Pricing of Air Pollution in the Swedish Transport Policy

LARS HANSSON

Swedish transportation policy has radically changed during the last decade. In 1979, the principle of a social marginal cost responsibility for road and rail traffic was introduced. The consideration of social costs for traffic accidents was the main innovation. Air pollution was only mentioned as an external effect that could not be calculated at that time. In 1988, when the Swedish parliament adopted the new Transport Policy Act, an essential part of the new transportation policy was the principle of internalization of some of the traffic emissions. They were accordingly considered explicitly in the infrastructure charges for road and rail traffic, as well as for domestic aviation. The explicit evaluations of external effects in Sweden imply road user charges (gasoline and kilometer taxes) that amount to a cost recovery almost 3.5 times higher than the budgetary costs for highways and roads. The same cost responsibility for rail traffic would only increase its corresponding budget about 10 percent.

The ultimate goal of Swedish transportation policy (*1*,*2*) is to help maintain and develop prosperity. The general goal of the policy is "to provide the population and industry throughout the country with adequate, safe, and environmentally acceptable transport services at the lowest possible social costs." The policy is specified in five objectives:

- To increase efficiency of the transport system,
- To reduce the environmental damage,
- To increase road safety,
- To ensure adequate transport services in all parts of the country, and
- To promote regional balance.

These objectives define the orientation of a transportation policy that intends to pursue two different aspects of efficiency:

- To do things right, and
- To do the right things.

To do things right is to increase the efficiency of the transportation system as a whole. A measure of particular importance in current transportation policy is thus a deregulation of the transportation market.

However, to do things right is only one aspect of the market economy and the resource allocation. An equally important aspect, which is emphasized in the Swedish transportation policy, is to do the right things.

In order to provide services in areas where the population base is limited, public transportation is considered a necessity. The infrastructure and communications have played a historical role as an instrument of regional policy. The transport system should continue to play a part in achieving a balanced population trend and providing places of work and essential services in all parts of the country.

Another vital issue is the traffic impact on the environment. The transportation policy must be instrumental in promoting transportation that is environmentally acceptable and in reducing the effects of traffic on the environment. Being mainly a question of road transportation, the traffic safety is another issue of vital interest.

The principles of the Swedish transportation policy are shown in Figure 1. Transport modes and transport carriers shall operate and compete in a free transport market. This maxim is expected to increase efficiency in the transport system. It implies, e.g., that the Swedish State Railways (SJ) should operate traffic in a strictly commercial manner. If traffic is unprofitable for SJ, then it should cease.

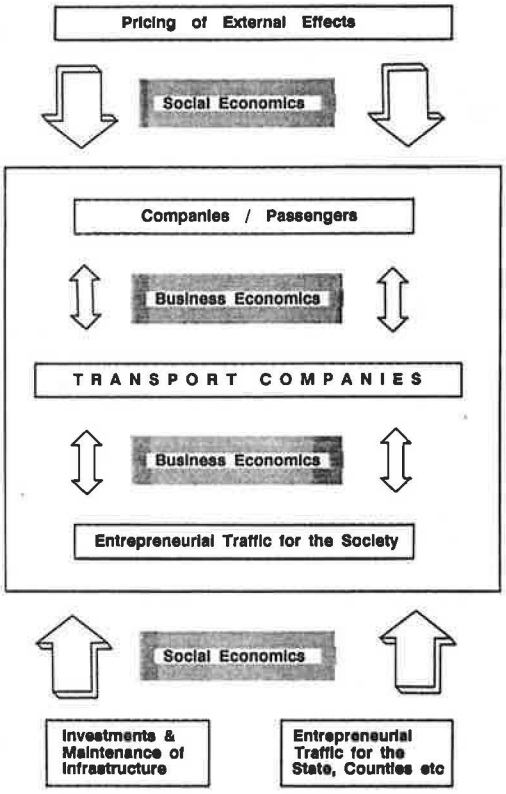

FIGURE 1 Swedish transport policy.

Swedish State Railways, Central Station Building, Stockholm, S-105 50, Sweden.

The transport market is affected by transportation policy that contains "rules of the game" to do right things. The three most important of these activities are

- Charges for traffic accidents and air pollution, the two most important external costs on the transport market;
- Investment appraisals of rail infrastructure, which are based on cost-benefit analysis in the same way as it is used for road investments;
- The entrepreneurial role of transport operators. If the Swedish Transport Board (which can purchase interregional passenger traffic) or the 24-County Passenger Transport Authorities (responsible for regional public transportation) want more traffic than is undertaken by the commercial operators, then they will purchase such traffic.

ROAD AND RAIL USER CHARGES

On July 1, 1988, the SJ was divided into two separate bodies: SJ, still owned by the State, and the National Rail Administration. The former is required to act as a strictly commercial transport enterprise, while the latter is responsible for railway infrastructure, acting as a governmental authority.

The National Rail Administration will act on the same formal inducement as the National Road Administration, i.e., accomplish a railway investment policy on the basis of cost-benefit analyses. SJ (and other prospective railway companies) is charged for the use of the railway network. The principle for charging is a two-part tariff, which also is applied to road traffic.

An important market principle is the internalization of external effects, i.e., pricing of the external costs for society.

The negative external effects are essentially of four different types: traffic accidents, air pollution, noise disturbance, and congestion. If these effects are not considered properly, it will cause an allocation of resources that

- Produce and consume too much transportation, and
- Favor transport modes that create many negative effects at the expense of those transport modes that cause few negative effects.

Traffic safety effects, traffic emissions, and congestion (only for rural road traffic) are considered explicitly in the infrastructure charges. Noise effects are explicitly evaluated in the investment appraisals used both by the National Road Administration and the National Rail Administration. They are hitherto not included in the pricing of external effects.

The pricing of external effects of accidents is applicable only for the transport sector. The air pollution charges are applicable both for the industrial and the transport sector. In the transport sector, international aviation and all maritime traffic are excluded.

These evaluations provide new figures in the analyses of cost responsibilities in transportation. The cost responsibility results should not be confused with traffic charges actually paid. Today, only private cars with catalytic converters, rail traffic on the main line system, and domestic aviation pay according to the current evaluation of external costs. Private cars without catalytic converters (65 percent of passenger car kilometers in 1990), trucks, buses and coaches, together with rail traffic on the county line system, pay only part of their external costs. International aviation and maritime traffic pay no charges at all.

Despite insufficient charges for most of the traffic, the pricing of external effects has affected the user charges to a large degree. One example is the increase of kilometer taxes, weight-distance taxes used for diesel vehicles. In 1989, the calculations accounted for the transportation policy act led to a 45 percent increase in the kilometer taxes for trucks and a 100 percent increase for buses and coaches.

The total social marginal costs for trucks were calculated as follows: 43 percent wear and tear, 26 percent external costs from traffic accidents, and 31 percent air pollution charges. The trucks paid for 58 percent of these costs, i.e., they paid for all their budgetary costs consisting of wear and tear. They paid only for about one-quarter of the external costs for traffic accidents and air pollution. The 45 to 100 percent increases in the kilometer taxes were insufficient, but political difficulties kept them to these levels.

PRICING OF AIR POLLUTION

In economic theory, the basis for the evaluation of costs and benefits is willingness to pay. If someone suffers from an external effect, there will be a certain amount of money that can compensate for the disutility. In cost-benefit analysis, that amount is used as a social cost. If the sufferers are compensated with at least this amount, it will be equivalent to a business transaction in the market, i.e., a price label on the external effect.

External effects such as noise, air pollution, and visual intrusion are normally considered to be incommensurable effects. In spite of this, explicit choices about these effects are sometimes made, i.e., they are traded off. Knowledge about these trade-offs provide the same information about the evaluation of the external effects as market prices do for commensurable goods and services.

It is important to realize that the willingness-to-pay concept is a compensation for those currently being affected. Also the concept is based on existing preferences. Both these prerequisites are to be considered when air pollution is evaluated, which requires a more extensive point of view.

How can the emissions of CO_2 and its effects on the environment be evaluated? There are no financial costs for the feared green-house effect. It's not fruitful to ask people about their willingness to pay for reduced CO_2, or to look for their revealed preferences. It can only be concluded that there are no ways to deduce a proper value or a cost for the emission of an external effect such as CO_2.

Baumol and Oates (*3*) approach this problem by drawing attention to the fact there is an inability to measure marginal social costs:

> If there is little hope of estimating the damage that is currently generated, how much less likely it is that we can evaluate the damage that would occur in an optimal world which we have never experienced or even described in quantitative terms.

The problem is thus that the environment impacts can neither be estimated nor evaluated, i.e., a cost responsibility determined. Even if an optimal charge can't be defined, so-

ciety is compelled to establish restrictions, regulations, economic incentives, etc., to reduce the environmental impacts. These measures are undertaken in the light of the fact that nature can't manage current pollution.

For the emissions of NO_x, HC, and SO_2, there are some measureable costs. But these costs only cover some of the expected effects. Environmental quality aspects (outdoor life, the historic remnants, etc.) are not included. Of what value is it that people, if it was possible, express a willingness to pay for something they don't know about or can't imagine. Even if some preferences could be observed, the preferences for the environmental qualities change over time as people meet with alterations. Yesterday's evaluations are not the same as today's and tomorrow the effects of air pollution are more severe than they are today.

Finally, there is the inheritance to future generations. Historic remnants are a gift not only to the current generation, but also to the next generations. Most important of all, future ecological catastrophe is equivalent to a consumption, where the bill has to be paid by future generations.

Even if there is no way to make acceptable cost-benefit calculations, it's important to undertake some measures to reduce the emissions. The relevant issue is to find out what nature can tolerate. Most ecologists and environmental researchers (in Europe) agree that NO_x must be reduced by 70 to 80 percent to attain a sustainable ecological balance for environment. The Swedish parliament has adopted the objectives presented in Table 1 for reduction of emissions.

With these objectives as a background, the pricing of external effects may be motivated by two different reasons; on the one hand, a cost responsibility can be considered as a compensation for costs or disutilities; on the other hand, it can be used as an economic instrument to reach an aim or end as cost efficiently as possible. These two aspects concur as an incentive, which results in a better resource allocation. The current policy is based on the second approach.

Once an environmental objective is formulated, e.g., as a specified limitation for an emission, the question is how to reach this objective. Legal restrictions and preventive measures can be used to some extent. The question is how to reach the reduction with a minimum of costs for the variety of restrictions and measures possible.

Cost minima for any specified limitation of emissions are reached if externality charges are used. The principle incentives given by an externality charge for emissions are the choice between the three following alternatives:

- Continue the emissions, and pay the charge;
- Take measures to reduce the emissions, and thus pay a reduced charge;
- Stop production (e.g., stop making the journey) and pay no charge at all.

TABLE 1 ENVIRONMENTAL OBJECTIVES FOR EMISSIONS

Compound	Reduction (%)	Period
NO_x	30	1980–1995
SO_2	80	1980–2000
CO_2	0	1988–
HC	50	–

The level of the charge decides whether it is favorable or not to take measures to reduce the activity creating the emissions. Those activities with the lowest costs for reducing the emissions (to a specified level) are automatically chosen by the market mechanism.

The conclusion is thus that a cost responsibility should be implemented for the incommensurable external effects, even if there are no costs for them.

AIR POLLUTION FEES AND CHARGES IN SWEDISH TRANSPORTATION POLICY

Swedish transportation policy has changed radically during the last decade. In 1979, the principle of a social marginal cost responsibility for road and rail traffic was introduced. The consideration of social costs for traffic accidents was the main innovation. Air pollution was only mentioned as an external effect that could not be calculated at that time. In 1988, when the Swedish parliament adopted the new Transport Policy Act, an essential part of the new transportation policy was the principle of internalization of some of the traffic emissions. They were accordingly considered explicitly in the infrastructure charges for road and rail traffic, as well as for domestic aviation.

The air pollution fees were developed in three steps. The first step was taken in 1982 when a commission appointed by the Department of Transportation tried to calculate the costs for air pollution. In 1985, the commission presented some cost calculations, e.g., loss in productivity in forestry, corrosion from SO_2, and health effects. However, the calculations were rudimentary. They were therefore questioned for being both underestimated and overrated.

The second step was taken when parliament adopted the 1988 Transport Policy Act. The main philosophy was that environmental measures undertaken should be consistent. This means that the same evaluations should be used for reducing the same kind of emissions with different measures.

Implicit evaluations of some current measures implemented, e.g., catalytic converters (compulsory for new cars from 1989); stricter emission standards for diesel engines (compulsory for heavy vehicles from 1994); regulations restricting the emissions from combustion plants; etc., were calculated as a support for the explicit evaluations. Implicit values of NO_x reductions ranged from 10 to 80 SEK per kilogram, where HC and S were weighed together with NO_x to an NO_x equivalent (1 SEK = 0.18 U.S. dollar).

In the Transport Policy Act it was suggested that some caution should be applicable to the incorporation of environmental effects in the social marginal cost calculations. Despite this, the Act nevertheless ascertained that it was necessary to consider these costs when variable charges for the use of transport infrastructure (gas taxes, kilometer taxes, rail charges, and landing charges) are to be determined. The basis for evaluation of air pollution was that they corresponded to a cost responsibility of 15 SEK per kilogram of discharge of NO_x.

The final step was taken in 1990, when the Commission on Economic Instruments in Environmental Policy (*4*,*5*) presented analyses of the scope for using economic instruments in environmental policy, and submitted proposals to the par-

liament for the framing of such instruments. The charge proposals applicable to the transport market are presented in Table 2.

Part of these charges have already been adopted by parliament. In 1988, the emissions of NO_x and HC were included in the cost responsibility for road, rail, and domestic aviation. The explicit charges were 15 and 7.50 SEK per kilogram, respectively. In 1990, the charge for CO_2 was implemented for road traffic and domestic aviation. On January 1, 1991, the sulfur charge was imposed on coal, peat, and oil. On January 1, 1992, the charge of 40 SEK per kilogram of NO_x will be imposed on large combustion plants.

In addition to these charges, there is a tax difference between leaded and unleaded petrol amounting to 0.30 SEK/L.

In February 1991, a government bill will be presented to parliament, based on the charge proposals suggested by the Commission on Economic Instruments in Environmental Policy.

EFFECTS OF THE PRICING PRINCIPLE

What do these monetary values stand for? The first calculations for the transport sector in 1985 were mainly based on financial costs. The 1988 evaluations were explicit values based on implicit values. The proposed values laid the main stress on pricing to attain objectives. The reasons for this change in emphasis of evaluation principles are the inherent shortcomings of the traditional basis for social costs.

Even if it is futile to make cost-benefit calculations, etc., in order to find the optimal economics, it is crucial to undertake measures to reduce the emissions. However, the relevant issue is to find out what nature can withstand, i.e., the required reduction in emissions in order to attain a sustainable ecological balance. Once an environmental objective is formulated, e.g., as a specified limitation for an emission, the question is how to reach this goal.

Any specified limitation of emissions will be reached more efficiently, i.e., to decrease total costs, if externality charges are used. Those activities with the lowest costs for reducing the emissions (per kilogram, etc.) are automatically chosen by support of the market mechanism.

Without a charge, there are only costs for measures reducing the emissions. With emission charges, there are counteracting reductions in the total charges paid for the emissions. The levels of different charges thus determine whether it is favorable or not in different branches to take measures to reduce emissions.

When the NO_x and HC charges were introduced in 1988, LIN, the major domestic airline in Sweden, started to replace the combustion chambers on their Fokker F28. The emissions of HC were reduced by 90 percent, NO_x by 15 percent. The pollution charges for an average flight (380 km) were consequently reduced from $100 to $26.

The cost for the replacement program was $4.4 million plus $0.5 million per year in variable costs. On a yearly basis, LIN will save about $3.6 million. If the replacements are written off, e.g., during 5 years and with a 5 percent real discount rate, the net return is 200 percent.

TABLE 2 AIR POLLUTION CHARGES IN SWEDISH TRANSPORTATION POLICY

	Charge	
Substance	(SEK/kg)	($/kg)
Sulfur	30.00	5.25
Nitrogen oxides	40.00	7.00
Hydrocarbons	20.00	3.50
Carbon dioxide	0.25	0.04

SOME EXAMPLES OF THE RELATIVE EFFECTS OF CHARGES FOR EMISSIONS

Highway and Road Traffic

The cost responsibility based on external effects will only affect the variable road user charges. Here the external costs for road accidents and air pollution are much more important than the financial costs for road maintenance and traffic surveillance (*6*).

Concerning nonurban traffic, the social marginal costs (including a minor external cost for congestion) for cars are almost 10 times higher than the budgetary costs for road maintenance and traffic surveillance, compared with the ratio of about 15 for cars without catalytic converters. The marginal external effects (i.e., the average cost responsibilities, which are based on the average of marginal effects for different roads and highways), are presented in Table 3 for vehicles with fuel consumptions of 0.8 and 1.0 L per 10 km.

An external cost of 10 cents per 10 km corresponds to a traffic charge of 10 cents per liter of gas for a vehicle with fuel consumption of 10 km/L. For a car with a fuel consumption of 12.5 km/L, the traffic charge would be 12.5 cents per liter of gas. For cars with and without catalytic converters, the traffic charges imputed as a tax on gas per liter are presented in Table 4.

The variable traffic charge for cars in Sweden is a flat tax on gas, differentiated between leaded and unleaded gas: $0.57 and $0.53, respectively. A value-added tax of 25 percent is charged, based on the gas cost ($0.51) including the traffic charge. The gas price thus is $1.35 and $1.30, respectively (as of December 1990).

The reasons why the traffic charges correspond to the social marginal costs for cars with catalytic converters are, on the one hand, that the Swedish car fleet is rapidly converging to

TABLE 3 EXTERNAL EFFECTS FOR PRIVATE CARS WITH DIFFERENT FUEL CONSUMPTION (CENTS PER 10 km, 1990)

	Catalytic Converter			
	Yes		No	
	Fuel consumption in liters per 10 km			
External Effect	1.0	0.8	1.0	0.8
Road maintenance, traffic surveillance, and congestion	5.4	5.4	5.4	5.4
Traffic accidents	25.9	25.9	25.9	25.9
Pollution	14.1	11.3	44.1	35.4
Total	45.4	42.6	75.4	66.7

TABLE 4 TRAFFIC CHARGES IMPUTED AS A TAX ON GAS

Fuel Consumption (liters per 10 km)	Tax per Liter
With Catalytic Converter	
1.0	\$0.45
0.8	\$0.53
Without Catalytic Converter	
1.0	\$0.75
0.8	\$0.83

catalytic converters (2 years after catalytic converters were compulsory, more than 30 percent of all vehicle-kilometers are on the account of cars with catalytic converters); on the other hand, a great number of cars without catalytic converters can use unleaded gas.

The possibilities for differentiating the traffic charges for diesel vehicles are better, as these vehicles pay kilometer (weight-distance) taxes.

Rail Traffic

The National Railway Administration charges SJ and other railway companies according to a principle of two-part tariffs. The variable charges are based on short-run marginal costs for maintenance (wear and tear) of the track, plus external costs. The charges are different for various types of vehicles, locomotives, and tracks. The fixed charges are based on wheel axles for different vehicle-litteras, and driving axles for locomotives. The total payment responsibility for SJ during 1989 is presented in Table 5 in relative figures.

The Swedish rail network is to a large degree electrified. The charges for air pollution emanate from diesel locomotives, for which currently a charge of 4.8 cents per liter of diesel fuel is paid. When the proposed emission charges are adopted, the new charge should be 9.3 cents per liter. This charge excludes charges for the emissions of CO_2. A reason for this is that the competing road traffic (trucks as well as coaches) do not pay for their total external costs at present.

Air Traffic

In addition to the emission charges proposed for air pollution, a charge will also be implemented for noise. For a typical flight, charges are suggested as presented in Table 6.

The environmental charges, determined on the basis of international certification data for civil aircraft engines, account for 35 to 40 percent of the total charges for older aircraft, whereas more modern planes have a share of about 20 percent. [A DC–9–41 will pay \$470 out of \$1,320 (36 percent), whereas a B737–500 will pay \$195 out of a total charge of \$1,085 (18 percent).]

As international flights are concerned, the conditions are somewhat different. Swedish authorities are not permitted to charge international traffic for other costs than the management of airports, i.e., external effects are not allowed to be included in the landing charges.

TABLE 5 THE PAYMENT RESPONSIBILITY FOR RAIL TRAFFIC, 1989

Charges	Percent
Variable	
• Traffic safety	20
• Air pollution	2
• Maintenance of tracks	27
Fixed	51
	100

NOTE: The fixed charges cover about 20 percent of the total fixed costs. The basis of payment responsibility for fixed costs (i.e., nonmarginal costs) is formulated ex ante.

TABLE 6 CHARGES PROPOSED FOR DOMESTIC FLIGHTS

Charge	DC–9–41	MD–82
Landing, etc.	\$850	\$1,030
HC + NO_x	110	100
CO_2	215	160
Noise	150	25

NOTE: (Dollars per flight at Arlanda Airport; distance of 380 km; the cabin factor is 65 percent.)

The Commission on Economic Instruments in Environmental Policy therefore suggests environment-related landing charges, which don't increase the revenues for airports or the state. The revenues will instead be transferred back to the airports to reduce the conventional charges. Before the proposal is implemented, further analyses of the limitations imposed by international agreements, especially within ICAO, may prove necessary.

The principle of the environment-related landing charges is illustrated with two planes, where one is a winner and the other a loser in the proposed system (Table 7).

A DC–9 thus will have to pay an additional landing charge of \$115, an increase of 7.7 percent, whereas the charge for an MD-80 will be reduced by \$155, a decrease of 7.8 percent. The environmental charge per seat is \$6.50 for the DC–9 and \$2.80 for the MD-80.

The environmental charge for a DC–10 is net 7.5 percent (the charge per seat is \$7.90), whereas the environmental subsidy for a Boeing 676 is net 11.5 percent (the charge per seat is \$2.60).

TABLE 7 CHARGES PROPOSED FOR INTERNATIONAL FLIGHTS

Charge	DC–9 (\$)	MD–80 (\$)
Conventional Charges		
Landing, etc.	1,530	1,970
Proposed Charges		
Landing, etc.	1,530	1,970
HC + NO_x	160	150
CO_2	320	240
Noise	225	40
Reimbursement	−590	−590
Net	1,645	1,815

Navigation

Sweden has almost no inland waterway traffic. The coastal traffic is open to international competition, which limits the possibilities for using environmental charges. However, the Commission on Economic Instruments in Environmental Policy proposes

> a system of charges for shipping, aimed at reducing discharges of sulfur in proximity of Sweden. The proposal is based on the assumption that it is impossible, in the near future, to achieve international agreements to impose direct regulations to reduce sulfur discharges from shipping.

The proposed sulfur charge will affect all shipping using oil with more than 0.5 percent sulfur. The charge is based on the extra cost of using low-sulfur oil, with an upper limit based on a distance of 350 km. It corresponds to a charge of about 10 SEK per kilogram, which can be compared with the general charge of 30 SEK per kilogram.

The proposed system includes both domestic and foreign shipping. Ships with frequent calls at Swedish ports are expected to choose low-sulfur oil, while other ships are expected to pay the charge. A merchant vessel of 20,000 tons will have to pay $1,230 at a maximum.

COST RESPONSIBILITIES FOR AIR POLLUTION

The emissions in Sweden of NO_x, SO_2, HC, and CO_2, weighed together with the proposed price tags, emanate to 45 percent from the transport sector. The proposed charges correspond to the following cost responsibilities for the Swedish transport sector, which are a challenge for the transport policy concerning traffic and price levels of 1990 (Table 8).

The emission costs, being more than 270 times higher for road traffic than for rail traffic, can be compared to passenger traffic being 16 times higher for road traffic (96 400 versus 6 120 million passenger-kilometers for rail) and freight traffic being ⅓ higher for road traffic (25 500 versus 19 100 million ton-kilometers for rail).

The evaluation of emissions has changed drastically during the last decade. This is illustrated for road traffic by the following data (Table 9).

From 1982 to 1990, the cost responsibility for the environmental effects from road traffic has increased by 700 percent, whereas road traffic (in vehicle-kilometers) has increased by only 25 percent.

A more thorough comparison between road and rail indicates how the infrastructure charges are drastically changed when external effects are considered. With the budgetary costs for the state and local communities made comparable by an index of 100, the external effects according to the Transport Policy Act of 1988 increased the costs for road traffic by 150 percent, whereas the costs for rail traffic were increased by only 5 percent. With the proposals presented earlier, the cost difference was even more striking. Road traffic costs increased by 240 percent, whereas rail traffic costs increased by only 8 percent (Table 10).

TABLE 8 COST RESPONSIBILITIES FOR AIR POLLUTION IN THE TRANSPORT SECTOR

Mode	Amount (million)
Road	$2,860
Navigation	460
Aviation	160
Rail	10

TABLE 9 EVALUATION OF AIR POLLUTION FROM ROAD TRAFFIC AT THE PRICE LEVEL OF 1990

Year	Amount (billion)
1979	+
1982 (costs)	$0.4
1987 (explicit)	1.8
1990 (charges)	2.9

SOME COMPLEMENTARY REMARKS

The evaluations and cost calculations of air pollution are important to support measures in obtaining the environmental and ecological objectives of the Swedish transportation policy. They are used in the cost-benefit analyses and investment appraisals of infrastructure measures, as well as in the formal cost responsibilities (excluding maritime traffic) to give incentives for better resource allocation.

However, the cost calculations of air pollution must be interpreted with some care. They should be applied to their full extent for a particular transport mode, only if all external effects, within as well as outside the transport market, are considered appropriately.

So far, the maritime sector is, as an example, excluded from the pricing of air pollution. This can be considered in the cost-benefit analysis for measures where maritime traffic is affected. However, the cost responsibilities for air pollution for the competing transport modes must consider this in a second-best pricing. So far, this has not been especially analyzed.

When more and more of the nonpecuniary external effects are included in the pricing, the matter of how to use the revenues must be considered. From a theoretical point of view, the revenues should be used in the same way as the general taxes, i.e., where the yields and benefits are most needed. Earmarked charges and taxes will suboptimize the use of resources.

In practice, pollution charges are questioned. The Swedish Road Federation, The Hauliers Association, etc., do not ac-

TABLE 10 COMPARISON OF FINANCIAL COSTS AND EXTERNALITY COSTS FOR ROAD AND RAIL TRAFFIC

	Road traffic (%)		Rail traffic (%)	
Cost	1988	1990	1988	1990
Infrastructure	100	100	100	100
Externalities:				
Traffic accidents	91	117	5	7
Air pollution	65	123	0	1

cept nonpecuniary effects to be included in the cost responsibilities. (However, they accept these effects to be included in the cost-benefit analysis of road measures, where the reductions of external effects increase the benefits). Naturally, the politicians take these facts into their considerations.

In practice, there is a risk if charges are used as general revenues. Charges for external effects might be adopted because of the revenue effects.

In the future, there must be a sharper distinction between the incentive effects and the revenue effects. Also there must be a stronger connection between the environmental and ecological objectives and the use of the revenues from pollution charges. If this is done, by financing ecology funds, etc., society is avoiding dependency on the revenues mentioned.

The purpose of the charge for external effects must be the incentive effects, not the revenue effects (except for pecuniary costs, of course). Reduced emissions imply welfare gains, but also a reduction of revenue. If the charging is extremely successful, there will be no emissions. Accordingly, there will be no revenue. This is, of course, not a problem if the revenues have been used for measures undertaken to obtain the objectives for which the charges were formed. It would be regarded as a problem if the revenues have been used for general purposes. The need of money remains, but the source where it came from is empty.

The use of pollution charges proposed for international flights is a good example in which the incentive effects are implemented without creating more revenues for the state. Of course, air pollution charges increase the costs for those transport modes that pollute the most. However, with tax neutrality, they will pay only for those measures undertaken, not for the other nonpecuniary effects. This can be expected to increase the acceptance for pollution charges.

REFERENCES

1. L. Hansson. The Swedish Approach to Multi-Modal Transportation Planning. AAR 1990 Intermodal Policy Conference, Key Largo, Fla., April 6–9, 1990.
2. Trafikpolitiken inför 90-talet; Proposition 1987/88:50 (Government Bill on Transport Policy for the 1990s).
3. W. J. Baumol and W. E. Oates. The Use of Standards and Prices for Protection of the Environment. *The Swedish Journal of Economics*, Vol. 73, No. 1, 1971, pp. 42–54.
4. Sweden's Environmental Charge Commission. Ekonomiska styrmedel i miljopolitiken (Economic Instruments in Environmental Policy). SOU 1989:83.
5. Sweden's Environmental Charge Commission. Sätt värde på miljön. Miljöavgifter och andra ekonomiska styrmedel (Setting a Value on the Environment. Pollution Charges and Other Economic Instruments). SOU 1990:59.
6. L. Hansson and I. Leksell. Vägtrafikens kostnadsansvar (*The Cost Responsibility for Road Traffic*). The Swedish Society for Nature Conservation, Stockholm, Sweden, 1990.

Publication of this paper sponsored by Committee on International Activities.