# Effluent Charges:
# Good Government, but Bad Business

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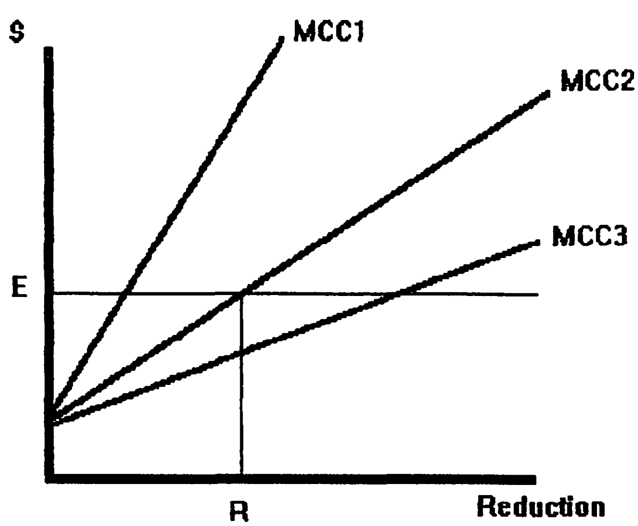
**Effluent Charges - Good Government, but Bad Business**

In examining current government policy on regulating negative externalities caused by pollution, it becomes obvious that more efficient policies are needed. One such policy, which many economists support, is an effluent charge. However, the groups who influence government most rarely support effluent charges. In this paper I will cover common economic theory used to support effluent charges, mention some arguments against effluent charges, and finish with their economic affect on business.

To establish the framework of this paper a definition of current and new policy are required. Current policy will be referred to in this paper as regulation. This consists of a government agency estimating effluent levels of industries, then requiring the firms in these industries to take specific measures that the government agency feels will reduce effluents to an optimum level. The effect of this policy is diverse and complex, but this paper will consider the intent rather than the specific regulation. The new policy being discussed will be called an effluent charge throughout the paper. This consists of the government levying a tax on firms based on the amount of effluents produced by the firm. In this paper this tax is assumed to be constant at all levels of effluents and consistent from firm to firm.

There is substantial literature comparing effluent charges to regulation and their effect on society. The three main points are: least cost, incentives, and welfare loss. The first question is whether regulation and effluent charges are least cost solutions. When we look at graph 1 we see the marginal control cost curves of three firms. The proper effluent charge is plotted on the Y axis and the proper regulation level is plotted on the X axis. To keep the example simple it is assumed that the distance along the line plotted from the effluent charge between firms 1 and 2 is equal to the distance between firms 2 and 3. Furthermore it is assumed that the distance, along the line plotted from the regulation level, between firms 3 and 2 is equal to the distance between firms 2 and 1. So at the effluent charge E and the regulation level R the level of effluent abatement is equal. At the effluent charge E notice that no firm can reduce one more unit of effluents at a lower cost than the last unit reduced by other firms. However at the regulation level R firm 3 can reduce its next unit of effluents at a lower cost than both firm 2 or 1's last unit abated and firm 2 can reduce its next unit of effluents at a lower cost than firm 1's last unit abated. This shows that effluent charges are a least cost solution while regulation is not.

Graph 1

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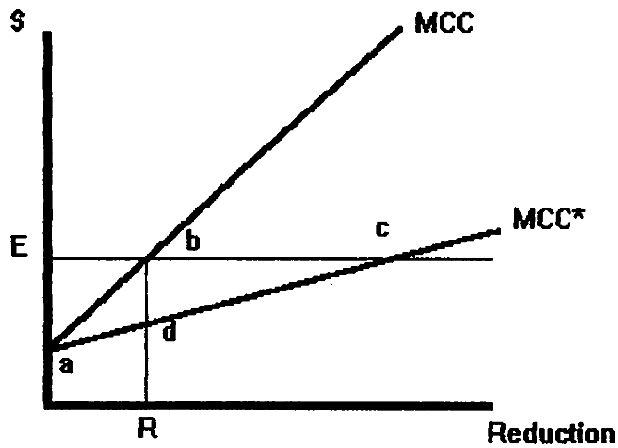
The second point is that effluent charges give a greater incentive to prevent pollution and reduce abatement costs compared to regulation. In graph 2 we have two marginal control cost curves, the firm's original curve MCC (Marginal Control Cost) and a cost curve after some technological advancement MCC*. Under regulation a firm cannot remove its current abatement equipment until the EPA decides the new equipment is better. When they do decide it is better the EPA will require the rest of the industry to use this equipment as well. So, a firm may gain a slight advantage in market power or a short term increase in profits because they were able to begin implementing this equipment sooner. Notice that when the firm adds this technology under regulation the increase in their profits are enclosed by the area a, b, and d, but when they add this technology under effluent charges they increase their profits by the area enclosed by a, b, and c. Under effluent charges a firm is able to implement this technology immediately, thereby receiving the benefit for a longer period. So not only do they gain a greater increase in profits or market power from this innovation, they are able to gain these advantages until another firm can match their innovation. This additional profit would induce firms to take risks in developing new technology and finding ways to reduce pollution initially.

Graph 2

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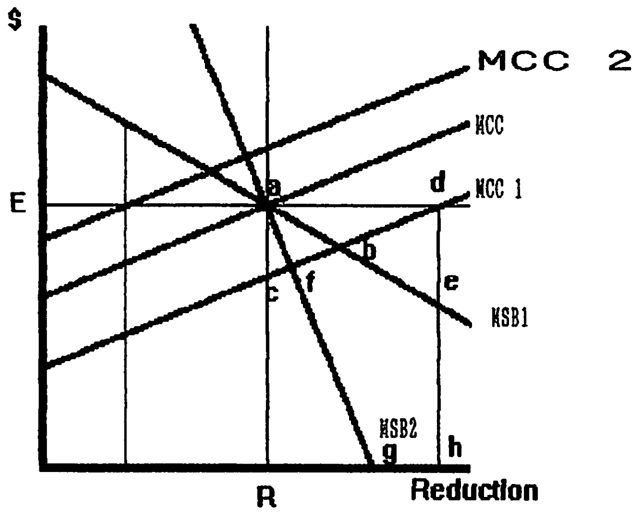
The third point is the size of the welfare loss created by a mistaken level of the policy. Elasticity of the MSB (Marginal Social Benefits) curve and the MCC curve affect the size of the welfare loss created by the two policies. Effluent charges limit the maximum marginal cost that will be imposed on a firm for their effluents regardless of the level produced. Regulation puts a limit on the amount of effluents that will be produced regardless of the cost to firms. This is a good starting point for deciding which policy to use. The more critical it is to reduce waste, and the less important it is that the pertinent industry is negatively affected, the better regulation is. This can be illustrated by manipulating the basic graph used earlier. As it becomes more critical to achieve a certain amount of abatement the marginal social benefits curve becomes less elastic as illustrated in graph 3. This causes larger social welfare losses from an effluent charge policy, and a smaller one from a regulation policy. In Graph 3 with MSB 1, an elastic curve, the welfare loss for MCC1 with an effluent charge is b, d, e where with a regulation policy it is a, b, c. With MSB2, an inelastic curve, the welfare loss for an effluent charge is f, g, h, d where with a regulation policy it is a, f, c. You will see that if you use MCC2 you will find the same results.

Graph 3

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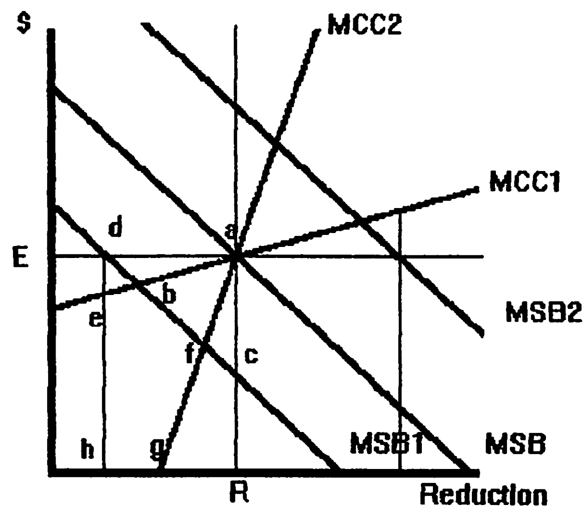
The negative effects to the pertinent industry become more profound, as illustrated in Graph 4 by the marginal control cost function becoming less elastic, the welfare loss from regulation becomes more severe while the welfare loss from effluent charges lessens. In Graph 4 with MCC1, an elastic curve, and MSB 1 regulation gives us a welfare loss of a, b, c while the effluent charge gives us a loss of b, d, e with MCC2, an inelastic curve, and MSB 1 regulation gives us a welfare loss of a, f, c while effluent charges give us a loss of d, f, g, h. You will see that if you use MSB 2 you will get the same results.

Graph 4

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Now that we have seen that effluent charges can be in society's best interests, we must consider the affected parties. There are three groups of people who influence policy choice. The first is the general populace. Since our government is elected, the beliefs of the general populace are an important influence on public policy. The current feeling of the populace seems to be against the effluent charge. Taxes are rarely supported by the general populace. Detractors of the policy have also done a good job of convincing people that they would pay the tax associated with effluent charges. Additionally detractors say that it wouldn't have anything to do with cleaning up the environment, but would just increase the income of the government. A specific part of this group is the environmental groups. They have a strong lobby in Washington and most of them if not all are against this policy. They feel it is selling our world and that the people making the decisions won't be motivated to protect the world as the environmentalists want.

A second group is the government. This consists of committees making recommendations and decisions on environmental issues, the elected officials, and government agencies like the EPA. The government is also against effluent charges. This seems to be because of the lack of support by the general populace and business, as well as the investment of time, money, and training in the current system.

Finally, there is business. Business seems to be against effluent charges as well. The reason for this is not so obvious as the others. Effluent charges would return the decision process to business. They would be able to decide how to reduce and how much effluent to reduce. There is evidence to support that this would actually lower businesses' costs. If this is true, why is business against this policy and why do economist support it? Lets take a closer look at how this policy would affect individual businesses.

Regulation on how a firm treats its effluents would be removed. A tax on each unit of effluent would be levied. A firm would then treat each unit of pollutant that could be treated for a lower cost than the tax. This tax would raise the Marginal Cost of Production, because in most cases the level of effluents would be directly related to the level of production and therefore the amount of the tax would be directly related to the level of production. However, since firms would be allowed to install the pollution abatement equipment best suited to them it is logical to assume they would be able to find less costly means of reducing their effluents. This would lower their fixed costs. Lets create a model so we can take a closer look at how this change in MC and FC will effect an individual firm.

First we must list our assumptions.

1) All variables other than those representing the change in MC and FC for a change in policies are constant. This is so we can isolate the effect the change in policies is having on the firm.

2) All firms existing within the industry are homogenous, therefore the industries cost and revenue curves are similar to the firms. This is to simplify the model into a workable form.

3) The market system is functioning in perfect competition except for the affects the abatement policies have on it

4) The only difference between firms existing in the industry and those attempting to enter is their fixed cost for pollution reduction. This is to isolate the affect the change in policy has on the firm.

5) Both policies are implemented perfectly and the same level of abatement is targeted for both policies. This is to simplify the model into a workable form.

6) AR(Q)=AR(q)=100-Q. The average revenue of the industry is equal to the average revenue of a firm(The units of course are different but the relation is the same) This is because of assumption 2 and for the remainder of the assumptions I will only use Q, but this stands for both Q and q. The formula 100-Q is used because there will be no shift in the AR curve and it keeps the graphs simple.

7) $MR(Q)=d((Q)(AR(Q))/dQ$

$MR(Q)=d(100Q-Q^2)/dQ$

$MR(Q)=100-2Q$

8) $C_r(Q)=aQ^3+bQ^2+cQ+d\{+e\}$. This equation is used as the cost function under regulation because it creates a curve that closely resembles most

cost curves in reality. The part in brackets represents the difference between existing and entering firms.

9) $AC_r(Q)=(aQ^3+bQ^2+cQ+d\{+e\})/Q$

10) $d(AC_r(Q))/dQ=d((aQ^3+bQ^2+cQ+d\{+e\})/Q)/dQ$

$d(AC_r(Q))/dQ=((3aQ^2+2bQ+c)(Q)-(aQ^3+bQ^2+cQ+d\{+e\})(1))/Q^2$

$d(AC_r(Q))/dQ=(3aQ^3+2bQ^2+cQ-aQ^3-bQ^2-cQ-d\{-e\})/Q^2$

$d(AC_r(Q))/dQ=(2aQ^3+bQ^2-d\{-e\})/Q^2$

11) $MC_r(Q)=d(C_r(Q))/dQ$

$MC_r(Q)=d(aQ^3+bQ^2+cQ+d\{+e\})/dQ$

$MC_r(Q)=3aQ^2+2bQ+c$

12) $C_e(Q)=aQ^3+bQ^2+cQ+fQ+d+g\{+h\}$. This equation is used as the cost function under effluent charges because it creates a curve that closely resembles most cost curves in reality. The part in brackets represents the difference between existing and entering firms.

13) $AC_e(Q)=(aQ^3+bQ^2+cQ+fQ+d+g\{+h\})/Q$

14) $d(AC_e(Q))/dQ=d((aQ^3+bQ^2+cQ+fQ+d+g\{+h\})/Q)/dQ$

$d(AC_e(Q))/dQ=((3aQ^2+2bQ+c+f)(Q)-(aQ^3+bQ^2+cQ+fQ+d+g\{+h\})(1))/Q^2$

$d(AC_e(Q))/dQ=(3aQ^3+2bQ^2+cQ+fQ-aQ^3-bQ^2-cQ-d-g\{-h\})/Q^2$

$d(AC_e(Q))/dQ=(2aQ^3+bQ^2-d-g\{-h\})/Q^2$

15) $MC_e(Q)=d(C_e(Q))/dQ$

$MC_e(Q)=d(aQ^3+bQ^2+cQ+fQ+d+g\{+h\})/dQ$

$MC_e(Q)=3aQ^2+2bQ+c+f$

16) $a>0$, $b<0$, and $c>0$ This is because the MC function should be positive throughout. It is not reasonable to be able to produce another unit at a 0 or negative cost. For this to be true its graph, a parabola, must plot as a U not an inverse U. Hence the coefficient of the $Q^2$ term (a) must be positive. Furthermore the minimum point, where $d(MC_r(Q))/dQ=6aQ+2b=0$, must be

positive. Therefore MC(Q), where Q=-2b/6a=-b/3a, must be positive. This is definitely a minimum because $d^2(MC_r(Q))/dQ^2=6a$, and since a>0 it is always positive. So $MC_{rmin}(Q) = 3a(-b/3a)^2+2b(-b/3a)+c = (3ac-b^2)/3a$ >0. For this to be true $3ac>b^2$, and so c>0, because a>0 so if c is not >0 3ac will be 0 or negative and therefore not less than $b^2$ since squares are always positive. We also know that Q must be positive because you can't produce a negative output. So Q=-b/3a must be positive. For this to be true b < 0 because a > 0.

17) d>0 d represents the fixed costs to a firm, and logically these must usually be positive.

18) e>0 Assumed to be positive because it represents additional fixed costs for a new firm versus an existing firm under a regulation policy.

19) f>0 Assumed to be positive because represents new tax.

20) g<0 Assumed to be negative because it represents the reduction in necessary fixed costs for pollution reduction due to the removal of government requirements.

21) h < e represents additional fixed costs for a new firm versus an existing firm under an effluent charge policy. Since we assume a firm can better choose technology to reduce their effluents than the government, we assume h < e. It is also possible for h to be negative because an entering firm will not have certain unamoratized capitol expenditures from obsolete abatement equipment.

Now lets repeat the formulas without the explanations for easier reference

1) AR(Q)=100-Q

2) MR(Q)=100-2Q

3) $C_r(Q)=aQ^3+bQ^2+cQ+d\{+e\}$

4) $AC_r(Q)=(aQ^3+bQ^2+cQ+d\{+e\})/Q$

5) $d(AC_r(Q))/dQ=(2aQ^3+bQ^2-d\{-e\})/Q^2$

6) $MC_r(Q)=3aQ^2+2bQ+c$

7) $C_e(Q)=aQ^3+bQ^2+cQ+fQ+d+g\{+h\}$

8) $AC_e(Q)=(aQ^3+bQ^2+cQ+fQ+d+g\{+h\})/Q$

9) $d(AC_e(Q))/dQ=(2aQ^3+bQ^2-d-g\{-h\})/Q^2$

10) $MC_e(Q)=3aQ^2+2bQ+c+f$

11) $a>0$

12) $b<0$

13) $c>0$

14) $3ac>b^2$

15) $d>0$

16) $e>0$

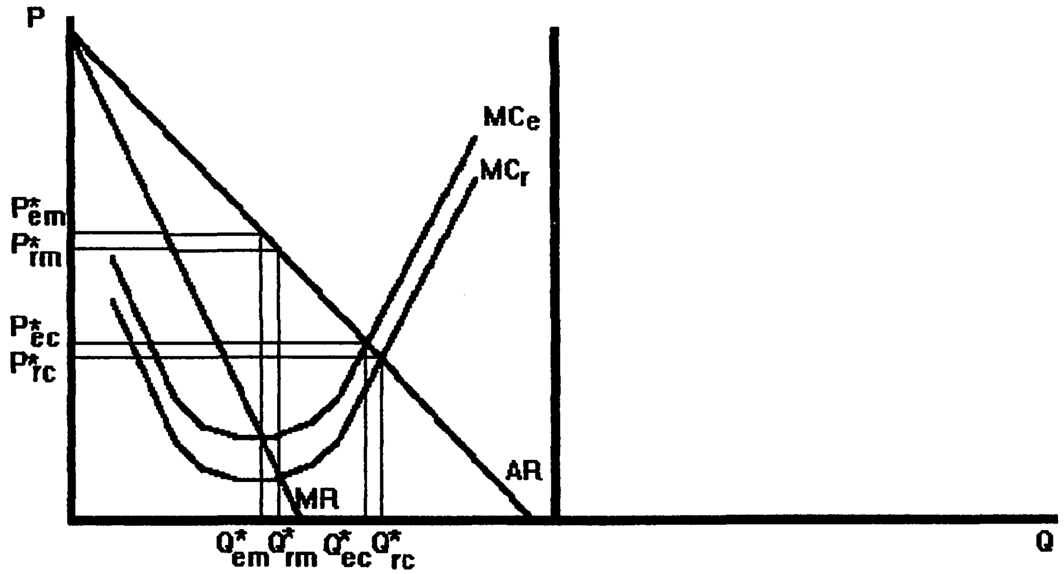
17) $f>0$

18) $g<0$

19) $h<e$

Now let us consider how the Industry would look under perfect competition and monopoly with both these policies. Profit maximization in a competitive market occurs where AR=MC. Profit maximization in a monopoly market occurs at MR=MC. Lets look at how this looks graphically.

Graph 5

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Lets look at this mathematically.

$Q^*_{rm}$ is defined where

$100-2Q^*_{rm}=3aQ^{*}_{rm}{}^{2}+2bQ^*_{rm}+c$ or

$-2Q^*_{rm}=3aQ^{*}_{rm}{}^{2}+2bQ^*_{rm}+c-100$ or

$Q^*_{rm} =(100-(3aQ^{*}_{rm}{}^{2}+2bQ^*_{rm}+c))/2$

$Q^*_{em}$is defined where

$100-2Q^*_{em}=3aQ^{*}_{em}{}^{2}+2bQ^*_{em}+c+f$ or

$-2Q^*_{em}=3aQ^{*}_{em}{}^{2}+2bQ^*_{em}+c+f-100$ or

$Q^*_{em} =(100-(3aQ^{*}_{em}{}^{2}+2bQ^*_{em}+c))/2-(f/2)$

$Q^*_{rc}$ is defined where

$100-Q^*_{rc}=3aQ^{*}_{rc}{}^{2}+2bQ^*_{rc}+c$ or

$-Q^*_{rc} =3aQ^{*}_{rc}{}^{2}+2bQ^*_{rc}+c-100$ or

$Q^*_{rc} =100-(3aQ^{*}_{rc}{}^{2}+2bQ^*_{rc}+c)$

$Q^*_{ec}$ is defined where

$100-Q^*_{ec}=3aQ^{*}_{ec}{}^2+2bQ^*_{ec}+c+f$ or

$-Q^*_{ec} =3aQ^*_{ec}{}^2+2bQ^*_{ec}+c+f-100$ or

$Q^*_{ec} =100-(3aQ^*_{ec}{}^2+2bQ^*_{ec}+c)-f$

So our Q*s are

$Q^*_{rm} =(100-(3aQ^*_{rm}{}^2+2bQ^*_{rm}+c))/2$

$Q^*_{em} =(100-(3aQ^*_{em}{}^2+2bQ^*_{em}+c)/2)-(f/2)$

$Q^*_{rc} =100-(3aQ^*_{rc}{}^2+2bQ^*_{rc}+c)$

$Q^*_{ec} =100-(3aQ^*_{ec}{}^2+2bQ^*_{ec}+c)-f$

Notice that in both perfect competition and perfect monopoly the difference in Q* is based solely on f. For perfect monopoly it is -(f/2) when you change to an effluent charge and for perfect competition it is -f. Since we have seen that $f>0$, notice that a change to an effluent charge would reduce the quantity produced by the industry in both cases, regardless of the savings on fixed costs.

Lets look at how price is affected mathematically. Since P* is equal to AR(Q*) lets plug our Q*s into the AR function.

$P^*_{rm} =100-((100-(3aQ^*_{rm}{}^2+2bQ^*_{rm}+c))/2)$

$=100+((-100+(3aQ^*_{rm}{}^2+2bQ^*_{rm}+c))/2)$

$=100-(100/2)+(3aQ^*_{rm}{}^2+2bQ^*_{rm}+c)/2$

$=50+(3aQ^*_{rm}{}^2+2bQ^*_{rm}+c)/2$

$P^*_{em} =100-((100-(3aQ^*_{em}{}^2+2bQ^*_{em}+c)/2)-(f/2))$

$=100+((-100+(3aQ^*_{em}{}^2+2bQ^*_{em}+c))/2)+(f/2)$

$=100-(100/2)+(3aQ^*_{em}{}^2+2bQ^*_{em}+c)/2+(f/2)$

$=50+(3aQ^*_{em}{}^2+2bQ^*_{em}+c)/2+(f/2)$

$P^*_{rc} =100-(100-(3aQ^*_{rc}{}^2+2bQ^*_{rc}+c))$

$=100-100+(3aQ^*_{rc}{}^2+2bQ^*_{rc}+c)$

$=(3aQ^*_{rc}{}^2+2bQ^*_{rc}+c)$

$P^*_{ec} =100-(100-(3aQ^*_{ec}{}^2+2bQ^*_{ec}+c)-f)$

$=100-100+(3aQ^*_{ec}{}^2+2bQ^*_{ec}+c)+f$

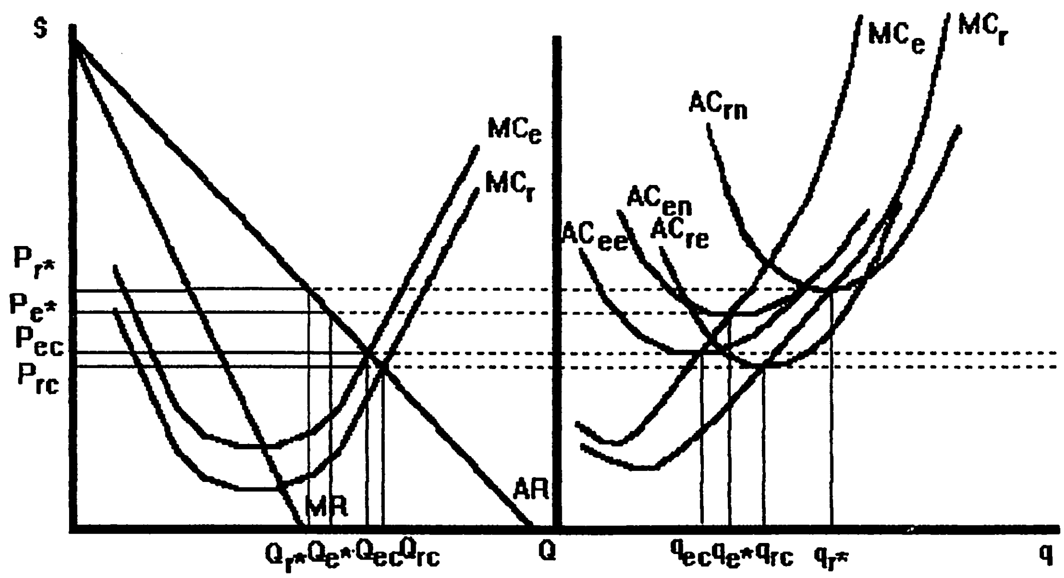
$=(3aQ^*_{ec}{}^2+2bQ^*_{ec}+c)+f$

Notice that once again in both perfect competition and perfect monopoly the difference in P* is based solely on f. For perfect monopoly it is +(f/2) when you change to an effluent charge and for perfect competition it is +f. Since we have seen that f>0, notice that a change to an effluent charge would increase the price of goods within the industry in both cases, regardless of the savings on fixed costs.

We know though that there are no known cases of a perfect monopoly or perfect competition. What these prices and quantities really represent is the parameters within which the market will fall. Since we know that the AR curve represents the price of goods at different quantities and that under our assumptions the AR curve is fixed, we know that the market equilibrium will be somewhere between the monopoly and competitive equilibrium's found for each policy and along the AR curve. Second we have stated earlier in our assumptions that the market is working in perfect competition except for the affect that the abatement policy has on it. This isolates the affect the policies have on competition.

Now lets look at how the change in costs will affect individual firms in a profit maximizing industry.

Graph 6

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We see that existing firms are in equilibrium at the same levels as perfect competition. New firms however although they have the same MC have a different FC and so different AC. Because it would take a price at the new firms' equilibrium to induce entrance into the market and the firms are profit maximizers the existing firms are able to price just below this level.

Firms will charge a price slightly below the level that new firms would have to charge to enter the market. So lets find the price new firms would need to charge. First we need to find at what q* their MC=AC. This will be their minimum average cost. So the price, if you plug this into the MC or AC curves, will be the minimum price they would be willing to sell their product for. So we need to find $q^*_{rn}$ and the $q^*_{en}$ and plug them into the $AC_{rn}$ and $AC_{en}$ respectively. We can then plug them into $MC_{rn}$ and $MC_{en}$ to check our answer.

$q^*_{rn}$ is where

$(aq^*_{rn}{}^3+bq^*_{rn}{}^2+cq^*_{rn}+d+e)/q^*_{rn}=3aq^*_{rn}{}^2+2bq^*_{rn}+c$ or

$(aq^*_{rn}{}^2+bq^*_{rn}+c)+((d+e)/q^*_{rn})=3aq^*_{rn}{}^2+2bq^*_{rn}+c$ or

$(d+e)/q^*_{rn}=3aq^*_{rn}{}^2+2bq^*_{rn}+c-(aq^*_{rn}{}^2+bq^*_{rn}+c)$ or

$(d+e)/q^*_{rn}=2aq^*_{rn}{}^2+bq^*_{rn}$ or

$(d+e)=(2aq^*_{rn}{}^2+bq^*_{rn})q^*_{rn}$ or

$(d+e)/(2aq^*_{rn}{}^2+bq^*_{rn})=q^*_{rn}$

$q^*_{en}$ is where

$(aq^*_{en}{}^3+bq^*_{en}{}^2+cq^*_{en}+fq^*_{en}+d+g+h)/q^*_{en}=3aq^*_{en}{}^2+2bq^*_{en}+c+f$ or

$(aq^*_{en}{}^2+bq^*_{en}+c+f)+((d+g+h)/q^*_{en})=3aq^*_{en}{}^2+2bq^*_{en}+c+f$ or

$(d+g+h)/q^*_{en}=3aq^*_{en}{}^2+2bq^*_{en}+c+f-(aq^*_{en}{}^2+bq^*_{en}+c+f)$ or

$(d+g+h)/q^*_{en}=2aq^*_{en}{}^2+bq^*_{en}$ or

$(d+g+h)=(2aq^*_{en}{}^2+bq^*_{en})q^*_{en}$ or

$(d+g+h)/(2aq^*_{en}{}^2+bq^*_{en})=q^*_{en}$

Notice that the difference between $q^*_{rn}$ and $q^*_{en}$ is related only to the difference between d+e and d+g+h. In other words it is the difference in total fixed costs for an entering firm that affects the quantity a firm produces.

Now lets find the prices caused by these policies.

$p^*_{rn}$ is at

$AC_{rn}(q^*_{rn})=(a(q^*_{rn})^3+b(q^*_{rn})^2+c(q^*_{rn})+d+e)/q^*_{rn}$

$p^*_{en}$ is at

$AC_{en}(q^*_{en})=(a(q^*_{en})^3+b(q^*_{en})^2+c(q^*_{en})+f(q^*_{en})+d+g+h)/q^*_{en}$

Since $q^*_{rn}$ and $q^*_{en}$ are being plugged into the formula we know that the total fixed costs will affect the difference in price. Once again the total fixed costs are involved in this formula specifically. In addition the change in marginal costs affect the price.

Given that we know the constants in these formulas we can estimate the affect a change in policy would have on price and quantity. What is more important, however, is how this change affects a firm's economic profits. We now know what quantity a firm will produce under both policies. Their economic profits will be equal to this value multiplied by the difference between the market price minus AC for the firm at that q and under that policy. Mathematically this is.

$$(q_{rn})(((a((q_{rn}))^3+b((q_{rn}))^2+c((q_{rn})) +d+e)/(q_{rn}))-((a(((q_{rn}))^3+b((q_{rn}))^2+c((q_{rn})) +d)/(q_{rn}))) =(q_{rn})(e/q_{rn})=e.$$

The economic profit for a firm under effluent charges is.

$$(q_{en})((a((q_{en}))^3+b((q_{en}))^2+c((q_{en}))+f((q_{en}))+d+g+h)/(q_{en}))-((a((q_{en}))^3+b((q_{en}))^2+c((q_{en}))+f((q_{en}))+d+g)/(q_{en}))=(q_{en})(h/(q_{en}))=h$$

Notice that neither the change in marginal costs nor the change in an existing firm's fixed costs has any effect on a firm's profits. Only the change in the additional fixed costs an entering firm has affects the profits. So, if $h < e$, the former assumptions are in place, and firms are profit maximizers, those firms who aren't afraid of failing will be against effluent charges.

Lets repeat the findings. The parameters of the market are affected by the change in marginal cost alone. The change in quantity produced by a firm is affected by the change in the total fixed costs of a firm trying to enter the market. The market price will be affected by both the change in total costs of entering firms and the change in marginal costs. Finally, the change in economic profits will be affected solely by the change in the additional fixed costs an entering firm would face compared to an existing firm.

Creating public policy to protect our environment is a complex process. There are several reasons to believe effluent charges could be an effective alternative to regulation. First, it is a least cost solution. Second, it creates incentive to prevent pollution. Third as the MSB curve becomes more elastic and or the MCC curve becomes less elastic the welfare loss from a mistake in regulation becomes more profound while the loss from a mistake with an effluent charge lessens. These points show how effluent charges can be a better choice than regulation.

Still support for effluent charges is not there. The general populace is afraid that the policy will be implemented in a way that causes more damage than good. The government supports the policies it already has a large investment in. Business realizes that it will often reduce barriers to entry thereby reducing their economic profits. The way effluent charges are perceived will have to go through a great deal of change before any large scale policy involving them is adopted.

I feel that effluent charges should be added to the EPA's choice of policy. It is an efficient policy in theory, and could be used very effectively on large scale problems with low costs of abatement. Effluent charges should compliment rather than replace regulation. Between regulation and effluent charges a very complete and adaptable policy could be created to deal with the negative externality problems of production.

The real problem with effluent charges is their implementation. As with any policy offered in this area, the potential to alter it for individual gain is immense. Several areas stand out. The first is the problem with measuring effluents. One answer is to put that responsibility on the firm. This could be successful, but only if there were severe penalties for fraud aimed at the people responsible. A second problem is setting the proper tax. There is the potential of the people in charge of setting the tax having personal interests involved with the firms involved or the environmental groups, etc. In addition if the people who set the tax are responsible or are under the supervision of those responsible for spending the revenues you again have the possibility that the tax won't be set to attain the proper pollution level.

Effluent charges deserve a more in depth look. They are probably the best choice of policy in many cases. They are efficient and transfer the costs to those that receive the benefits. When properly implemented they will greatly improve the government's capability to internalize the negative externality of pollution.

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