

Driving towards the green light?

Economic incentives to reduce carbon dioxide emissions
from passenger cars in Sweden

Abstract

In this thesis four economic incentives to reduce exhaust emissions of carbon dioxide are studied. The incentives are: the carbon dioxide tax, carbon dioxide differentiated vehicle tax, green car cash bonus and old car scrapping bonus. They are analysed and discussed in deeper theory. Where figures and numbers are available these are studied. Economically they are all more or less efficient. The environmental efficiency depends on peoples' responses to the subsidies. The carbon dioxide tax provides efficiency for the environment in the long run, when demand elasticity for fuels is more elastic. As always caution needs to be taken when subsidies are used. There is a risk that the cash bonus increases the number of cars on the roads instead of just substituting old cars for new ones. A scrapping bonus might make people unwilling to scrap a car whenever a bonus is not present.

The main conclusion drawn in the thesis is that the CO₂ tax is important as a complement to all the other measures as it works counter productive to the environmentally unfriendly effects the subsidies might have.

Keywords: carbon dioxide, CO₂, tax, vehicle tax, scrapping bonus, green car cash bonus, economic incentives, emissions, passenger car transport, efficiency, elasticity, car

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1 Introduction

Since the 1960's the threat of global warming has been a well-known problem among scientists and people. As it is a global issue it is frequently debated all over the world and everyday we are reminded of the severity. Its consequences are shown in pictures and covered in articles and it is argued over what can, should or should not be done to lessen the burden on the environment. In 2003 the European Union decided that a cap and trade system, i.e. transferable permits to emit carbon dioxide, would be introduced from the 1st of January 2005. The aim of the system was to realise the Kyoto protocol goals of 1997 through cost effectiveness. The system comprises the industrial and energy sectors and covers about 50 per cent of green house gas emissions (Hammar & Jagers, 2007, p. 377-378). A sector not included in the system is the transport sector. This sector was in 2007 responsible for 25 per cent of global CO₂ emissions and nearly half of all the oil demanded in the world was demanded by the sector (Olsson et al, 2006, p 185). By far, the most common vehicle fuels used are diesel and petrol, both fossil fuels. Cars in Sweden that run on petrol or diesel are the ones that emit most carbon dioxide per car in all of Europe (Naturvårdsverket, 2007, p 164). Of total CO₂ emissions in Sweden the transport sector emitted 22 per cent in 1990. Out of that passenger transport was accountable for 55 per cent (Bergman, 1996, p. 77).

From 1960 to 1993 passenger car transports increased by almost 200 per cent in Sweden (Bergman, 1996, p 20). This number is far greater than the increase in GDP for the same period. A possible explanation is that demand for transport diversifies with GDP growth. Families of today, in general, contain of two working individuals. Thus the car becomes a necessary factor for the family to go about the daily activities efficiently; such as transport of children to day care etc.

In 1989 two tonnes of carbon dioxide per capita were emitted in Sweden while the world per capita emission was 1.1 tonnes. Estimations were made in the middle of the 1990's showing that to stabilise the concentration of carbon dioxide at the 1990¹ level world emissions would have to decrease by 60 per cent. If the aim is for the world to decrease

emissions so that all countries emit the same level proportionally, Sweden would have to decrease emissions by 80 per cent.

Emission of green house gases (GHG) is a global problem. It does not matter where the emissions take place as the gases are not directly harmful to people and surroundings. The problem occurs when the gases are being accumulated in the atmosphere and improve the natural green house effect. The consequence – global warming – affects the whole planet. There is therefore a need for international agreement to reduce GHG emissions. But as the source of the emissions is not just companies and industries, but millions and millions of people driving cars in their daily life, there is also a need for a societal adjustment to get to the problem. According to Bergman (1996, p. 14) the way to do this is by information and economic incentives directed toward households and companies.

1.1 Purpose

The ways for households to decrease their contribution to pollution are either to decrease their use of sources of pollution in volume (in this case, drive less car) or by technical fixes, e.g. by replacing an old car with a new one emitting less carbon dioxide per kilometre (either run on renewable fuels or, due to technology improvements, emitting less CO₂ per kilometre) (Bergman, 1996, p 15). According to a report from the Swedish Environmental Protection Agency (Naturvårdsverket, 2007, p 48-49) the most efficient existing instruments to reduce the use of fossil fuels or replace fossil fuels with less CO₂ emitting ones are the energy tax, the carbon dioxide tax and the vehicle tax exemption for motor vehicles driven by bio fuels. As mentioned above, the problem of CO₂ emissions is global and not area specific and the sources of pollution are many. Economists seem to agree that economic incentives to reduce exhaust emissions are more efficient than the more traditional approach using command and control. Since there is no market price on pollution, only external costs, there is a market failure present. When the cost calculations for a good or an action are made, the company or

¹ The year 1990 is commonly used as the base year for measuring CO₂ and the government has set the emission level as the goal for the Swedish emissions.

the individual does not include pollution in their calculations. If the level of emission is to be lowered, economic incentives are essential. They provide no force, they take the externalities into account and internalise them into the market (McKay et al, 1990, p. 2). However, that does not necessarily mean that the economic policies used today are efficient. The aim of this thesis is to study the following question:

Are economic incentives to decrease CO₂ emissions from passenger transport efficient?

The policies chosen for the study are: the carbon dioxide tax, the carbon dioxide differentiated vehicle tax with tax exemption for green cars, the green car cash bonus and the scrapping bonus. All of them used, or will be used, in some extent in Sweden today. Efficiency will be considered as whether the environmental aim is achieved and if the policy at the same time can be economically justified. If the costs of reducing emissions are bigger than the benefits it may not be an optimal outcome to society. Minor attention will be drawn to distributional outcome to reflect the social aspects of the economy. This is important to mention as a policy can be efficient but at the same time have very undesired distributional effects. To evaluate the costs of these means discussion will also be done regarding the estimation of the costs that will occur if CO₂ emissions are not abated. Sweden will be used as a case for the study. One of the reasons for that is that the interest for the question asked in this thesis awoke because of the green car cash bonus that has been tested in Sweden for two years but not been thoroughly evaluated yet.

1.2 Delimitations

Travelling by car has, for most distances, advantages in flexibility, comfort and in time spent on travelling than any other alternative has (Bergman 1996, p 63-72). For most people public transport and other types of collective means of transport is more of a complement to car travel than a substitute. An assumption supported by the fact that cross price elasticity for fuel and public transport suggests that these goods are not inversely related (Romero-Jordán & Sanz-Sanz, 2009, p. 157). For that reason public transport will not be considered a perfect

substitute for car travel in this thesis and therefore the effects of subsidising public transport will not be studied. This thesis will study passenger car transport, not goods transport. The interest of the study is to see how to get to households, not companies as many of them are already included by the cap and trade system.

There are several instruments in use in Sweden today that works counter productive to the four measures studied in this thesis. Examples of those are free parking for employees providing by employers, free cars provided by employers, and the possibility of tax relief for travelling to and from work. These will not be more than briefly mentioned in this study. The four instruments will be studied in isolation from other effects.

Another limitation applied in this thesis is that where numbers and figures are used as complements to the theories these will regard Sweden. This is based on the already mentioned notion that the Swedish passenger transport sector is of extra interest as cars in Sweden emit more than the average car in the EU. Another reason for using Sweden as an example is that interest for environmental issues is big there. It is therefore likely that much research will exist about Sweden and this issue.

When fossil fuels are used a lot of other gases, such as nitrogen oxide, and particles are emitted. In the late 1980's when the catalyst was introduced exhaust emissions of fossil fuels were rapidly reduced but not carbon dioxide. To decrease carbon dioxide exhaust emissions the alternatives are to improve energy efficiency, reduce emissions from exhaust and to substitute fossil fuels for renewable fuels (Bergman, 1996, p 20). Because of this and the other characteristic of CO₂ - that it is a global problem - the thesis is delimited to study the decreasing of CO₂ emissions.

As the emission of green house gases has been notified the last 20 years when the consequences have been more visible it seems natural to delimit so that references are from the last 20 years.

1.3 Method

In this thesis I will not make any empirical research myself. Numbers and figures will be taken from databases. The purpose is not to test the instruments' demand effects for significance but to analyse theoretically. Numbers will be presented but not tested. There will

be some empiricism in the thesis to complement the theoretical analysis. The reason for not finding the use of empiricism important in this analysis is that theories concerning pollution and external costs have been tested and are widely accepted within basic micro theory. There is no need to test them further but to see whether they can be complemented. What the thesis aims to do is to elaborate the theories and critically evaluate them.

1.4 Disposition

The thesis starts by going through the history of the use of economic incentives in Sweden leading up to what it looks like today. This section is followed by a presentation of what research has been done so far in the area and the literature and empiricism used in this study. Thereafter the basic theory of Pigouvian taxes and subsidies will be outlined. This will then be applied to both deeper theoretical discussions but also to some empirical numbers and facts. As the carbon dioxide tax is the one instrument affecting everyone driving a car driven by fossil fuels the discussions will start with that. It seems inevitable that it will be brought up during the whole discussion as it is present when decisions are taken regarding the other three instruments as well.

2 Background information

2.1 History

In the 1920's a tax on the possession of a vehicle was introduced in Sweden. In the beginning this tax was earmarked for road maintenance and construction. Today it is not, but if failing to pay the tax today one loses the right to use the public roads. In 1993 the Swedish vehicle tax was differentiated depending on what kind of fuel was used. Cars driven by diesel were taxed higher than petrol cars as diesel was otherwise cheaper than petrol. When the tax rate on vehicle tax for Cars type 1, i.e. the most environmentally friendly cars, were abolished in 1995 so were also the vehicle tax on these cars during their first five years of use. This policy shifted the aim of the vehicle tax towards becoming more environmentally oriented (Sjölin, 2000, p. 37-38).

Sales taxes on vehicles were introduced in Sweden in 1951. The aim was to balance the economy and to inhibit the fast growing trend of car use. Not until 1986 were sales taxes used as a mean of achieving environmental effects. Cars that were equipped with some kind of emission control were subsidised. In 1991 the sales tax was further developed as cars were divided into three groups depending on their effect on the environment and taxed based on what group they belonged to. The total tax burden was not supposed to change; the less environmentally friendly cars were taxed more heavily while the more environmentally friendly cars were taxed less. On the Swedish entry into the European Union in 1995 it was no longer possible for Sweden to use sales tax rates and they were therefore abolished (Sjölin, 2000, p. 37-38).

Between 1974 and 1993 the Swedish government taxed car owners per kilometre driven. Compared to the sales tax and the vehicle tax this tax was efficient in the sense that it actually taxed the use of a vehicle and not just the possession of one. However, this tax was, just like the sales tax, abolished when Sweden adapted its taxation system to become a member of the European Union. The tax takes the form of an excise tax. The carbon dioxide

tax has steadily been raised since 1991 and today it constitutes SEK 2.44 per litre petrol. For diesel it is different as the fuels emit different amounts of CO₂ (Skatteverket a; Skatteverket b).

In 1976 a car scrapping bonus was introduced in Sweden to prevent people from abandoning cars in the countryside. This was abolished on the 1st of January 2007. The money left in the scrapping fund was used to release larger car scrapping bonuses for a couple of months later the same year. It lasted until the fund was emptied (Naturvårdsverket, 2007, p. 176-177).

On the 1st of May 2006 the vehicle tax was differentiated in two aspects. Hybrid cars and electric cars now pay less vehicle tax because they emit less CO₂. Other cars are differentiated due to their weight or their CO₂ emissions. Until then the vehicle tax had had fiscal purposes, now the environmental aspect was taken into account too (Naturvårdsverket, 2007, p. 164).

In March 2007 the Minister for the Environment in the Swedish Government, Andreas Carlgren, announced that a green car cash bonus was to be introduced from the 1st of April that year (DN, 2007-03-29). The bonus, on SEK 10,000, was to be paid in cash from April 2007 until 31st December 2009. Electrical cars, hybrids and cars driven by renewable fuels were to be considered green cars. For conventional cars to qualify as a green car the emission of carbon dioxide from the car per kilometre could not exceed 120 grams. From the 1st of January 2010 the green car bonus will be replaced by a green car vehicle tax exemption (Olofsson et al, 2009). It will be retroactive for cars taken in use from the 1st of July 2009. Unlike the cash bonus the tax relief will be valid for company cars. The definition of green cars persists.

The emissions of green house gases in Sweden have decreased since 1990. Since 1999 they have been below the emission level of 1990 (PROP. 2008/09:162, 2009, p. 30 ff). In 2007 the emissions were 9.1 per cent less than in 1990. The global emissions, however, have increased by 24 per cent since 1990 (PROP. 2008/09:162, 2009, p. 47). Total emissions from Swedish transport have increased by 12 per cent (PROP. 2008/09:162, 2009, p. 81). Passenger cars become more and more efficient all the time and thereby emit less. But the problem of comparatively less efficient cars in Sweden persists. Of the cars that have been registered during the last ten years the average car in Sweden emits 20-25 per cent more than the average car in Europe. At the same time the share of green cars is steadily increasing, out of the 5.2 million cars in Sweden 200,000, i.e. 3.9 per cent, are green cars (PROP. 2008/09:162, 2009, p. 52).

2.2 Previous study

Most of the scientific articles considering the area of the thesis are written in the 1980's or the early 1990's since the problem of global warming was not noticed until the late 1970's. About a decade later the IPCC was founded by the UN and shortly after that agreements were made to decrease emissions of CO₂ to the level of 1990. The problem was more and more notified, interest grew and with that research and studies. Most of the studies are from OECD countries (See McKay, Pearson & Smith; Johansson; Hammar & Jagers etc).

Much of the research deals with trying to estimate the costs of allowing global warming to happen and the costs of preventing it. Some argue that the administrative costs of CO₂ taxes are so big that a tax is not justified. Others estimate the cost of CO₂ emissions to be so big that a CO₂ tax would need to be more than double of what it is today to lower the damage and cover the costs. Most studies deal with the CO₂ tax, some study the vehicle tax. The conventional instruments to fight pollution have been command and control, setting standards for production or quotas for pollution. Much of the research, therefore, deals with arguing for economic incentives' advantages compared to command and control. In this study the aim is not to compare economic incentives to command and control, merely to see whether they are effective in isolation or not.

In an article by Meyer, Leimbach and Jaeger (2007) the characteristics of demand for cars are outlined. The results, that the car is a different good in different parts of the world, are presented in later sections. McKay, Pearson and Smith (1990) have written a very thorough article about the carbon dioxide tax and the vehicle tax and their potential for effectiveness. Romero-Jordán and Sanz-Sanz (2009) outline the problem of heavy vehicles and carbon dioxide emissions in an article from 2009. A book read but not used in this thesis is the book "Valuing Climate Change" by Samuel Fankhauser (1995). The results of this book are present in many other studies as the result is a very detailed base for the costs of global warming.

The bonus systems of the green car cash bonus and the old car scrapping bonus have not been analysed and evaluated enough yet. Not surprising considering both of them have been actualised quite recently. My hope is that this study can make a contribution to fill the gap.

2.3 Literature

This thesis has mainly been based on academic articles, course literature, newspaper articles, government propositions and reports from institutes.

The course literature used is Paul Krugman and Robin Wells' book *Microeconomics* for basic micro theories. From taking classes in public finance and tax studies I was well acquainted with Harvey Rosen and Ted Gayer's book *Public finance*, which has been the base for theory but also for deeper analysis of public spending etc. Where more specific facts concerning the environmental part of the study was needed the book *Environmental and Natural Resource Economics* by Tom Tietenberg and Lynne Lewis has been a great complement.

For deeper understanding of the theories concerning passenger transport and exhaust emissions I have read several academic articles covering this subject. I chose a few of them for my study. Among the authors of the articles are Hammar and Jagers who have written about people's attitudes toward the CO₂ tax. Bengt Johansson has simulated what the transport sector would look like in 2015 to see what the chances of decreasing exhaust emissions are.

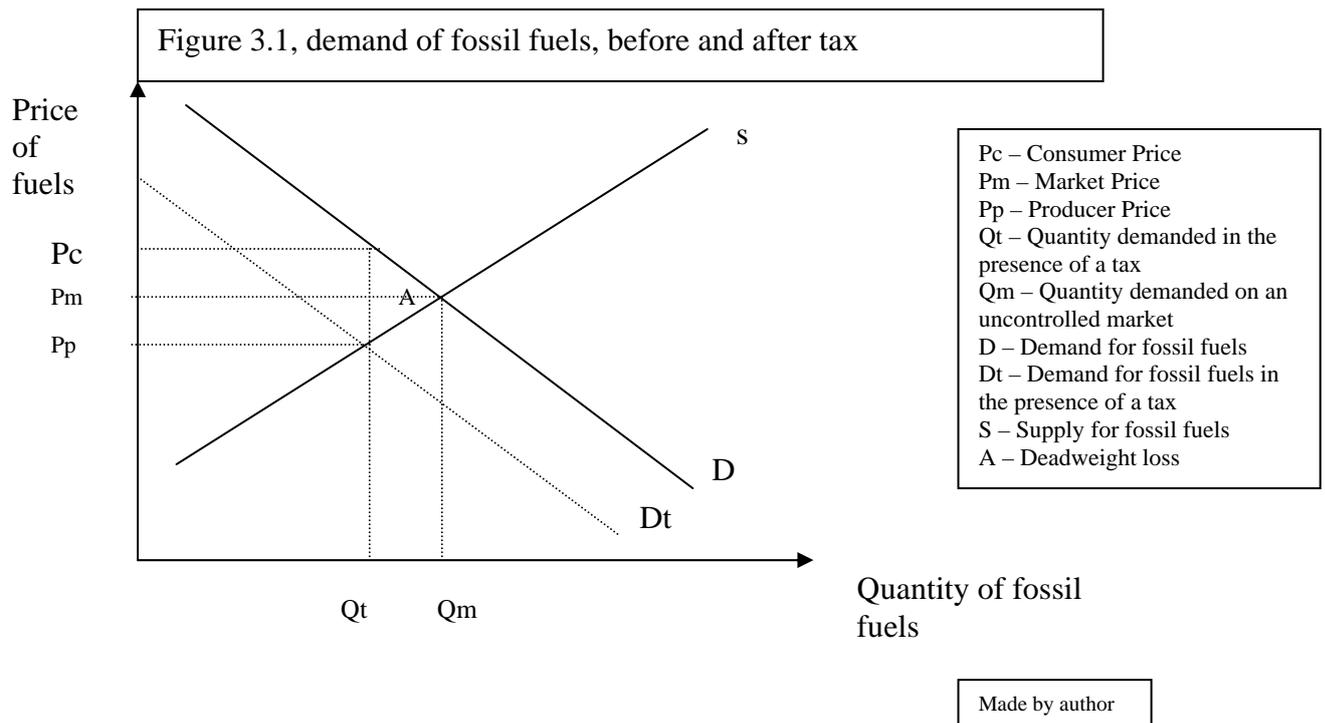
A report ordered by the Swedish Environment Protection Agency and written by Lars Bergman has provided a base for the problematic concerning the transport sector and its response to economic incentives. Other reports have complemented Bergman's study with estimates of how the economic incentives affect demand etc. Interest organisations, like Bil Sweden (Car Sweden), have contributed with the statistics that Statistics Sweden, the official institute for statistics, did not provide. For chronology and debates over the more recent policies that have not been covered by much research yet, i.e. the bonuses, I have turned to newspapers such as Dagens Nyheter and Svenska Dagbladet (both of them major Swedish newspapers). A majority of the references used for the theory parts are from the beginning of the 1990's but they have been complemented by facts and numbers from today. Most of the references used in this study are from OECD countries. As for this thesis it is not considered a problem since it deals with the Swedish car market. I have, however, been cautious with generalising my conclusions as the situation of countries outside the OECD is, in many ways, different.

3 Theory

3.1 Green taxes

The use of fossil fuels spills a negative externality on to society. When individuals and companies decide on how much fossil fuels they will use they consider a private cost in which the social cost is not included. Most of the people upon whom the costs of pollution fall have nothing to say in the matter (Krugman & Wells, 2004, p. 457-458). The polluters will therefore pollute more than the optimal level. There is a marginal social cost and a marginal social benefit of pollution meaning that up to a certain amount it would be inefficient not to pollute. Goods need to be produced and people need to be able to transport themselves between places and when this is done, there will be emissions and pollution. But the marginal benefit of pollutions is decreasing while the marginal cost of pollution is increasing. At a certain point they will intersect and that is where the optimal level of pollution is found.

In figure 3.1 a *Pigouvian tax* is levied on consumers. Consumer price goes up, demand decreases and a new equilibrium is found.

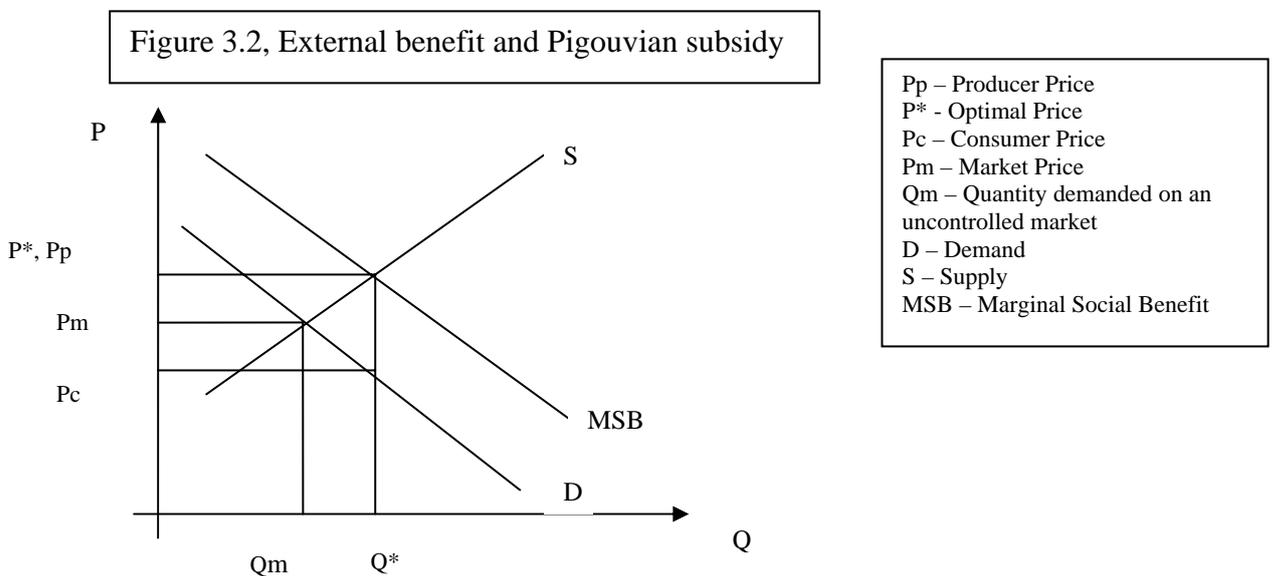


The carbon dioxide tax is a green tax (Naturvårdsverket, 2007, p 86). It was introduced for environmental reasons. Emitters, i.e. car drivers, now have to take into account the cost of emitting when deciding on how much to drive. The aim of taxing e.g. fuel in that way is not to gain revenue but to affect people's habits. When the amount of taxes paid depends on how much of something one uses, e.g. petrol, one can decrease the amount paid by decreasing the use of that good, or by using it more efficiently. Hence, there are two ways to avoid paying much carbon dioxide tax, one can use the car less (e.g. swap to public transport) or one can buy a car that emits less, or none, carbon dioxide. The problem is to find the optimal tax level and to know the marginal costs and benefits of pollution.

In the graph above it seems that consumers and producers share the burden from the tax equally. In reality the incidence of a tax depends on what the producer and consumer elasticities look like. When supply is perfectly inelastic (elastic) the incidence of a tax falls on the producers (consumers) and when demand is perfectly inelastic (elastic) the burden of the tax falls on the consumers (producers) (Rosen & Gayer, 2008, p. 305-313).

3.2 Subsidies

So far externalities have been mentioned in a cost circumstance, i.e. negative externality. Externalities can be either negative or positive. In the formerly mentioned example of pollution the externality was negative. In the case of a positive externality the benefit of a good, an idea etc is bigger than just the marginal benefit that one consumer gets from consuming it. The marginal social benefit consists of the consumer's marginal benefit plus the good's marginal external benefit. By introducing a *Pigouvian Subsidy* into the market the optimal level of the good can be produced or consumed. A subsidy can take the form of a tax exemption on a good; it might be levied on consumers or producers. It keeps consumer price under, or producer price over, the market price (Krugman & Wells, 2004, p 469-471). The vehicle tax exemption for green cars is an example of this kind of subsidy, it is levied on consumers. In figure 3.2 we see that a subsidy increases producer price and decreases consumer price so that the optimal level of the good will be produced and demanded. The size of the subsidy is the area producer price minus consumer price times the optimal quantity minus the market quantity.



Made by author

Apart from tax exemption subsidies there are direct subsidies. These take the form of a direct transfer of money from the state to the consumer, or producer, of a good (Sjölin, 2000, p. 12).

The green car cash bonus is an example of a subsidy keeping consumer price under the market price. Subsidies can also be motivated when there is a negative externality correlated with the good subsidised. In the case of the green car bonus or the scrapping bonus the externality is exhaust emissions. There is a comparative advantage of the average car being more environmentally friendly than the average car is today and therefore a subsidy to speed up the replacement of old cars with new ones is justified. Important to emphasise is that, in theory, these policies do not encourage the driving of a car, hence emitting, merely the owning of a car. In the case of a carbon dioxide differentiated vehicle tax the externality is the same, exhaust emissions. The differentiated tax makes it cheaper or more expensive to own a certain car. That ought to provide incentives to want to own a car emitting less carbon dioxide. The scrapping bonus can either be a direct transfer of money or a rebate on car sale so as to encourage the substituting of an old car for a new one.

Just like with a tax, the incidence of a subsidy depends on consumer and producer elasticity.

4 Discussion

4.1 Carbon Dioxide tax

4.1.1 Environmental Efficiency

The carbon dioxide tax is a proportional tax. It is also proportional to emissions as the emissions of carbon dioxide are directly proportional to the consumption of fossil fuels. There is no way of decreasing the CO₂ emissions per litre fuel, only decrease the amount of fuel used per kilometre driven (Bergman, 1996, p.74). Nevertheless, the tax ought to encourage the invention of a way to reduce CO₂ emissions from fossil fuels as that would decrease the tax burden. Taxes on petrol and diesel are differentiated depending on the environmental characteristics the fuels have, e.g. how much carbon they contain. According to the Swedish Environmental Protection Agency and the Swedish Energy Agency it has been effective in substituting the less environmentally friendly types of fossil fuels for the more friendly ones. Nowadays almost all fossil fuels sold in Sweden are Environmental class 1, i.e. the best from an environmental perspective (Naturvårdsverket, 2007, p. 168).

Bergman (1996, p 63-72) finds three different ways for households to limit the increased costs that taxes on emissions levy on them. The three categories are: Change of volume, change of structures and change of techniques. *Change of volume* means that due to the fact that travelling by car has now become more expensive households adapt their lifestyle to a way where they do not need the car as much as before. E.g. they might move closer to work, change their way of spending leisure time etc. The results of these actions are that the total volume of car travel and emissions from cars decrease. The second category is *Change of structures*. When the price of private car transport goes up people find a way of substituting the car for other means of transport. The car is the dominating means of transport for individuals, in 1993 four out of five passenger transports were done by car, but there are

many competitors. Within cities one can move around by foot, bicycle and bus or other forms of public transport while for long distances the substitutes would be, above others, train and airplane. For very long travels, or within and between big city centres, the alternatives might have advantages. There are, however, reasons to believe that the car has comparative advantages in the forms of flexibility, availability and comfort. There is need for a great change of cost for people to choose the competitors instead of the car. The last alternative, *Change of Technique*, occurs when people try to avoid fees by using newer techniques that have less environmental externalities. Either there is a technical development so that emissions are decreased, or there is an organisational change so that e.g. one big car is used instead of two small ones. The latter example is more related to goods traffic than passenger traffic. Bergman further states that technological change is most likely to occur out of economic incentives. Among economic incentives emission fees are the most efficient ones. By increasing the price on e.g. production, economic gains can be made by finding new solutions through technological improvements that reduce emissions.

As stated above, structural changes might not take place until there is a remarkable increase in cost. The same is probably true for voluminous change. Demand elasticity for fuel and transport is approximated to be low in the short run, meaning that there would have to be a large increase in price before people actually choose to leave the car at home

There are no real numbers calculated for the costs associated with these adaptations for households. The costs of technical improvements depend on the substitution possibilities to replace old technology vehicles with new ones and to substitute fossil fuels for other kinds of fuels (Bergman, 1996, p 15). The costs of decreasing the volume of consumption depend on how much one values these goods. This would imply that especially the latter one is highly subjective but both are possible to impact politically. By subsidising the alternatives the relative prices change.

The transport related environmental problem is bigger than just carbon dioxide emissions. Bergman (1996, p 25-26) lists no less than six costs that the passenger transport sector generates on society. Those are: marginal congestion costs, marginal road maintenance costs, marginal surveillance costs, marginal risk of accident costs, marginal noise pollution costs and marginal emission costs. Further he states that the different costs have different impact in the countryside and in the city. While congestion and health related emissions are costs imposed on the city, accidental risks and noise pollution are problems in both cities and the countryside, although they might be a bigger problem in the cities than in the countryside. The more global environmental costs of emissions are caused by traffic everywhere but

countryside traffic is to blame for a larger share. If the use of private car driving is decreased due to the CO₂ tax there is an advantage beyond its prime aim - all other costs of emissions and driving, as listed above, are decreased. If instead, it leads to the purchasing of a lot of new cars, the other negative effects are still present, although the emission of carbon dioxide will be decreased.

4.1.2 Economic Efficiency

When households due to a price distorting tax decrease their demand for a good, i.e. transport by car, there is a loss of welfare (Bergman, 1996, p. 84-85). This cost is very difficult to measure, as it is subjective. For some it might be the loss of not being able to move to the countryside because they can not afford to commute. For others it might be not being able to visit a friend. Some might need to change to a smaller car which is normally less safe.

Both the income effect and the substitution effect suggest that demand for petrol will decrease due to the tax (Rosen & Gayer, 2008, p. 417). On the other hand, a survey made in 1996 (Naturvårdsverket, 2007, p. 160-161) concluded that most households projected that they would not decrease their car use even if the price on gasoline would go up by 50 per cent. The price elasticity on demand for petrol is 0.7 to 0.8 in the long run but in the short run it is estimated to be just 0.2 to 0.3. This means that in the short run people will not stop demanding fossil fuels because of a rise in price due to carbon dioxide tax. The deadweight loss would still occur even if demand is not changed.

As stated above demand elasticity for fuels is low in the short run. This means that consumers will pay most of the actual tax when it is raised. Consumers find it hard to adapt to a higher fuel cost in the short run and therefore they are prepared to pay more. But we do not know anything about supply elasticity. If supply elasticity is inelastic the tax might as well fall even between consumers and producers. In the long run it might even fall mostly on producers as demand elasticity is higher in the long run. On the other hand, if supply elasticity is elastic it seems clear that the burden falls on consumers.

The carbon dioxide tax is a green tax, meaning that it exists for environmental reasons and not due to fiscal purposes. It should therefore be evaluated from an environmental point of view, not from how much revenue it brings in. It is easy to see why. If the purpose is to decrease the emissions of CO₂ the aim is in one sense to not gain any revenue at all from the tax, as that would mean that people do not consume CO₂. However, from an economic efficiency point of view it is probably not desirable not to consume any fossil fuels, but to

consume less. The fact that the tax does not exist for fiscal reasons does not mean that there can not be an efficiency loss if there is a big deadweight loss present. The deadweight loss is a societal cost, the cost that the tax levies on society is therefore not just the direct cost of paying the tax, there is also a societal cost in the form of a welfare loss (Rosen & Gayer, 2008, p. 331-335). The revenue might be used to pay for the growth loss that might be the result of not being able to consume as much CO₂ as before.

In 2008 the carbon dioxide tax contributed to the national budget with SEK 25.746 billion. Bear in mind that this number is not only for the transport sector. But when compared to the green car cash bonus that cost SEK 322 million the same year it may be assumable that there is actually some money left over for a double dividend even if the CO₂ is assumed to finance the subsidy (SCB a; SCB b). Taxing CO₂ is commonly related to decrease of growth and therefore criticised. In a press release from the Swedish Ministry of Finance, the Ministry of Environment and Industry and Ministry of Employment and Communication (Sjöqvist et al, 2009) it was stated that economic incentives should move toward double dividend, that is, tax increases should be reflected by tax relieves. The idea is that by raising taxes on environmentally harmful things, such as emissions, the demand for them should go down so that less will be emitted. The revenues from the taxes will be used to decrease the income tax and the employer's fee. The result of that will be the double gain, jobs will be created and GDP growth increase. (Leander, 2007-07-11) However, whether double dividend is positive for GDP growth or not is debated. This issue will not be further elaborated in this study.

Quantifying environmentally related real costs is difficult. Especially for damage done by emissions such as carbon dioxide as the damage is done accumulatively and during a long period of time rather than a single year. Not only is time the limit, when quantifying damage of CO₂ emissions geography too is a limit. The cost of reducing emissions of carbon dioxide is private, as much of the emissions come from short trips from households, while the costs of pollution is global. (Tietenberg & Lewis, 2009, ch. 18) In the climate proposition for 2009 from the Swedish government (PROP. 2008/09:162, 2009, p. 71) some of the costs are listed. So far the effects have been visible within agriculture and forestry, the rising of the sea level, in health related issues, such as people dying from heat etc and other areas. As a result of these problems others follow, such as increased migration and streams of refugees.

4.1.3 Attitudes toward the carbon dioxide tax

Sweden might be expected to be in favour of a CO₂ tax as the country is “considered one of the most environmentally engaged countries and has one of the most eco-concerned populations in the world” (Hammar & Jagers, 2007, p. 378). On the other hand, as Hammar and Jagers (2007, p 378 ff) further discuss, there is a high tax burden of almost 50 per cent of GDP in Sweden and the CO₂ tax is already high compared to other countries. Opinion polls show that the CO₂ tax, as well as further increase of the tax, receives much dislike. The authors ascribe some of this aversion to the fact that all kinds of taxes will be disliked in a country that already imposes high taxes. Self-interest also plays a part in the explanation to the disliking of the tax - this tax is noticeable for most people. For low income groups that are dependent on private transport the tax is extra harsh. Low income households already spend a bigger share of their income on fuel and energy than households in the higher income brackets. McKay et al (1990, p. 14) show that when the petrol tax in UK was increased by SEK 1.8 per litre² (original figures 55 Pence per gallon) the richest decreased their consumption of petrol by 7.8 per cent while the poorest decreased it by 11.3 per cent. It is likely to believe that by decreasing their demand for fuel a deadweight loss occurred and they ended up with less utility than before. In figure 3.1 the deadweight loss is depicted in the triangle named A. However, when statistically tested for significance there was none found regarding whether income bracket is related to how one feels about higher CO₂ tax. Being a car driver, on the other hand, affected one’s feelings toward the tax. People that used a car on a daily basis were less supportive of a CO₂ tax increase than other groups. It is not easy to estimate how many people have access to a car but knowing that there in Sweden are 5.2 million cars registered compared to a population of approximately 9 million a guess is that a lot of people are affected by the CO₂ tax.

The fact that people do not like a tax such as the CO₂ tax is not very surprising. The benefits of taxing pollution take place in the future while the costs are imposed now. With no tax it would be the other way around. All the benefits of pollution could be used now, and then the costs would be very great in the future. Irrespective of the tax being popular or not, estimates by request from the Swedish government suggest that total emissions of Swedish based green house gases would have been 20 per cent higher in 2010 compared to 1990 if the taxes had not been raised since then (PROP. 2008/09:162, 2009, p. 62). According to

Fankhauser, as the taxes were designed in 1993 actually the entire transport sector was subsidised when the norm for taxation was determined from the social cost to society of emissions (Sjölin, 2000, p 41). It can once again be stressed that the tax internalises the external social costs of pollution. People are not supposed to like the tax. They are supposed to dislike it so that they behave in a way that makes them not needing to pay the tax. But of course it is difficult to implement a tax that is much disliked when fighting for votes. And if there is a risk that many cars will be filled up in neighbouring countries levying lower CO₂ taxes the tax rate might be set too high. As the tax is not supposed to have fiscal purposes it should not matter for fiscal reasons where cars are filled but if fuels are cheaper somewhere else the environmental goals are not reached as, according to basic micro theory, cheaper fuel means more consumption.

Studies have shown that consumers may have a faulty perception of the value of saving fuel. One survey found that consumers only consider the first three years of fuel consumption when they make decisions regarding buying a green car or a non-green car. Thereby, they might undervalue possible fuel savings by up to 60 per cent (Tietenberg & Lewis, 2009, p. 458). This fact might suggest that there is a need for complementary measure to tax when the aim is to reduce CO₂ emissions. When even more tax exemption or advantages are present people might be one step closer toward seeing the real value of choosing to drive a green car. The following sections will discuss the possibilities.

4.2 The green car cash bonus

4.2.1 Environmental efficiency

Demand for transport is positively correlated with growth in GDP. Knowing that, it might seem futile to encourage the use of more environmentally friendly cars as the increase in transport still will increase pollution. In 2003 the average passenger car in Sweden weighed about 100 kilos more than the average EU car (Zervas & Lasarou, 2008, p 250). Suggesting, as heavier cars normally consume more fuel, that only by changing the trend of heavy cars in

² Calculated by author. 55 Pence = SEK 6.78 and one gallon = 3.79 litres

Sweden could the emissions decrease. To return to Bergman's three ways of escaping a fee this bonus is part of the *Change of technique*. If the bonus increases the demand for cars with better techniques it will also be supplied.

Subsidies are commonly analysed when there is a positive externality associated with the good subsidised. It might be subsidising education which is common in many countries or the maintaining of a natural reserve of some kind (Rosen & Gayer, 2008, p. 136-137). In this example the good subsidised is in ways already mentioned not good for the environment, only better than the alternative. The aim of the subsidy is to minimise a negative externality.

In his study "Strategies for reducing emissions of air pollutants from the Swedish transportation sector" Bengt Johansson (1995) tries different future scenarios of what the exhaust gases from the transport sector might look like in 2015. Total transport demand between 1990 and 2015 is increased by 30 per cent. This level of transport is then multiplied by three different levels of average technology that are assumed to possibly be the case for 2015. These are *Average sold technology* where the average car in 2015 has an efficiency, and emits as much, as the average sold vehicle in 1991; *Best available technology* where the average car in 2015 has the average energy efficiency and emission factors equal to the best commercially available vehicles in 1991; and *Improved technology* where the energy efficiency and emission standards are those of the vehicles that were available as prototypes but not in stores in 1991.

What is considered in the study is partly whether the different technology levels can help stabilise the Swedish CO₂ emission level in 2000 to the level of 1990 in Sweden as is the goal set by the Swedish Government. If the goal is to stabilise the global emission level to that of 1990, and to be done to equal levels globally, Sweden has to reduce the emission of CO₂ by 80 per cent compared to the 1990 level.

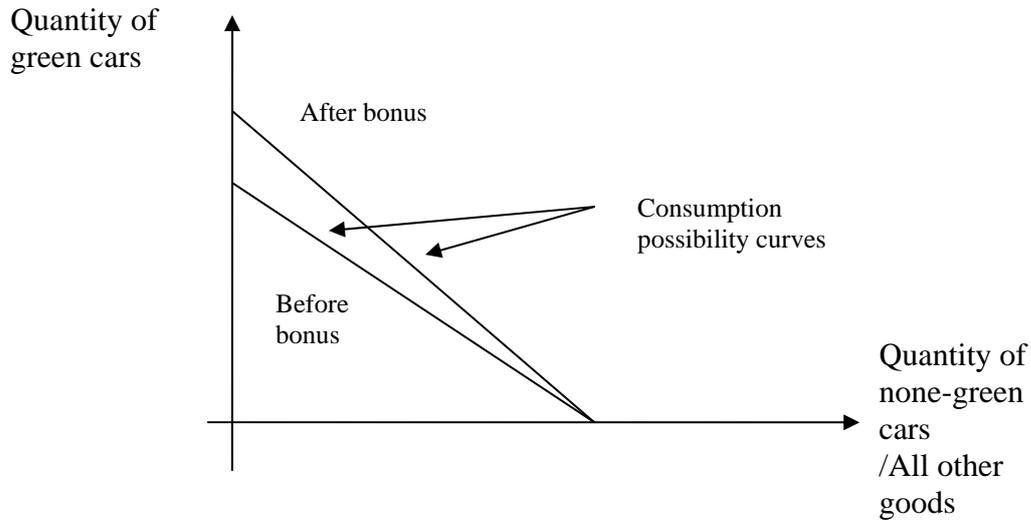
The result of the study is that none of the technology standards leads to a decrease of CO₂ exhaust emissions by 80 per cent. In the average sold technology the emissions are even increased by 20 per cent while in the best available technology scenario the emissions are almost that of 1990. The increase in volume of transport works in the opposite direction as that of the technology improvements. If the transport volume would be the same in 2015 as in 1991 the emissions would be remarkably lower. If the best available technology was used and the level for transport was to remain the same as in 1991 the CO₂ emissions would decrease by 24 per cent. The conclusions that Johansson draws from the study is that improvements in technology and increased use of renewable sources are important to reduce CO₂ emissions from exhaust. The implications Johansson suggests are economic incentives

such as emission differentiated vehicle taxes and fuel taxes. Although the target is not reached in this scenario it is obvious that there is a big difference in emissions from cars with different technologies. Already in 1995 there was technology available that could drastically decrease emissions if it was to be used instead of the average technology used at the time. Assuming that the scrapping bonus and/or the green car cash bonus actually speeds up the replacement of older cars with new ones characterised by improved technology it might be a policy worth undertaking.

4.2.2 Economic efficiency

The bonus is not affecting the price of the car when it is bought in stores. It is a cash bonus paid by the Swedish Road Administration six months after buying the car. But as buying a new car is the only way of getting the bonus it can still be seen as a reduction in car price. Due to the green car cash bonus the relative price of green cars in terms of non-green cars has been altered (Krugman & Wells, 2004, p. 263 f) meaning that green cars are now relatively cheaper than before and demand should therefore increase. This is true for those already planning on buying a car. For those who had not planned on buying a car in the first place there might also be an increase in demand due to the cash bonus. The relative price of green cars has been altered in terms of all other goods as well as in terms of other cars (see figure 4.1).

Figure 4.1, Relative price green cars in terms of non-green cars/All other goods



Made by author

Buying a green car is now relatively cheaper than buying other goods and demand should therefore increase. This implies that, when a cash bonus like this one is introduced, people who otherwise would not have bought a car might now buy one and with more cars in use the number of sources of pollution increases. During April 2007, the first month of the green car bonus, 14.3 per cent of the cars sold were green cars. This number can be compared to 11.2 per cent the same month 2006. The total increase in car sales was 9.8 per cent (E24, 2007-05-02). The increase in green car sales numbers is bigger than the increase in total sales numbers. But important to stress is that the definition for green cars changed with the implementation of the cash bonus. Until April 2007 green cars were cars driven by alternative fuels or electricity. Since 2007 conventional cars are included by the definition as well, if emitting up to 120 grams CO₂ per kilometre. One should therefore be very cautious about drawing conclusions concerning demand for green cars.

Whether car price actually decreases with the bonus depends on the behaviour of the car salesmen. It is possible that car salesmen raise the car prices due to the cash bonus. If sales numbers increase because of the bonus there is marginal to do that without decreasing revenue. This assumption presupposes that producers have the power to set prices. If prices are raised there is always a risk that consumers turn to another car dealer. In the end prices might go back to their original level. It is important, however, to stress that this depends on whether the car dealers sell the same cars and people see different cars as identical goods or not (Krugman & Wells, 2004, p. 380-381). If different cars yield different utility levels for

the consumer and the first choice car is only sold by one car dealer nearby the dealer might actually be able to make some profit by raising the price on that car.

In one aspect, it can be argued that green cars should cost less than non-green cars. In that way the cost better reflects their effect on the environment. On the other hand, in reality a car's environmental effect depends on how much it is driven, thereby emitting, not on the car itself if it is just left standing. In that way, the carbon dioxide tax seems like a more fair way of paying for transport related environmental costs. But that is not to say that a cash bonus is not desirable. There are considerable relative gains to be made if the car that is driven the most, thereby emitting the most, is a green car instead of a non-green car.

The green car cash bonus is meant to increase the demand for green cars, not to encourage driving, and thereby consumption of fossil fuels. The prices of fossil fuels do not change because of the bonus. One would, however, have to know the cross-price elasticity of demand between the goods "passenger car" and "passenger car fuels" before drawing the conclusion that demand for fossil fuels will not increase if demand for cars increases. If the goods are complements, which is a reasonable assumption as one can not drive a fuel driven car without fuel, the demand for fuel should increase with the demand for cars. How much demand goes up depends on how strong complements cars and fuels are (Krugman & Wells, 2004, p. 121). Two goods are perfect complements when only the consumption of both goods in the same ratio yields utility (Krugman & Wells, 2004, p. 268-269). The consumption of one good without the other yields no utility. Owning a car but no fuel, or owning fuel but no car yields no transport. But, a thought is that it is still possible that the possession of a car yields some utility, in the form of status etc. Cars and fuels may therefore not be perfect complements, but nonetheless complementary goods, meaning that demand for fuels will increase if demand for cars increases. The CO₂ works counterproductive to this effect. Bear in mind that the, by far, most common fuels in the world are diesel and petrol – both fossil fuels.

Car demand is positively correlated with income. In a study by Meyer et al (2007, p 6335) demand elasticity for cars in different regions of the world show that in developed nations cars are normal goods, demand for them increases proportionally with income. In earlier stages of their development, as for developing nations today, it was/is a luxury good. When income increases, demand for cars increases even more. This ought to suggest that means to affect people's decision on what kind of car to buy can (proportionally) give more positive results in developing countries than in the developed world, e.g. Sweden. But that is not to say that using these means in Sweden is futile.

Buying a new car is not a fast decision, renewing an entire car fleet is a process. As a car costs much more than the SEK 10,000 bonus it is questionable who can afford to buy a new car when the bonus only is a marginal part of the price? But, from the environmental point of view that is not necessarily bad. When those who can afford a new car decide to buy one it is likely that their old car will be sold on the second hand market. In the next part of the chain, people with really old cars might decide to scrap their cars and buy a new one on the second hand market. If demand for new cars is increasing due to the cash bonus it is likely to assume that supply for second hand cars will increase, which might lead to a fall in price, which might increase demand. In the end, then, even those not buying a new car, but a second hand car will gain from the bonus, as they might be able to buy a newer car than the one they have got now. A car that is e.g. ten years younger than their previous car will probably consume less fuel meaning that they will also gain from not having to use as much fuel, and thereby pay as much tax as before.

Subsidising a good means that there is a cost that needs financing. To be able to do this the government will either have to decrease another expenditure or increase taxes. If taxes are to be increased it is important to know how this might affect efficiency. A good that is characterised by high demand elasticity is not a good idea to tax for fiscal reasons since that would not generate the revenue that is wished for. A good where demand elasticity is low, on the other hand, may lead to large revenue. It is, however, important to make sure that this is not earned on the expense of a big excess burden. That way, efficiency is still distorted.

Today there are no specific rules concerning company cars with an environmental aim. This in spite of the fact that 25 per cent of all new cars bought are company cars. As company cars are provided by work there are no economic incentives at all to choose a greener car (That is if fuel is provided by work as well, otherwise there is the CO₂ tax). At the time it also seemed that company cars tended to be heavier and more fuel consuming than the average car (Naturvårdsverket, 2007, p. 170). This implies that there is room for making the policies in Sweden even more efficient.

In 2009 it was announced that the cash bonus would be abolished later the same year. Instead, new green car owners would not pay vehicle tax during their first five years of use. Company cars would now qualify for the benefit. The Minister for the Environment of the Swedish Government, Andreas Carlgren, motivated the decision with “It is not reasonable in the long run that the tax payers are paying our car purchases. Therefore it has been

reasonable to replace the green car cash bonus with a long term solution”³ (Carlén, e24, 2009). The vehicle tax is discussed in the next section.

4.3 Vehicle tax

4.3.1 Environmental efficiency

Private road transport is taxed relatively heavy because of the environmental effect this sector has. Apart from the formerly discussed CO₂ tax the vehicle tax too is supposed to reflect the costs (Sjölin, 2000, p. 12). Since 2007 a vehicle tax differentiated by the amount of carbon dioxide emitted has been levied on Swedish car owners. Electric cars and hybrids were assigned a group called class 2005. According to a report by the Swedish Environmental Protection Agency, vehicle taxes differentiated by exhaust emissions have been important for emission reduction in Sweden. The report further states that for this kind of tax to be efficient it should be rather sharp (Naturvårdsverket, 2007, p 167).

The government has set more efficient energy use as one of the most important concepts when trying to achieve environmental objectives. When the vehicle tax is set at the same rate for all cars it can be perceived as a lump sum tax paid once a year. In this form it does not discourage people from driving as once it is paid the marginal cost of driving an extra kilometre is merely the fuel cost; the cost of owning the car is still the same. When differentiated for engine size or emission per kilometre it still does not discourage the use of a car but it can affect what kind of car is driven. The same amount of tax revenue could still be raised but less from low-emission cars and more from high-emission cars. After while, as people start swapping from high-emission to low-emission cars, revenue would decrease. The same would be true for the CO₂ tax. Revenues would decrease as people adapt to the tax. From an environmental perspective, however, the CO₂ tax has an advantage. It not only encourages people to buy a more environmentally friendly car, it also discourages people from driving (McKAY, 1990, p. 15-16). The fact that the vehicle tax and the bonus, as they are designed today, do not differ between cars that emit different levels of CO₂ once they

³ Author's translation

qualify for the bonus/bate is a clear disadvantage (SFS, 2006:227, §8 & §9). While the CO₂ tax provides incentives to always reduce exhaust emissions further the tax exemption/cash bonus is the same for everyone irrespective of whether the car is a fossil fuel driven car emitting 120 grams of CO₂ per kilometre driven or a car driven by renewable sources, not emitting any CO₂ at all. This ought to imply that a carbon dioxide differentiated vehicle tax is more efficient when it is not combined with a tax exemption for some cars. That way it, just like the CO₂ tax, always provides further incentives for buying an even less emitting vehicle.

Since 2006 the vehicle tax has been SEK 360 per car and year up to 120 grams CO₂ emitted per kilometre (SFS, 2006:227, §8 & §9). For cars that emit more than 120 grams per kilometre there is an extra SEK 15 per gram CO₂ emitted per kilometre. It is now debated whether the extra fee should be SEK 20 instead of SEK 15 (Carlén, e24, 2009). At first sight it might seem like this tax is a “polluter pays” tax and therefore efficient in making people pay for the cost they bring. However, a car that is not well maintained consumes more fuel than a new car (STR, 2006, p. 223), meaning that for this tax to really make the polluter pay it would need to be very administratively advanced. Compare a car-owner having a car that emits 130 grams of CO₂ per kilometre and maintaining the car so that three years after buying the car it still emits 130 grams to another car owner with a car that originally emitted 120 grams but three years later the car emits 140 per kilometre due to bad maintaining. The former car owner will always pay for exactly the contributed emission, while the latter one will pay too little. To correct this would of course be very expensive administratively. Once again, there is the CO₂ tax complementing the other incentives. A badly maintained car will soon start costing more in fuel consumption and therefore there are still incentives to maintain the car.

The government concluded in the Climate Proposition (PROP. 2008/09:162, 2009, p. 82-83) that incentives play an important role in substituting fossil fuels for renewable ones on the market. Among the alternatives, tax abatements for cars driven by renewable fuels, are mentioned. The importance of tightening the definition of a green car is also stressed. This should be done without affecting cars already granted with the tax relief. Since all fossil fuel driven cars are bad for the environment it depends on where the limit is drawn at the moment if a car is subsidised or taxed. The limit today, that cars can emit 120 grams of CO₂ and still be a green car, will be lowered in the future. This means that those cars that from the 1st of July 2009 will be taxed negatively might be taxed positively in the future.

Another problem when subsidising a certain type of car or fuel is to know which ones (if any) are going to be all good in the long run. E.g. in the United States in the 1990’s methyl

tertiary butyl ether (MTBE) was added to petrol to make it burn cleaner (Tietenberg & Lewis, 2009, p. 453). After a while it was discovered that it contributed to the contamination of groundwater and drinking water and its consequences was therefore worse than what it was aimed at fighting. When things like this change rapidly it can affect both the economy and individuals. In E24 it was stated that insecurity prevailed on the market and that it is important to be consequent (E24, 2008-01-03). Before being sure that e.g. ethanol really will be demanded in the long run, and not just now when ethanol driven cars are subsidised, it is likely that neither the industry nor people are willing to take the risk of investing in it. To return to the former paragraph concerning the tightening of the green car definition, it is important that the government is clear about how the bonus will change in the future so that people do not get confused and annoyed.

It is difficult to determine how much emissions can be reduced with the vehicle tax as an economic instrument. Almost all cars emit carbon dioxide and demand for cars is increasing. Another problem, valid for the whole thesis, is that Sweden is such a small part of the total market for cars and fuels so that even if results were successful here the total effect would be marginal (Naturvårdsverket, 2007, p 168).

4.3.2 Economic efficiency

A subsidy means that another tax needs to be raised or another expense needs to be withdrawn to finance the subsidy. According to the *inverse elasticity rule* goods that are not related in consumption should be taxed inversely proportional to demand elasticity (Rosen & Gayer, 2008, p. 357). This means that goods where demand is characterised by low elasticity should be taxed highly and vice versa. The reason for this is that when demand elasticity is high taxing the good is pointless out of fiscal reasons. When price goes up, demand will go down and tax revenues might even decrease. As discussed before, demand elasticity for petrol is low in the short run meaning that CO₂ is not just efficient for environmental reasons, but also because it brings in large revenues to the state. But that is in the short run, demand elasticity for petrol is higher in the long run. Demand elasticity for cars is estimated to be inelastic in the long run (Stephenson, 2007). If the vehicle tax can affect the demand for cars the demand will not change very much in the long run, meaning that the vehicle tax too can be used for fiscal purposes. The carbon dioxide differentiated vehicle tax yielded SEK 11.307 billion in 2009. Revenues from the vehicle tax has never been this high before. (SCB

a; SCB b) This might imply that the vehicle tax itself has a chance of financing the tax exemption for green cars that will be introduced in July 2009.

One problem with the tax exemption is that when the same amount of transport can be achieved to a less cost, we might start demanding more transport, as it becomes relatively cheaper, and thereby using more fuel (Naturvårdsverket, 2007, p 73-74). In this case the term transport includes the cost of buying, owning and driving a car. When the cost of owning is decreased, the sum of these three costs is decreased. On the other hand we have the CO₂ tax working counter productive. A tax on fuel makes driving the car more expensive.

The government not only sees costs related to preventing global warming, also business possibilities opening up due to the great need for technical development and improvement (PROP. 2008/09:100, p. 54). There is a possibility of new jobs being created. The demand for cars and new technology in other areas is believed to have the potential of being positive for the economy.

4.4 The scrapping bonus

There are two economically efficient ways of speeding up the process of scrapping old, polluting cars. One is to make it more expensive to own an old car, e.g. by increasing the registration fee for old cars that pollute more. The other option is to provide a bonus for those choosing to retire a car of that kind (Tietenberg & Lewis, 2009, p. 458). The costs of buying, owning and driving a car have been discussed. The scrapping bonus can be seen as the opportunity cost of owning a car. The pros and cons of substituting old cars for new ones have been outlined in the section above. The scrapping bonus will now be discussed specifically. When choosing to scrap an old car a one time cash bonus is paid to the former car owner. Relatively it has become more expensive to own an old car, depending on people's preferences some should now choose to dispense with their car.

During the economic slump in the spring of 2009 interest organisations have started to request a scrapping bonus for old cars in Sweden. Germany, France and Italy, countries that have introduced an old car scrapping bonus, have all seen their new car sale number increase during the crisis, contra wise to all other countries. This rise in demand has been ascribed to

the scrapping bonus. There are, however, countries that have introduced a scrapping bonus among the countries where sales numbers have decreased. According to the interest organisation Bil Sweden, this is not an argument to turn down the bonus. They estimate that sales numbers would have been even lower without the bonus. Swedish politicians points to the fact that a green car cash bonus already has been implemented to defend the rejection of a proposed scrapping bonus in Sweden (Bilsport, 2009-04-17).

As was mentioned in section 2.1 there has been a scrapping bonus in Sweden until 2007. In 2007 a fund was set up to pay out a larger scrapping bonus than the one that had been paid out before. The temporary bonus followed the first come, first served rule. By the time the fund was emptied 25,000 cars had been scrapped (Svt, 2009-02-08). Energy advisers warn about a risk related to grants. The reason for that is that when the government starts subsidising a good people might expect more grants and therefore await taking action to see if more things will be subsidised or receive grants (Naturvårdsverket, 2007, p 77-78). A speculation of a problem that might occur when a scheme like the scrapping fund is implemented and then taken away is that few people will be willing to scrap their old car afterwards. If they believe that there is a chance that the scrapping bonus will come back they will wait to scrap the car. The result is that there are more old cars still in use than would have been the case otherwise.

The debate over the scrapping bonus goes in two directions. On the one hand it could be a policy worth overtaking if it can be proven that it would reduce the amount of old, polluting cars on the Swedish roads. Others argue over whether it is justifiable to implement because it increases the sales of new cars in Sweden and thereby contribute to GDP growth. If the bonus is to contribute to growth of the Swedish economy the bonus would not only have to be earmarked for buying a new car but also for buying a car produced in Sweden. A possible problem is that a person owning a car old enough to qualify for a scrapping bonus might not be able to afford buying a new car. If a scrapping bonus was paid out, a second hand car might be of interest but if that is not an option maybe instead the car will never be scrapped. A bonus that was not earmarked, on the other hand, could have an effect of the opposite kind. People who would not have scrapped their old car otherwise might then decide to dispense with their car, which would mean that the risk of a certain high emitting car ever being used again is abolished. A possible problem with a not-earmarked bonus, on the other hand, is that there is no control of what will be the effect of the money that is paid out. If it all goes to non-environmentally friendly consumption the effect of the bonus is diminished. If it is motivated as a stimulus for the economy it needs to be conditioned both by the buying of a

new car but also that the car should be produced in the country where the old car is scrapped. If the scheme is environmentally motivated it is enough to pay the bonus when a car is scrapped.

The car producer Renault has implemented their own scrapping bonus. When showing a receipt from a scrap dealer one gets a SEK 20,000 discount on a new Renault. Adding the SEK 10,000 cash bonus to that the total rebates when buying a new car is SEK 30,000 (Automatsport, 2009-05-09). Cars from Renault have now become relatively cheaper compared to all other brands, for those who possess a car older than ten years. When, as in this case, the scrapping bonus is implemented by a car company and not by the government financing is provided. The only downside to it might be that people might receive less benefit from their car if they feel that they need to choose a certain car type because it provides the bonus. If they would have chosen another brand in the absence of the bonus there might be a deadweight loss present. For those who would have bought a Renault anyway, consumer surplus has increased.

5 Summary

In this section the pros and cons of the four policies and their potential for efficiency will be outlined in a table.

Table 5.1 Pros and cons of the four policies studied

Policy/ Effect	Pros	Cons
Carbon dioxide tax	<ul style="list-style-type: none"> ➤ Decrease demand for fossil fuels ➤ Incentives to always further reduce use of fossil fuels ➤ Complement other policies ➤ All other emissions decrease if transport is decreased ➤ Revenue ➤ Double dividend 	<ul style="list-style-type: none"> ➤ Demand elasticity for fossil fuels low in the short run ➤ Deadweight loss ➤ Dislike → increases risk for cheating
Greens car cash bonus	<ul style="list-style-type: none"> ➤ Distorts relative prices between green and non-green cars ➤ Increase supply of better cars on 2nd hand market ➤ Encourage development of better techniques 	<ul style="list-style-type: none"> ➤ Subsidises negative externality ➤ Increases demand for a 2nd car ➤ Financing ➤ Demand for cars up → demand for fuels up
Carbon dioxide differentiated vehicle tax with tax exemption for green cars	<ul style="list-style-type: none"> ➤ Incentive to buy greener car (non-green cars) ➤ Encourage development of better techniques ➤ Revenue (taxes) ➤ Demand for new techniques → GDP up 	<ul style="list-style-type: none"> ➤ No incentive to buy greener car (green cars) ➤ No incentive to maintain car ➤ Increase demand for transport? ➤ Financing
Old car scrapping bonus	<ul style="list-style-type: none"> ➤ Relatively more expensive to possess a “bad” car ➤ Demand for new cars could mean higher GDP 	<ul style="list-style-type: none"> ➤ People get used to the subsidy ➤ Financing

6 Conclusions

After discussing and studying these four economic incentives and their potential to decrease carbon dioxide emissions from exhaust it seems that they all, although in differing extent and ways, can contribute to the objective. At the same time they also are economically justified as they provide incentives to adapt and decrease emissions, not force.

It might seem a bit odd that when trying to internalise the costs of pollutions into the market two, and partly a third, of the measures used actually subsidise the polluting actions. From the environmental point of view it might seem like the best alternative is to increase the carbon dioxide tax so much that people simply choose not to drive a car anymore. But the loss of utility from having to choose a less desirable option of transport might be bigger than the gain from decreasing exhausts emission.

While the carbon dioxide tax might have the effect that people keep their car, but using it less in the long run, the bonus might make people buy a new car and not needing to drive the car less, as a green car means less fuel consumption. As has been stated before, a potential problem with the green car cash bonus and the vehicle tax exemption is that those people owning cars that pollute the most probably can not afford to buy a new car even if the price is SEK 10,000 less. With that in mind it might actually be motivated to implement a scrapping bonus as well. If that can make people see the value of dispensing with a car that they might not use much anyway it will have positive effects. People owning cars they hardly ever drive might suddenly see the chance of getting cash for the car and scrap it without buying a new one. In this scenario the CO₂ tax is of importance as well, as higher fuel costs might be the reason that people potentially do not use a car they own much.

Although the transport sector show some improvements concerning carbon dioxide emissions it is important to remember that there are other measures working side by side with economic incentives. Swedes are, as mentioned above, environmentally enlightened. When studying incentives it is easy to ascribe improvements in emissions to these policies but some might just be due to information and the fact that people actually care about the environment and are prepared to make some sacrifices to contribute.

Counterproductive to these economic measures are both trends of having big vehicles in Sweden but also other measures going in other directions. Take the free parking and the company cars provided by many companies meaning that people do not actually have to take the fees into account.

As the discussion above has outlined, there are many potential problems with the measures. The green car cash bonus might make people buy a car without getting rid of the old one. When keeping two cars it does not matter how much better the newer car is than the older one. The result will be more pollution. There is also the energy cost of producing a new car to take into account. People that buy a car in spite of high CO₂ taxes probably see the benefits bigger than the cost of fuels, meaning that for many people it is probably justified to pay the price of driving if they have once decided to buy a car. As the carbon dioxide tax hits low income groups harder and makes these groups decrease their fuel consumption more than rich people it is probably more efficient in a poorer country as the majority of Swedes are middle class. But that is not to say that it is not efficient in Sweden. Another problem, valid for the whole thesis, is that Sweden is such a small part of the total market for cars and fuels so that even if results were successful here the total effect would be marginal.

It is difficult to implement policies that bring costs to people as it might be perceived as only costs are visible today and the benefits are for the future. This, of course, is a misperception as we have harvested the benefits of pollution for years while the costs of us doing that will be left for the future. But it shows some of the complexity concerning levying costs on households.

While the CO₂ tax will probably inhibit growth, the bonus systems may actually ignite growth. This might lead to a situation where policies like the bonuses are preferred to tax systems as they can be economically motivated. They are also probably more popular among people as they do not levy a direct cost on them. This might be problematic from the environmental point of view if it means that more cars will be on the roads and cars will be driven a lot if there are not enough taxes to inhibit that.

For economic efficiency it is equally important to evaluate all of these measures as long as they are used. If they distort a cost on society and people that is bigger than can be justified they have to be revised. From the environmental point of view it is even more important to evaluate the bonus and tax exemptions systems as they actually subsidise activities that are not entirely good. If it for example leads to more cars in use instead of cars being substituted for better cars then it is hard to justify the presence of the subsidy for environmental reasons. The main finding in this thesis, as has been mentioned several times

in the discussion sections, is that when subsidising cars in different ways the CO₂ tax is of great importance as a complement so that demand for transport over all do not increase.

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