages.

Important among economic and political issues is the potential for economic instruments to provide the same level of environmental improvement as administrative methods but for a lesser cost: the issue of cost savings. It is also possible to trade off some of the cost savings for an even higher level of environmental improvement. For instance, material has been presented elsewhere that demonstrates the maximum environmental benefit from one particular application of economic instrument (Farrow and Bluffstone). The other side of the benefit is the potential to maximize the cost saving while achieving the same environmental objective, an analysis that is presented in this paper.

This paper summarizes existing knowledge about the cost savings that might be achieved in the Czech Republic through the use of economic instruments. Relatively little numerical work has been done on potential cost savings in the Czech Republic. Consequently, information is based on Czech data as much as possible but experience with economic instruments in the United States and studies of potential cost savings in Poland are also referenced.

The paper proceeds by examining several case studies of potential cost savings if additional flexibility is provided for compliance at an individual site. Suggestive macro results are also provided for the Czech economy. Later sections identify many additional points of comparison between administrative and economic instruments and summarize the lessons learned from the U.S. experience. An appendix contains supporting documents.

II. Enterprise and municipal level applications

Current Czech law or its implementation does not appear to allow trading of pollution among enterprises or even among sources within a single plant. Experience in the United States has shown that such flexibility, even within a single enterprise, can be a substantial source of cost savings. There is little existing evidence on the Czech ability to reduce costs compared to administrative methods through the use of economic instruments. Therefore this section briefly reviews an experiment in Poland allowing two companies to trade pollution, develops two examples of potential internal trades and their cost savings in the Czech Republic, and suggests research topics for the Czech situation.

In Poland, an agreement was reached between the Power Plant Chorzow and the Kosciuszko Steel Mill such that the power station would provide the funding to upgrade the pollution control technology at the mill. Although not normally allowable under Polish law, this "trade" was allowed as an experiment. Analysis suggests that the trade will both help the environment and help channel investments for technological improvement into the area where they will do the most long run good for the economy because the power plant is anticipated to be closed in 5-6 years (Zylicz; Dudek, Kulczynski and Zylicz .)

Czech Case Study I: Financing for the Environment

The kind of trade described above where one company finances the pollution control of others has also been suggested for funding additional household conversions in the Czech Republic (Farrow and Bluffstone.) In the illustrative analysis prepared for the Czech Republic, industry financing of household conversions in exchange for a delay of compliance for one year at five industrial sites can: a) improve the environment by at least the amount that would have resulted from controlling the industrial sources, and b) save the industrial sources up to 1.3 billion crowns.

The estimate was obtained by first calculating the number of converted households necessary to achieve the same quantity of pollution reduction as would be achieved without the one year delay at the industrial sites. The cost of conversions are then compared to the interest cost avoided if the sites can delay expenditures one year. Similar applications could be developed for funding other types of pollution sources such as small industrial boilers or other investments in pollution control.

The analysis did not take into account the possible improvement in health from controlling emissions from low stack compared with high stack sources. Thus the environmental benefit could be greater than assumed in the illustration. At the same time, the calculation of environmental benefits is in present value terms so that the environmental improvements are spread out over the length of time the household uses natural gas. The potential costs savings are however, large.

Czech Case Study II: Emissions Caps

Another type of trade at the Prunerov power plants in the Czech Republic demonstrates how setting an emissions cap for the enterprise can achieve environmental goals while saving money for other economic and environmental purposes. Aggregate emission caps to meet individual boiler or emission stack requirements have been the

largest cost saving change to regulations in the United States while not harming the environment. When the appropriate geographical region is defined for such a policy, the specific source of the emission may not be environmentally important. As an extreme example, consider a power plant or a heating plant. The environment is unlikely to be affected if 80 percent of the emissions come from one boiler and 20 percent of the emissions come from another, compared with an equal (50 percent) split of emissions. However, the costs may be significantly affected if the equal reduction is not required by law.

Individual source flexibility while meeting strict aggregate limits can be achieved in numerous ways: different fuels and control technologies can be used, different investments in productivity improvements can be implemented, operation and maintenance can be improved, and so on. This case study constructs an illustrative example of cost savings in Northern Bohemia from aggregate control instead of individual control at power plants Prunerov I and II.

It will be shown that the overcontrol of baseload boilers can compensate, as an extreme case, for no control on a peak or swing (part-time) boiler. If the nationwide power company, CEZ, itself took advantage of this cost savings to control less on one boiler, the policy would be like the emission cap (or bubble) policy in the United States. If CEZ were allowed to sell the overcontrol to compensate for a part-time boiler at some other facility, say a district heating plant or an industrial boiler, then the policy would be like the offset policy in the United States. The one strategy investigated here, although many others might be possible, is to ask, "Keeping the same emission cap as with individuals standards, how many boilers do not need to be controlled as a result of overcontrolling on the base load boilers?

Example of emission cap:

Data from CEZ (Spilkova) and Power International (1994) are used to develop an illustration of cost savings if an aggregate emission cap were applied to Prunerov I and II. Because the cost data are not specific to the application and because some technical parameters such as capacity factors are assumed, the computations should be considered illustrative of the strategy of overcontrolling on base load units in order to avoid control on peak or part-time units.

As described in Spilkova, after 1998 CEZ plans to operate 21 boilers at 5 locations in Northern Bohemia. The boilers range in size from 110 to 210 megawatts. Nine of the boilers, 5 of 210 megawatts and 4 of 110 megawatts, are located at Prunerov I and II. The policy investigated here is if an emissions cap were created for all 9 boilers based on the existing valid legislation, but without specific limits on any one boiler. Table 1 below presents the data and calculations for each boiler. The results suggest that annual cost savings, taking into account the higher cost for control at the over-controlled boilers, might be as high as 950 million crowns per year. This cost saving estimate is likely to be an upper bound as it is based on U.S. cost data while recent negotiations in the Czech Republic have shown that competition may reduce the cost of building desulfurization units[1]. A second measure, the gross cost saving at these two sites, can also be estimated if the cost of desulfurization at 3 of the 110 megawatt boilers can be avoided. In that case the gross cost savings might be approximately 2.4 billion crowns based on cost of investment data released by CEZ.

Key assumptions of the analysis for the 9 boilers are as follow:

- The 210 megawatt boilers are baseload boilers and used at 90 percent capacity; each boiler's uncontrolled emissions are assumed to be 14,000 tons; the valid individual boiler limits are 500 mg/m3 requiring 91 percent control to reach the standard; overcontrol to 96

[1] A report by VSCHT (1994) also suggests that per unit desulfurization costs may be significantly lower although issues of comparability between the data supplied by Power International and VSCHT could not be resolved at this time.

percent removal is assumed to increase total cost by 10 percent (this is a cost elasticity of 2--for each one percent increase in control the total cost increases by 2 percent).

- Two of the four 110 megawatt boilers are assumed to be swing production boilers that are operated at 50 percent of capacity; each boiler's uncontrolled emissions are assumed to be 4,000 tons; the valid individual boiler limits are 1700 mg/Nm3 requiring 71 percent control to reach the standard; overcontrol to 91 percent removal is assumed to increase total cost by 28 percent (a cost elasticity of 1--for each one percent increase in control the total cost increases by 1 percent).

- The remaining two of the four 110 megawatt boilers are assumed to be peak production boilers that are operated at 10 percent of capacity; each boiler's uncontrolled emissions are assumed to be 1,000 tons; the valid individual boiler limits are 1700 mg/m3 requiring 71 percent control to reach the standard

Table 1 (following the References) shows each of the boilers and key data such as uncontrolled emissions, controlled emissions and costs under the different scenarios. In column 4 at the bottom is the total emissions control that is assumed to result from meeting the current standards. A similar total is shown in column 7 for the alternative, emissions cap, policy showing the emissions could be controlled somewhat tighter. The annual cost savings are identified in the last column as the change in cost, in crowns using an exchange rate of 28 crowns to the dollar. These cost savings are the net result of higher costs on the baseline and one swing time boilers due to overcontrol (identified by the positive numbers in the last column) and the cost savings (negative numbers) from leaving uncontrolled the emissions on one swing time boiler and the two peak boilers. The <u>annual</u> cost savings estimated in Table 1, based on United States cost data, is approximately 950 million crowns.

Table 1 can be found after the References

Environmentally, the two policies are designed to be equivalent over a 1 year time period. In periods of peak production, the emissions would be larger under the alternative policy than with standards. However, it is important to note that analyses elsewhere (Farrow and Bluffstone) suggest that full compliance with the 1998 standards may lead to overcompliance with the ambient air quality standard. Alternatively, given the large estimated costs savings (over a 30 year span, the present value savings may be several billions of crowns) it may be possible to undertake some moderate emission reduction actions that lead to improvement of both the environment and the compared to the improvement from the use of standards.

In fact, planning is already far advanced for adding desulfurization units to all CEZ facilities. Consequently, instead of an internal trade within the Prunerov complex, it is possible to look at an alternative policy of offsets at the same point in time but across enterprises. For instance, suppose that desulfurization units were completed on all the 110 megawatt units at Prunerov I and II with a required level of control of 71 percent. If each unit were operated at a higher removal rate -- say 90 percent -- that overcontrol is sufficient to completely compensate for one, 110 megawatt unit potentially controlled at a 71 percent rate at another location -- for example, at the steel tube rolling mill in Chomutov. This would generate cost savings of the same order of magnitude as the cost savings estimated in the internal trade.

Case Study Conclusions

Using the 9 boilers at Prunerov I and II as examples, it has been estimated that cost savings from an emissions cap approach might be as high as 950 million crowns per year while annual emissions remain the same. Of course, these calculations are not precisely accurate. Capacity factors and costs are certainly different although every effort was made in this analysis to use real data that might be relevant to the boilers of Prunerov. It remains up to CEZ and industry to investigate, using their data that are

accurate for the actual operating conditions and the Czech situation, the size of potential cost savings.

There is no environmental impact on an annual basis from the alternative policy although the effect on peak emissions might be investigated as part of the cost analysis. Several alternative strategies, such as offsetting emissions across companies, importing peak power at unusual pollution times (as is the current practice), or the possibility for regional overcontrol when the 1998 standards are implemented, might also address the issue about the timing of emissions. In conclusion, this analysis has suggested one strategy that might lead to large savings for the economy. Such cost savings are important as investments in new productive equipment other than environmental equipment can help both the economy and the environment.

In addition to these examples, there are at least two Czech groups that might be able to provide information on cost saving from the use of economic instruments. The Czech Environmental Management Center (1994) has surveyed a number of member firms for their expected cost of compliance. It may be possible to organize their data by industry and numerically estimate a cost of pollution control function for each industry. Such functions could be investigated for the cost savings when marginal costs are equated at the level consistent with the standards, instead of forcing each enterprise to comply with the standard individually. A second opportunity may exist by using data sets for a particular city, such as that for Decin (Sauer, et. al.) Again, such data might be investigated for the total cost of pollution control in the city when all boilers are controlled to the same level, the administrative solution, or when they are controlled to the same marginal cost.

Recommendation: Pragmatic work can be done to investigate the validity of small scale forms of trading. One or two regional or national work groups could be formed with representatives from industry, the government, the cities and environmental groups to analyze the economic and environmental impact.

III. Aggregate cost savings

Little is also known about the aggregate cost savings that might be possible in the Czech Republic from the use of economic instruments. This section briefly surveys the U.S. experience, a study of Polish air pollution policy, and a study of sulfur and nitrogen oxide releases from the Czech Republic. This survey lead to a preliminary hypothesis about the size of aggregate cost savings in the Czech Republic.

In the United States, there have been frequent studies showing that administrative methods may be 2 to 4 times more expensive than the "least cost" method (U.S. EPA.) Economic instruments are identified as a least cost method on the basis of theory. However, real policies in practice do not seem capable of fully achieving the ideal least cost solution. The costs of finding trading partners and the interaction of market approaches within an administrative system have limited the actual cost savings achieved in the United States. However, the modest applications of economic instruments to national air quality regulation have probably reduced the cost of air pollution programs by about 10 percent, which amounts to saving many billions of dollars to the U.S. economy.

Research in Poland has, so far, been similar to the first stages of research in the United States, which compared the cost of administrative methods with the theoretical least cost solution. Toman, Cofala and Bates (1994) used a model of Polish air pollution and compliance costs to estimate the national cost of compliance under various administrative regimes, including those consistent with EC standards and with German standards. The estimates were compared with the least cost solution. They found, assuming that all internal firm trading was currently allowed (which it is not), that economic instruments might save between ten and twenty percent of the cost of administrative methods. They explained this relatively small difference primarily by noting the assumption that all internal trades were allowed and that the performance

standards written for the current system were more flexible than specifying a technology. Both factors work to reduce the estimated proportion of cost savings.

Even modest percentage reductions in cost can however, have a significant impact on individual companies and release significant amount of investment funds. For instance, CEMC (1994) has estimated that air pollution control regulations may cost Czech industry 127 billion crowns for compliance. If ten percent, or 12.7 billion crowns, can be saved through a change in regulatory approaches then the change is likely to be a topic worthy of policy discussion.

Czech Case Study 3: Aggregate Air Pollution Control Costs

A recent study of the aggregate cost of sulfur and nitrogen oxide air pollution control control in the Czech Republic by the Netherlands Energy Research Foundation (ECN) with the help of VUPEK and SRC International also establishes the least cost baseline for analysis of the Czech. In Figure 1 (following the References) ECN reports that the least cost investment plans to achieve the goals of the Second Sulfur Protocol are predicted to cost the Czech Republic approximately .75 percent of Gross Domestic Product. A reduction in nitrogen oxide emissions of about 45 percent is estimated to cost a similar amount (see Figure 2.) As the estimates are based on the least cost of achieving the emission reduction, costs would be expected to be somewhat higher in practice for an application of economic instruments and perhaps several tenths of a percent of GDP higher still if administrative methods are used. If these scenarios occurred, close to 2 percent of GDP might be paid by the economy for reducing nitrogen oxide and sulfur emissions alone. If economic instruments can reduce these costs by even a few tenths of a percent they are likely to be economically worthwhile while achieving the same environmental goal in practice.

Further work on the ECN model used to develop estimates of the cost of compliance for the existing administrative system could provide a numerical comparison of the maximum savings in a nitrogen oxide or sulfur program.

Another research group, VUPEK Economie, has constructed a model of the energy sector of the Czech economy that also includes emissions data. This work has been funded by both the Ministry of Industry and Trade and by the Ministry of the Environment. Additional work on this energy sector model might also allow a comparison of the cost to the economy of alternative environmental policies. The VUPEK Economie model has the advantage of being constructed and used within the Czech Republic. As it is a simulation model however, it may require additional work to develop comparable scenarios for a least cost and an administrative regime.

Recommendation: The integration of economic and environmental policy will be helped when Czech analysts can answer the question of how large the cost savings might be from using economic instruments. Given the modest but important cost savings experienced in the U.S. and suggested by studies of the Polish economy, numerous Czech interests such as the energy sector, industry, and the economic and environmental industries should fund and do work on the potential size of cost savings in the Czech Republic.

IV. Comparing economic and administrative methods and the US Experience

Previous pages have focused on the cost savings potential of economic instruments compared with administrative methods. There are however, other points of comparison between the two approaches that should not be ignored. Six of these points are discussed below, along with a summary of the lessons learned from the application of economic instruments in the United States.

First, some individuals wish to create a philosophical consistency among policies so that environmental policies used by Government are consistent with the market organization of an economy. Economic instruments move Government regulation

towards the tools and methods that are practiced in the market economy compared with the use of administrative methods (Appendix I).

Second, any organization whose mission is to preserve the environment must focus on environmental outcomes: is the environment improved by an equal amount or even made better after the application of economic instruments? In the United States the answer is usually embedded in the design of economic instruments such that the environment is at least improved by the amount expected under administrative methods.

Third, a topic that remains clear in theory but not yet investigated in practice is the different incentive for technological change provided by economic and administrative methods. Economic methods, which provide an ongoing incentive to reduce costs, in theory produce more technological change. This is very important because studies of technological change indicate that the majority of wealth that has been created over the last century has come from technological change.

Fourth, do economic instruments balance benefits and costs compared with administrative methods? As standardly developed, the comparison between the two methods is the least cost of achieving a given environmental objective. Both kinds of instruments can be mis-applied in the sense that the objective may over or under control such that the additional (marginal) costs exceed the benefits.

Fifth, the impact of each kind of instrument on the financial and environmental health of industry and other groups can be studied. The preferences of different interest groups are describable but are just being studied in an economic context. One naturally expects environmental groups to be most concerned about the quantity of pollution, a focus that leads to a preference for administrative methods or marketable permits. This preference has also been justified in theory if the damage function from emissions is quite steep relative to the control costs. Industry is expected to be most concerned about costs. In the economic framework this might lead one to expect a preference for pollution taxes. However, pollution taxes as typically administered result in industry incurring costs both

for reducing pollution and paying an additional amount for those emissions they do not emit. In contrast, marketable permits, when given (grandfathered) to the polluting industries, can convey a valuable property right that increases the asset position of the firm. Although tax credits can be structured in a way that is parallel to grandfathered permits (Farrow, 1995) the U.S. experience is that tradable permits are more acceptable to industry if they must face a given level of regulation.

Finally, bureaucracies and governments themselves have preferences. Agencies become staffed with personnel who have particular training and interests and who in turn develop connections among the affected interest groups. An agency dominated by economists is going to be fundamentally different than an agency dominated by natural scientists. Each would be expected to favor regulations that control the measures they best understand.

These additional points of comparison between economic and administrative approaches typically assume that clear policies of one type or another is implemented. In practice, economic approaches have been attached to an existing administrative approach. These programmatic interactions must be evaluated on a case by case basis. The particular issue of the interaction of the Czech system of of charges and standards is presented in Appendix II. In that appendix it is shown that the charges achieve purposes such as raising revenue and providing an incentive to enterprises to begin controlling pollution. However, it is also shown that the Czech system of charges as currently implemented is not expected to reduce costs relative to an administrative system.

Lessons learned from comparing US administrative and economic instruments

- Economic instruments can improve the environment to the same degree or more than with administrative instruments. This criterion has been built into the design of some economic instrument programs.

- Actual cost savings can be significant to individual companies. This has been demonstrated in cases involving air and water emissions and phasing out material inputs.

- The largest actual cost savings to companies in the U.S. have come from an ability to make internal trades to meet a standard for an entire plant.

- The total cost savings realized to date may have been somewhat less than ten percent of the cost of the stationary source air emissions program.

- Economic approaches do not seem to have a direct effect on technological change although the recent interest in pollution prevention that pays may be an indirect impact of administrative and economic instruments.

- Actual cost savings are likely to be significantly less in total than the maximum cost savings predicted from a pure economic instrument in a world with no transactions costs. This has been demonstrated in simulation models and in the level of observed use of economic instruments.

- Economic instruments can succeed or fail. Their ability to deliver cost savings depends on the design of the program, especially the way that the economic instrument interacts with other requirements imposed by administrative standards. The greater the certainty and flexibility given to a company, the greater the savings.

- Public interest in implementation is likely to be driven by very local concerns and the benefits of economic instruments may seem very abstract. Discussions about job savings may be politically important to the public.

- The allocation of tradable permits to industry by "grandfathering" or the use of a tax credits with pollution taxes may be politically important to industry.

- Choosing between economic and administrative instruments does not solve the question of how much pollution to control. Economics can, however, inform such policy debates through the use of benefit-cost analysis.

V. Conclusion

Studies of the potential cost savings from the use of economic instruments in the Czech Republic are still in their infancy. The available data suggest, however, that the specific nature of the Czech pollution control regulations are likely to provide opportunities for cost savings while achieving the same environmental improvements as with administrative methods. Illustrative strategies for one or a few firms were shown to potentially generate savings of billions of crowns. The high expected level of aggregate expenditures on pollution control in the Czech Republic also suggests that cost savings of even a fraction of the total may sum may release a significant amount of internal investment funds for the Czech economy.

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Figure 1: Sulfur Dioxide

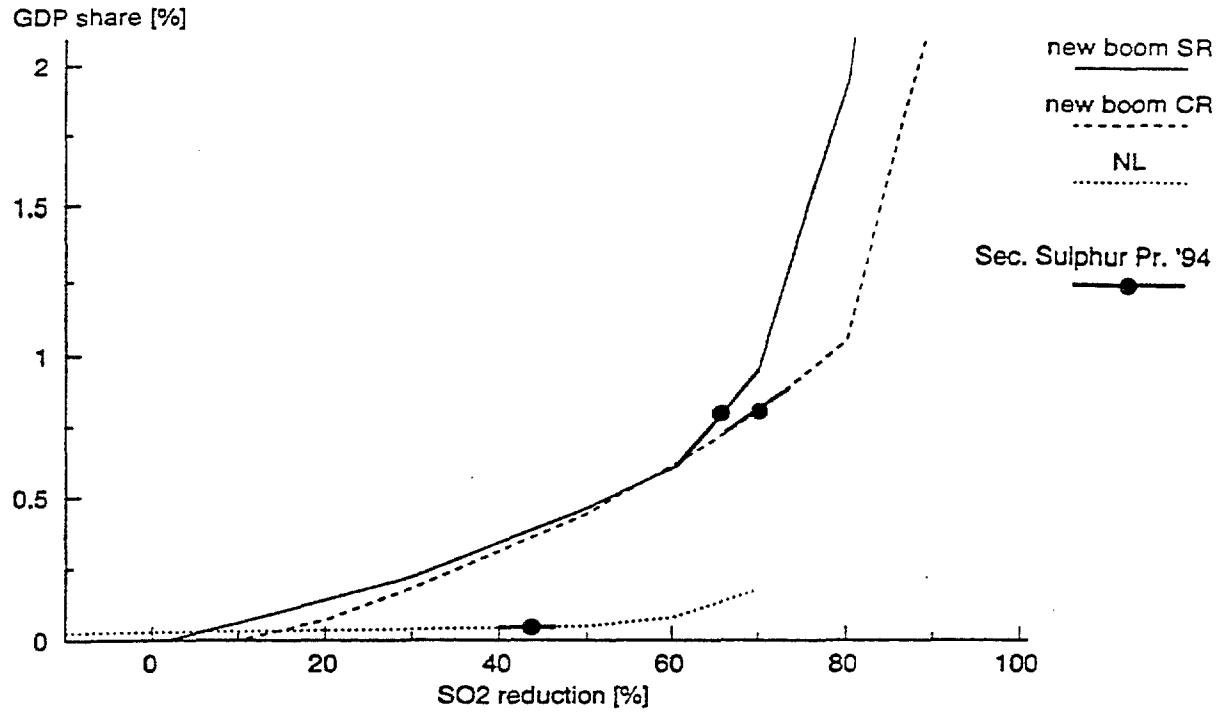

Figure 8.8. *Comparison of SO_2 emission reduction cost curves by country for the year 2015 (% of GDP-2015 versus 1988-% avoided emission).*

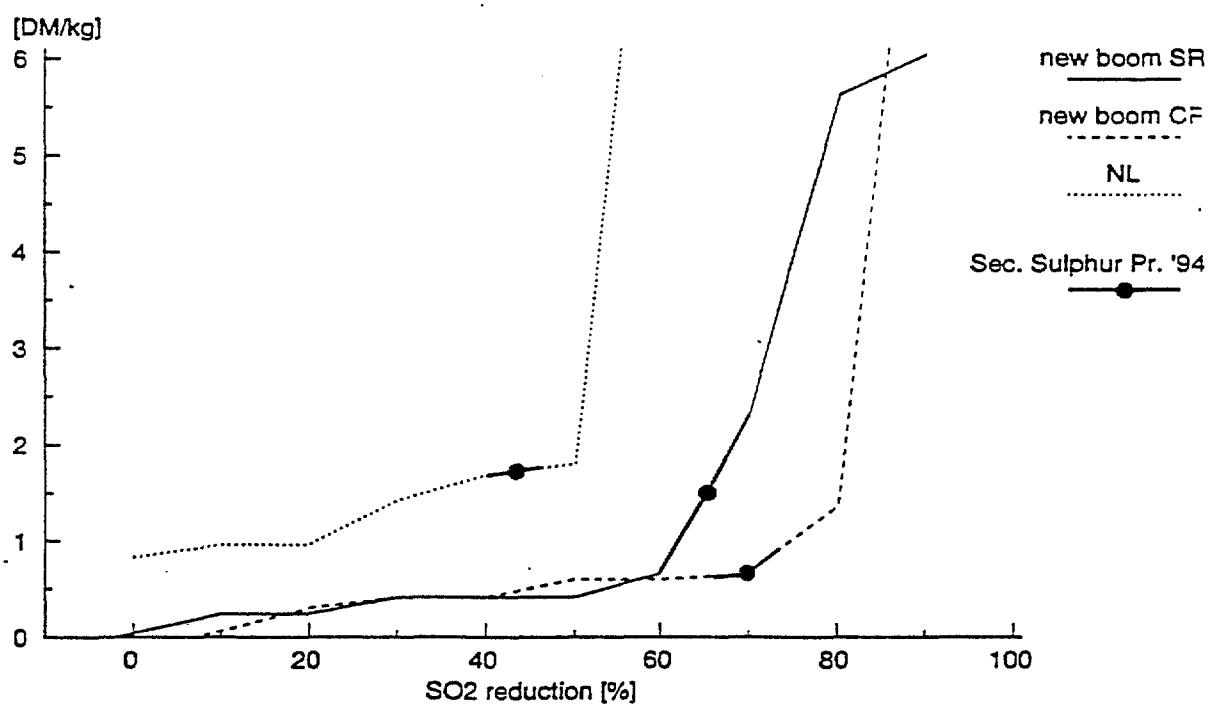

Figure 8.9. *Comparison of SO_2 emission reduction cost curves by country for the year 2015 (levelized marginal costs versus 1988-% avoided emission).*

Source: Netherlands Energy Foundation, 1994.

Figure 2: Nitrogen Oxide

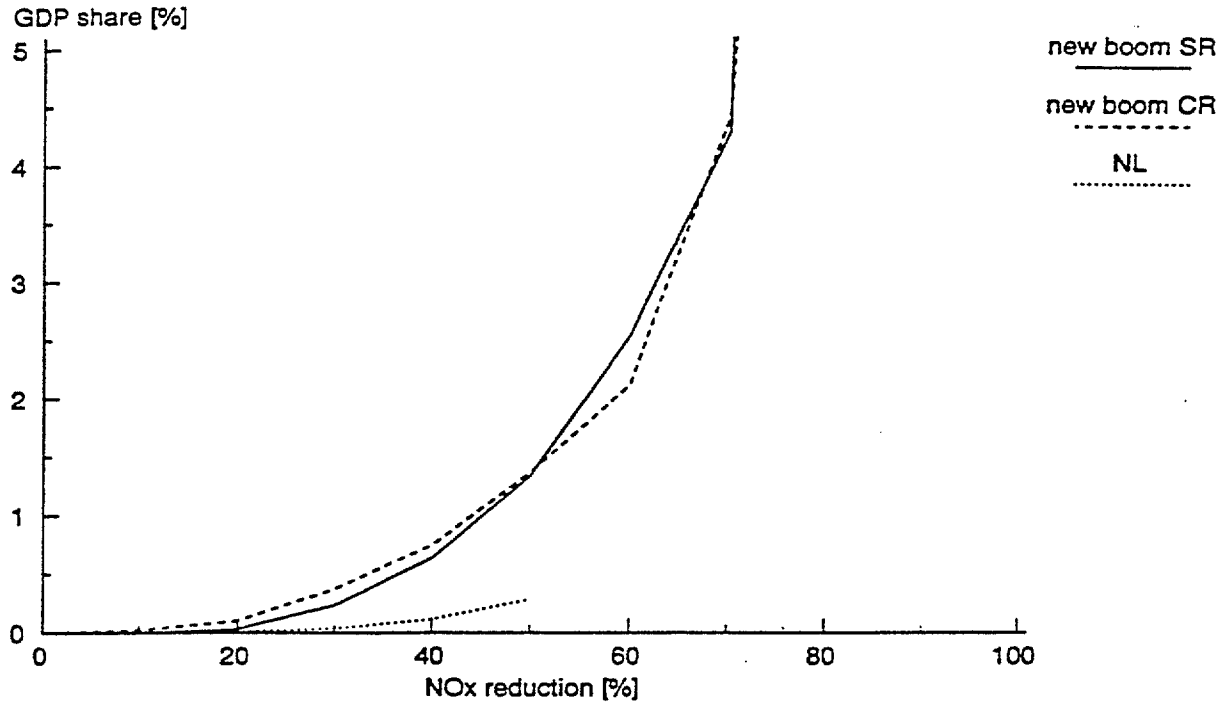

Figure 8.5. *Comparison of NO_x emission reduction cost curves by country for the year 2015 (% of GDP-2015 versus 1988-% avoided emission).*

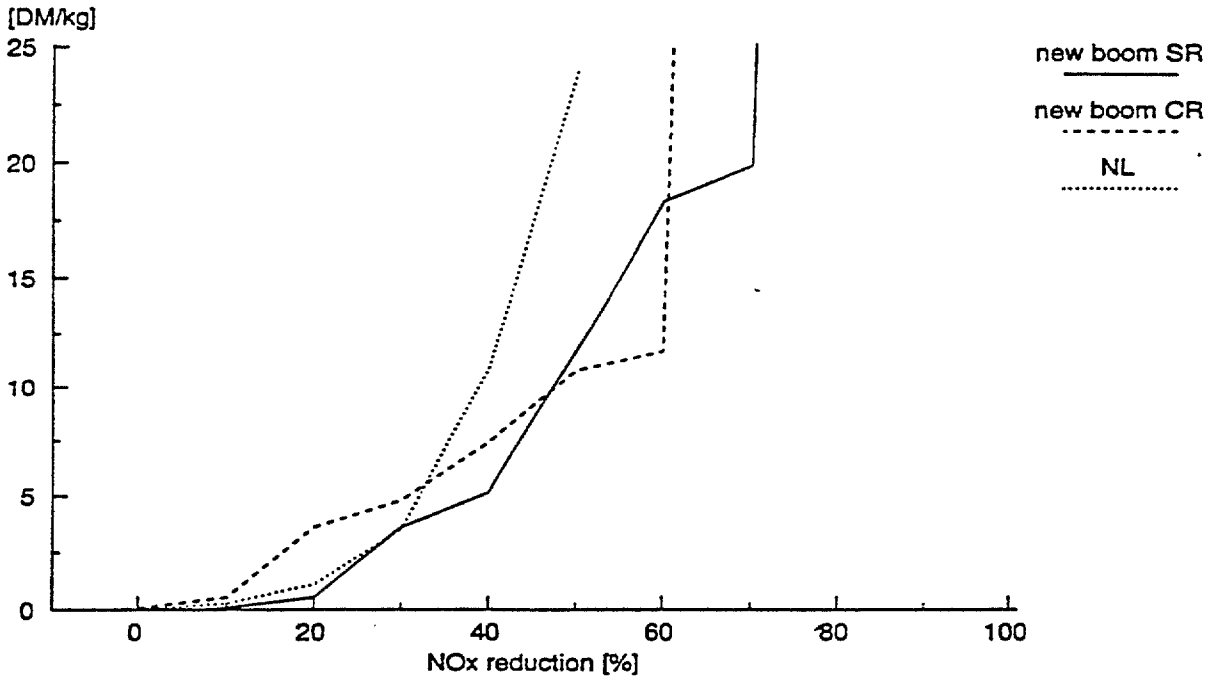

Figure 8.6. *Comparison of NO_x emission reduction cost curves by country for the year 2015 (levelized marginal costs versus 1988-% avoided emission).*

Table 1: Prunerov Case Study

Monetary Units in Crowns

Boiler	Limit	Uncontrolled Tons	Controlled Tons	Unit control Cost	Total Cost	Alternate Control	Alternate Unit Cost	Alternate Total Cost	Change in cost (Alt. - Base)
1	2	3	4	5	6	7	8	9	10
EPRU II									
B21 (210 MW)	500	14,000	12,740	15,848	201,903,520	13,440	16,520	222,028,800	20,125,280
B22 (210)	500	14,000	12,740	15,848	201,903,520	13,440	16,520	222,028,800	20,125,280
B23 (210)	500	14,000	12,740	15,848	201,903,520	13,440	16,520	222,028,800	20,125,280
B24 (210)	500	14,000	12,740	15,848	201,903,520	13,440	16,520	222,028,800	20,125,280
B25 (210)	500	14,000	12,740	15,848	201,903,520	13,440	16,520	222,028,800	20,125,280
EPRU I									
B3 (110 MW)	1,700	4,000	2,840	43,120	122,460,800	3,640	43,120	156,956,800	34,496,000
B4 (110)	1,700	4,000	2,840	43,120	122,460,800	0		0	-122,460,800
B5 (110)	1,700	1,000	710	683,200	485,072,000	0		0	-485,072,000
B6 (110)	1,700	1,000	710	683,200	485,072,000	0		0	-485,072,000
	Total	**control w/reg.**	**70,800**		**2,224,583,200**	**70,840**		**1,267,100,800**	**-957,482,400**

Appendix I

Integrating Environmental and Economic Policy Can and Should Be Done[1]

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Environmental policy can be consistent with the underlying principles of Czech economic management such as: privatization, deregulation and an emphasis on direct human action. Environmental policy is subject to the same search by rent-seekers to improve their economic position but market forces can limit the actions of these rent-seekers. Each of these points is discussed below.

Deregulation

Harnessing the invisible hand of the market-place requires correct price signals. Subsidies and the existence of technologies that do not communicate the correct prices hurt the economy and the environment. Examples of this are subsidies to the energy sector and commercial and household energy bills that do not depend on the measured quantity consumed.

Most countries have built large adminstrative organizations to implement technologically based environmental regulations. There is increasing awareness however, that economic approaches to environmental regulation such a tradable permits and environmental charges use the power of the marketplace instead of the adminstrative procedures to reduce the economic cost of regulation including, perhaps, the size of the environmental adminstration .

It is also well established in western economic thought that the environment is an example of a good that where everyone has responsibility, no one has responsibility. This is called the public goods problem. The result is that even when subsidies are removed on some goods the economically correct prices should include some additional amount for external damages. A deregulation program for environmental policy can be built upon:

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[1] This essay was written after reading an article by Prime Minister Klaus in The Economist, September 10, 1994.

- Environmental policy first supporting the deregulation of prices.
- Some prices should include a component for environmental damages
- Increasing the use of economic based instruments.

Privatization

Massive change in the economy of the Czech Republic and its hopes for economic improvement are based in widespread privatization. Environmental policy can also be based on the privatization of environmental resources through the use of economics instruments. No one currently owns the environment although the Government attempts to manage it. This is like the open rangeland of the United States western frontier in the late 1800's. The agricultural competition for water and rangeland led to violence and overgrazing. A technological change, barbed wire, allowed property rights to be easily defined by controlling the movement of the economic commodity, cattle. In the modern day, technological changes that measure pollutants can allow the privatization of key environmental resources.

In the United States, the government has in effect granted a type of property right when it allocated sulfur dioxide emission allowances to existing polluters. Those allowances can be bought and sold and listed on balance sheets. An alternative approach is for the Government to levy a user charge on emissions. The Government typically retains the ownership rights, it just charges for the use of an asset. However, it is also possible to grant tax credits to existing enterprises to offset some of the tax burden. These tax credits in effect transfer some property rights to the enterprise. A privatization program for environmental policy can be built upon:

- Allocating a limited number of emission rights to existing firms. It is important that the number is limited to achieve the environmental goals and to create an economic good, or
- Implementing economically meaningful user charges in conjunction with a fixed tax credit.

Direct human action

The most important economic and environmental improvements come from technological change. The largest improvement for the environment will come from the economic substitution of

technologies that are both more efficient and more environmentally beneficial. Consequently, direct domestic and foreign investment in industry and infrastructure is likely to be the largest source of environmental improvement with foreign aid playing a smaller role. Investment, whether domestic or foreign, is improved by stable economic conditions leading to lower observed interest rates, low taxes, and reductions in uncertainty. Also, direct citizen participation in environmental decisions can move the center of power from a government ministry to the market place. A direct human action program for environmental policy can be built upon:

- Stabilizing and reducing the environmental liability concerns of domestic and direct foreign investment.
- Reducing tax rates on beneficial actions that improve the economy and the environment, such as labor taxes and enterprise taxes, and increasing the rates on actions that harm the economy and the environment, such as emissions.
- Allocate some of the privatized ownership rights in the environment to citizens. They can directly decide, through themselves or proxy organizations to whom they sell their rights, how they wish their environment to be.

Integration of economic and environmental policy

Economic and environmental policy can be based on the same principles and use the same tools. Making the environment count in economic decisions is both sound economic policy and sound environmental policy.

Appendix II

The Interaction Between Charges and Standards

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In practice, charges and standards are often used together. One example is the Czech Republic where charges exist for a variety of air and water pollutants while performance standards exist simultaneously. This note explains the conclusion made elsewhere (Farrow and Bluffstone, 1995) that the likely interaction of strict standards and politically feasible charges will not lead to cost savings in the Czech Republic relative to a pure standards system. This will be shown to result from charges that in an economic sense are less strict than the standards. A consequence of that situation is that the criteria for a least cost solution, that the marginal cost of control be equal for all enterprises, will not be met.

The explanation will proceed by examining 4 cases, each presented geometrically.

Case I: Charges only: least cost, each enterprise meets same charge

It is well known that charges can induce enterprises to equate the marginal cost of control at each source and consequently achieve the conditions for the least cost of control. In Case 1 below, the curves C1 and C2 represent the marginal cost of pollution control at two different locations. When a charge, k, is set, each location will equate the marginal cost of control with that charge, k. The cost minimizing solution is for enterprise 1 to control Q1 of pollution and enterprise 2 to control Q2 of pollution. The total amount controlled is Q1 plus Q2. As long as the marginal cost of control functions are different at the two locations, then the common charge level will lead to each enterprise controlling a different amount, but in an optimal manner.

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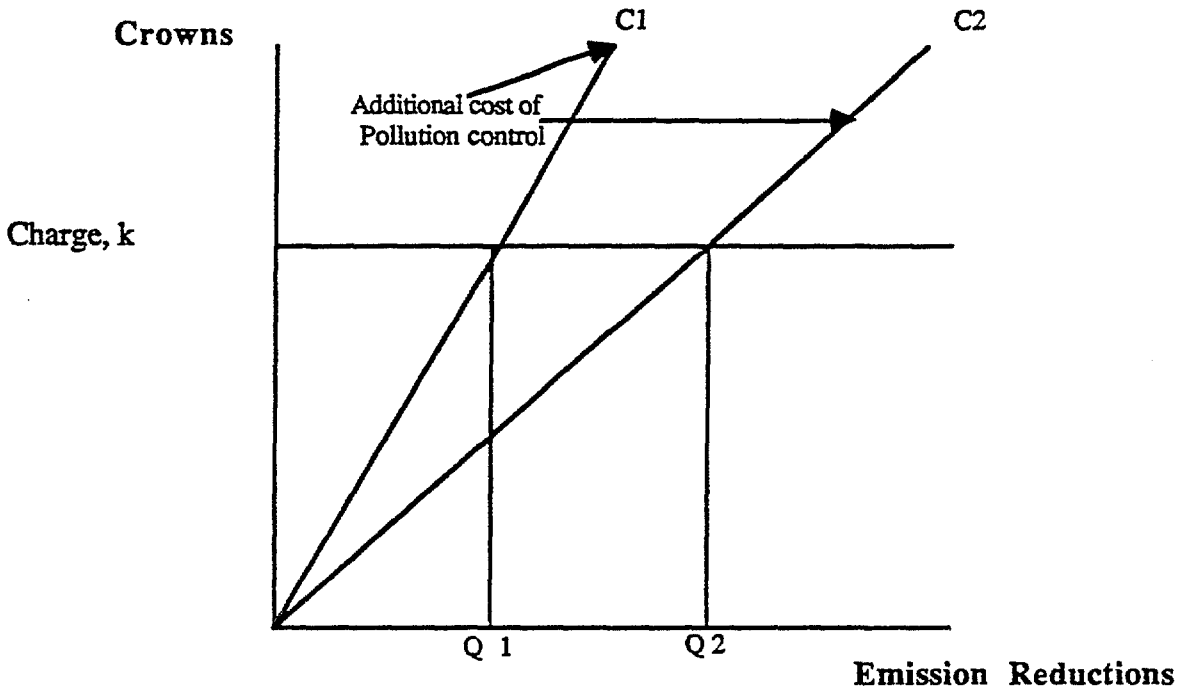
Case I: Least Cost Charges



Case II: Standards only: not least cost, each enterprise meets same standard

In Case 2 it is assumed that each enterprise must meet the same standard, shown here by each enterprise controlling the same amount of pollution Q*. It is clear that the marginal cost of control at level Q* will be different for each firm. This difference in the marginal cost of control implies that this type of standard cannot be a least cost environmental policy.

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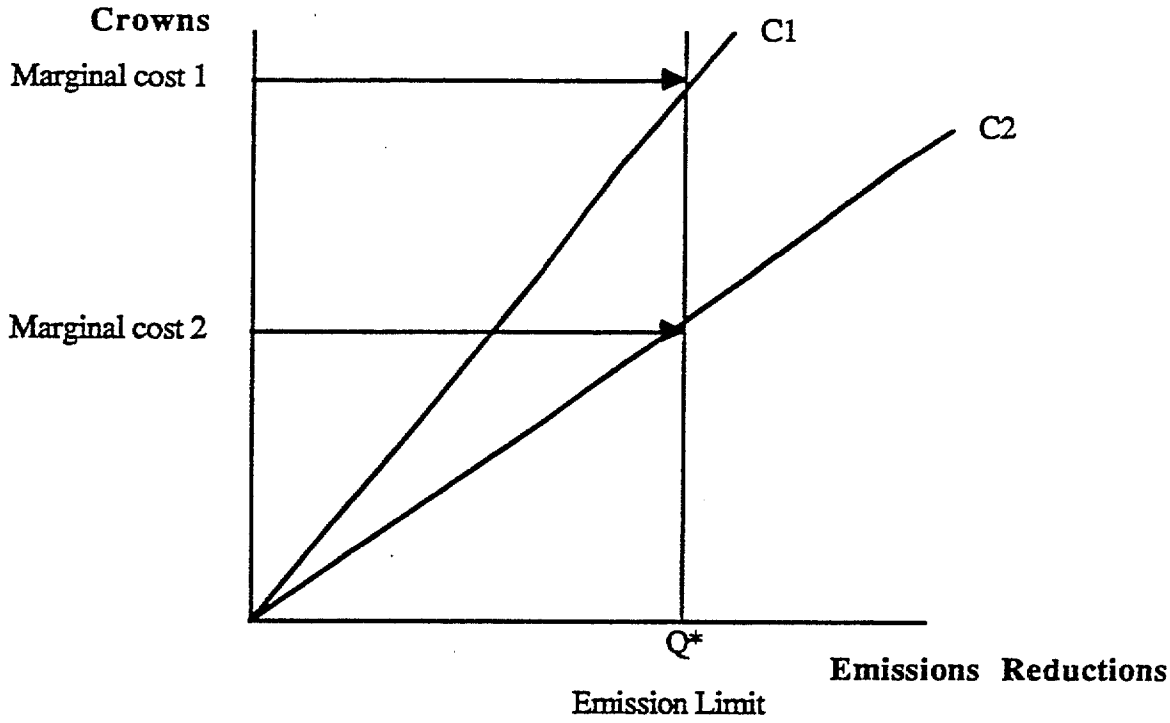
Case II: Standard only



Case III: Charges and standards together, not least cost if standards are stricter

In most locations, the Czech Republic is one example, the quantity of control required by the standards is stricter than the quantity that enterprises would choose to control if only a charge existed. This case is shown asCase 3 where Q* is larger than Q1 and Q2. It is apparent that the charge will encourage some level of pollution control, up to the point of Q1 and Q2. However, the more strict standard forces more pollution control. When the standard is achieved it is the standard that is binding and so the marginal cost of control is not equated across enterprises. Therefore this example of the interaction of charges and standards cannot be a set of policies that are the least cost.

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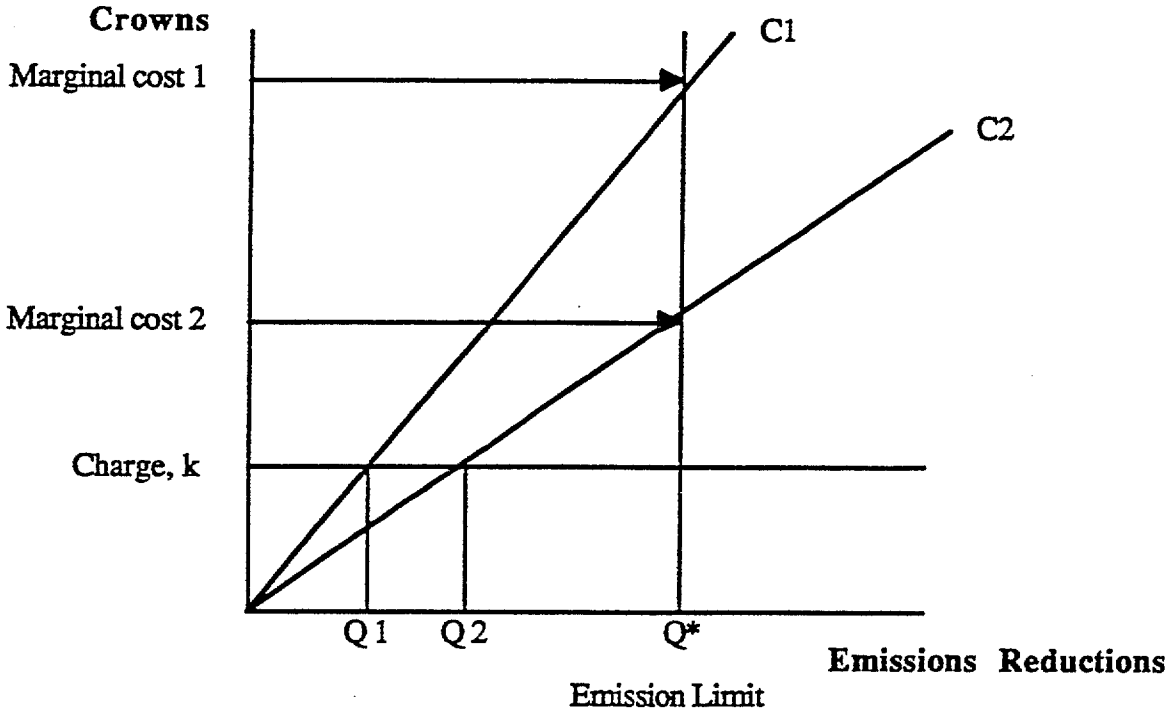
Case III: High Emission Limit and Charge



Case IV: Charges and standards together, least cost if charges are stricter

If the charge can become the stricter policy, then a least cost policy can be achieved. In order to achieve the same target level of pollution control in Case III, the level of the charge would have to be increased. At the same time the standard would either become non-binding or become a goal instead of a standard. In that case the enterprises will equate their marginal cost of control and control the amounts Q1 and Q2 as shown in Case 4. Those amount are greater than is necessary under the revised standard and so a least cost policy is achieved because enterprises act in a way to equalize the marginal cost of control.

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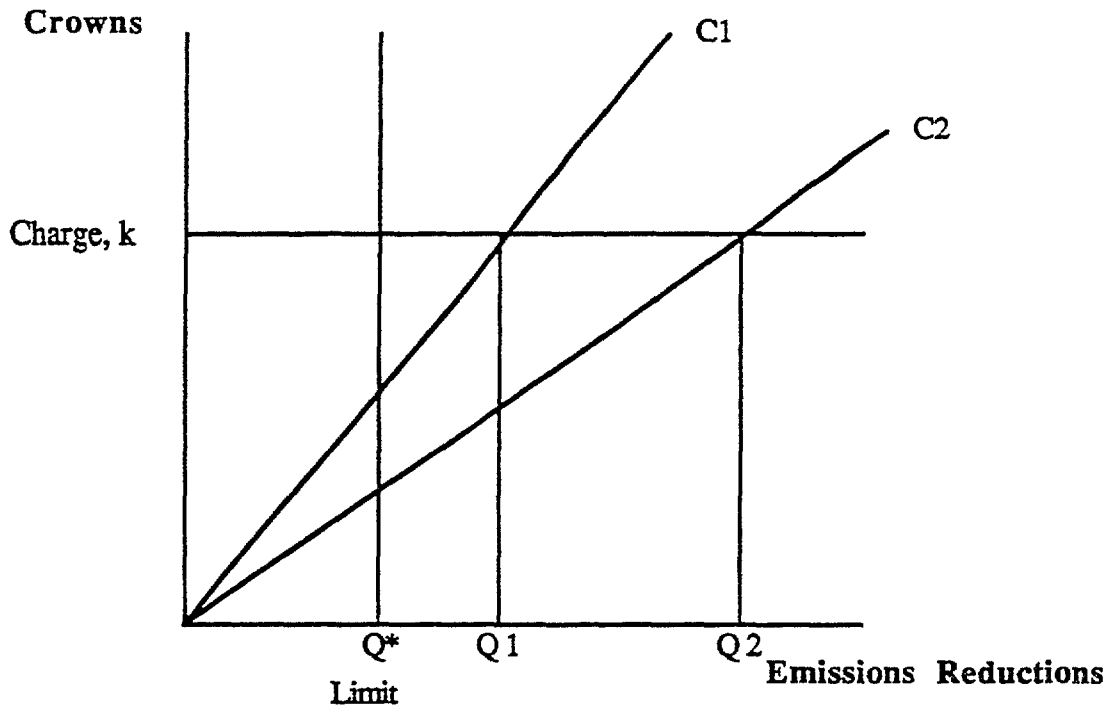
Case IV: High Charge with Standard



A major issue with higher charge rates is the financial burden on the enterprise. The enterprise usually pays both for the cost of actually controlling pollution and for the emissions that are released. New research (Farrow, 1995) has shown a way that higher charges can be used in connection with a fixed charge credit (giving an allowance of some fixed amount to the firm) to reduce the financial burden while still achieving the environmental objective at a least cost.

Conclusion

This note has demonstrated that when charges and standards interact, the result is not typically the least cost solution that is the frequent justification for charges. Instead, the usual conclusion about standards is seen to apply with the charge serving the function of raising revenue and encouraging the initial stages of pollution control. A least cost solution can be obtained only by raising the charge to a level that is more strict, in an quantity sense, than the standard. The

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burdensome financial implications of this result can be mitigated by providing a fixed charge credit to the enterprise.

References

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