INFLUENCING CAR BUYING DECISIONS FROM AN ENVIRONMENTAL PERSPECTIVE - A CONCEPTUAL FRAMEWORK BASED ON REAL OPTION ANALYSIS[1]

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1 INTRODUCTION

In the beginning of 2007, it has been acknowledged clearer than ever before that global warming and its devastating consequences, mainly caused by increased greenhouse gas emissions such as carbon dioxide (CO_2) which, in turn, result from an increase in the usage of fossil fuel (IPCC, 2007). Transport is a major contributor to the emissions of CO2, accounting for approximately 25% of the entire emissions within the European Union. Between 1990 and 2004, these emissions from the sector rose by 32%, seriously jeopardizing the 'Kyoto' targets. The use of private cars accounts for a major share of the negative effects. In addition, private car use also has as negative impacts on health, especially in urban areas, due to emissions of particular matter, mainly NO2, VOC and CO. Other problems caused by private car use are traffic noise, destruction of natural areas and aesthetic qualities, congestion, and traffic accidents (European Federation for Transport and Environment, 2007; Steg and Gärling, 2006; van Wee, 2006).

Nevertheless, car ownership and usage is rising continuously with numbers as high as 90% for passenger kilometres by private car per capita in Western Europe and 13% in the US between 1970 and 1990. Average domestic travel in Sweden averages 45 kilometres per individual per day for the entire population and the more than fourfold increase from 1950 can be almost completely explained by increased car use. In fact, the car accounts for more than 80% of the total daily distance of passenger travel in most European countries (Vilhelmson, 2006; Stradling, 2006).

The popularity of the car can be explained by several reasons. For many, it is simply the most attractive mode of transport, due to its convenience, independence, flexibility, comfort, speed, perceived safety and privacy. In Sweden, to travel by car means on average a time saving of 50%, compared to travel by public transportation. What is more, the car has strong symbolic appeal, which denotes social status, confidence, power and competence and might even become part of one's identity. Moreover, in many cities in the new world countries, as well as in rural areas in general, many people are dependent on the car due to land use patterns (Gifford and Steg, 2006; Vilhelmson, 2006; Gatersleben, 2006; Newman and Kenworthy, 2006).

So how can this dilemma be solved? Traffic emissions depend on the amount of vehicle kilometres, the driving behaviour and the technology of the vehicles

and fuels used (van Wee, 2006). Consequently, three different strategies exist in order to reduce the negative effects of transportation. Firstly, the number of trips and the kilometres travelled can be reduced. Secondly, a less environmental harming transport mode can be chosen (public transport, walking, cycling). Thirdly, a more environmental friendly car could be purchased. While the first two strategies have received a lot of attention in research, the latter one is considerably less discussed, both theoretically as well as empirically, even if it tends to have much greater environmental impact (Garvill et al., 2004; Stern, 2000). Although more environmental friendly cars will not be able to solve problems such as destruction of natural areas and aesthetic qualities, congestion, and traffic accidents, “it is now cleary established that if petrol-powered car fleets are replaced with alternative fuel car fleets, environmental benefits will be obtained” (Gärling et al., 2002, p. 94) and the importance of the reduction of greenhouse gas emissions make it worthwhile discussing how the car fleet can be changed towards more environmental friendly cars (Marell et al., 2004). This is the topic of this paper and is of particular interest in the Swedish context. Fuel consumption can be directly linked to the emission of CO2 and the Swedish car fleet has the highest average fuel consumption in Europe (Garvill et al., 2004; European Federation for Transport and Environment, 2007). Vlek (2006) calls for an inclusion of the supply side with regards to sustainable transport measures. This request shall be paid attention to in this paper accordingly by discussing possible measures aimed at the producers on the one hand and the consumers on the other.

The rest of the paper is structured as follows. The second section provides a discussion of whether government intervention is the only feasible way to increase the market share of environmental friendly cars. The third section provides an overview regarding the traffic demand management measures that can be used to influence consumer behaviour and the provision of green cars by manufacturers. Conclusions are presented in section 4.

2 IS GOVERNMENT INTERVENTION THE ONLY SOLUTION?

We will in this section examine the possible ways consumers, producers and government could act on the market in order to promote green car choice and whether it will be a likely outcome. Consumers can either explicitly or implicitly demand greener cars. Explicitly means in this context that consumers, for instance by means of green activist groups, organize a protest action or media campaign against polluting car models. Implicitly on the other hand means that the consumers by increased environmental concern and changed attitudes towards the importance of different car attributes can make it profitable for car producers to differentiate their products from competitors by more environmental friendly technology. Even without active participation from policy makers or producers, consumers are constantly receiving information from media and other sources about environmental effects. This environmental information can lead to changed consumer behaviour due to new information so that consumers buy more environmental friendly cars. Consumers as voters can also influence policy makers to regulate the car

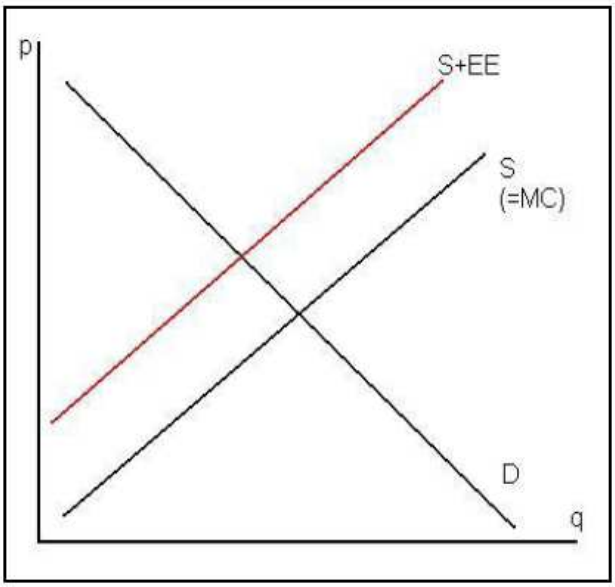
industry harder. It is in this context extremely important to remember that our societies have changed dramatically during a relatively short time span in history, for example implementing democracy and woman rights. These changes have not been initiated by governments but by movements starting in the population (bottom up).

The producers of cars can influence the choice of cars made by consumers in the first hand through the supply of environmental friendly cars. Not having an environmental friendly car in their product range makes it simply impossible for consumers to buy such a car. Producers can through advertising, either informational or emotional, try to change consumer attitudes in favour of greener alternatives. Pioneer producers of cars with green technology can try to influence the policy makers to adopt their technology as a standard and by legal regulation forcing competing producers to follow their example, to probable higher cost and without image benefits for the followers leaving the pioneer with a better market position. In the late 1980s for example, Opel succeeded in positioning themselves as a company with a positive image, showing social and environmental concern and acting responsible by being the first company to extensively using the catalyst technology accompanied by an intensive advertisement campaign (Böttger, 1996). However, early empirical studies do not find any significant impact of pioneer strategies on economic success, neither for green products in general (Ostmeier, 1990) nor green cars specifically (Böttger, 1996).

In well functioning private markets there is no need for public intervention. Nevertheless, this is seldom the case in reality. Economists define effects on the environment as an external effect, since the consumer or the producer does not take these effects into consideration when deciding about consuming or producing. Intervention in markets with strong external effects is a legitimate field of action for public policy according to economic theory.

Figure 1: Divergence between social optimum and market outcome under external effects

(S: supply; D: demand; p: price; q: quantity; EE: external effect; MC: marginal costs)



The problem with external cost is that there is too much consumption of car traffic from the society's standpoint. The social optimal level of car traffic is less than the actual market outcome observed (see Figure 1). Therefore, there is a need for government intervention in these markets. This could be done by regulation, prescribing a certain total quantity of car traffic that is acceptable. The problem is then to determine how the total car traffic quantity should be distributed in the population. Therefore, more market-based mechanisms are preferred. This will be discussed in detail in section 3.3.2.

One important reason for the lack of correlation between stated ecological preferences and norms and observed behaviour (Matthies and Blöbaum, 2006) are social dilemmas that often arise. We exemplify this problem with a game theoretic approach for green car choice. Assume a green car costs 1000 SEK more than a conventional car and that the valuation of clean air is 5000 SEK. The outcome of the decision game will yield the payoff matrix in Table 1.

Table 1: Payoff matrix for the green car choice game

		Other Consumers	
		Green car	No green car
You	Green car	4 000	-1 000
	No green car	5 000	0

If you buy a green car and no other consumer buys such a car, you pay a higher price for the green car but you receive no benefit since the adverse effects on air quality, climate etc remain (your payoff is -1000). If you choose a conventional car and the others buy a green car you will receive all the benefits but you do not have to buy the expensive green car and therefore have a 5000 SEK payoff (the free rider problem). The result is that in each individual decision problem it is optimal to purchase the conventional car, independently of what the others choose. The outcome of this game is that no green cars will be purchased, although it would be better for all consumers (and therefore for society) to coordinate actions and buy a green car. The case for government intervention is clear: subsidizing green car with 1 000 SEK will lead to an optimal outcome in the game above. The social dilemma game can also be applied to model the strategic interactions between car producers and therefore act as a possible explanation of the sticky ecological technology development in the car industry. We therefore conclude that the existence of social dilemmas and external costs in the car market necessitates public travel demand management in order to promote a greener car fleet. But it is important to keep in mind that consumers may have diverging preferences with respect to public and private solutions. For example, De Blaeij et al. (2003) find in a meta-analysis of 74 survey studies that the willingness to pay for road safety is about 80 percent higher for a private good than for a public good.

3 TRAFFIC DEMAND MANAGEMENT BY THE GOVERNMENT

3.1 Travel demand management measures evaluation criteria

This section shall provide an overview of measures in order to change the car fleet to a more environmental friendly one from a travel demand management perspective. Additionally, key evaluation criteria will be presented. Accor ding to Loukopoulos (2006) travel demand management and its definition underwent a historical development of evolutionary character from the 1960s to today. Contemporary, in the broadest sense, travel demand management can be defined as encompassing “any initiative with the objective of reducing the negative impact of the car” and “is a multifaceted, umbrella term for the collection of policies seeking to minimise the negative consequences of automobile use” (Loukopoulos, 2006, p. 5). Many different strategies and measures exist to influence these negative impacts, which can be separated into 'hard' and 'soft' ones, where the former focus on behavioural change and the latter focus on a change in norms, motivations, and perceptions (Litman, 2003; Loukopoulos, 2006; Vlek, 2003). These have three main outcome variables, namely public attitudes, political feasibility, and effectiveness, which are interdependent. Obviously, the more effective a measure to reduce the negative impacts of car use is, the greater the political feasibility. Yet, these measures might require greater change in behaviour, which, in turn, may reduce the public attitudes towards the measures. As the public can be treated similar to the voting public, their negative attitudes towards such measures will decrease the political feasibility. Yet, it should not be assumed that the more effective a measure is automatically results in lower public attitudes towards it. For example, various forms of road pricing are less popular than prohibition or road closures, due to presumed unfairness of equal treatment of various income groups in the society. The key outcome variables are in turn affected by several attributes or dimensions of the measures itself (Loukopoulos, 2006). An overview is presented in Figure 2.

Figure 2: Overview of TDM measures and their impact on outcome variables

(Source: Loukopoulos, 2006, p.6)

[Figure 2]

As presented in section 2, policymakers have influence on two main agents in the transport industry, on the one hand the producers and on the other the consumers/car owners. Accordingly, TDM measures can be aimed at either of them. These will be discussed in the following two sections.

3.2 Real option analysis

Uncertainty seems to be an important characteristic of the world we live in. Mankind in all times has had both theories to explain this uncertainty and tools to handle it. The span reaches from the Delfi oracle to modern insurance solutions. At first it was believed that the same was true for financial markets, before Black, Scholes and Fisher ingeniously in 1973 showed how to

completely eliminate the risk in a financial option. Even if their finding is now seen mainly as a pure theoretical result, not sufficiently describing real world behavior of financial markets, it has had a major impact on financial markets, massively boosting the market volumes of traded derivatives. In analogy to options based on financial assets, the idea was extended to include a company's investment possibility as an option on a real asset.

Real options take the uncertainty of the future into account and help us value the flexibility of different alternatives. A certain road may soon become obsolete because of unforeseen traffic increases, choosing a flexible alternative from the beginning might provide us with the possibility to adapt the road to a low cost, thus softening the impact of uncertainty and prolonging the roads economic lifespan.

A financial (call-) option is defined as the right but not the obligation to buy a certain asset at a certain time for a predetermined price. The real-option approach views an investment opportunity in real capital as an option: the right but not the obligation to invest a certain amount and thereby claim the future cash flows from the investment. One real option is the timing decision: we can, but we do not have to, invest immediately. The possibility of delaying the investment is a real option and the associated flexibility has a positive value if there is uncertainty about future cash flows.

In Krüger and Svensson (2009) the real option framework is extended to cover consumer choice with the motivation that major private decisions are similar to a company's investment decisions. The results suggest that there is a significant option value in the context of road safety investments and that perceived uncertainty decreases the probability to vote for the public good. Using real option analysis it is possible to identify different factors (derived from financial option valuation) affecting the option value and hence the purchase/investment decision (see Table 2).

Table 2: A comparison of financial options and real options

Financial options	Real options	Consumer real option	Impact on option value
Volatility of stock price	Volatility of future cash flows	Volatility/uncertainty about future benefits	+
Exercise price	Investment cost	Purchase costs	-
Time to expiration	Time frame for opportunity	Time frame for opportunity	+
Interest rate /Opportunity cost	Interest rate /Opportunity cost	Interest rate /Opportunity cost	?
Dividend	Value lost during options life	Value lost during options life	-
Stock price	Expected discounted cash flows	Expected utility in monetary terms	+

The option value can be seen as a threshold, necessitating that the benefits of investing or purchasing has to exceed the costs of doing so by a significant amount. Otherwise it would be preferable to wait and see if better information

resolves at least partially the uncertainty faced by the decision-maker. Hence, real option valuation can be seen as an extension to the traditional net-present-value criterion, so that the discounted net benefits should exceed the option value of waiting and not merely zero, in order to trigger immediate investment.

The option to delay the decision is one of several possible options. Other real options are the possibility to learn (also called growth option, since one project is necessary to pursue other projects that can be seen as options), the possibility to scale an operation up or down (for example, to react with respect to the business cycle), the possibility to switch (for example, to switch from one input to another) or the possibility to abandon a project earlier than planned. In fact, owners of a ethanol car have a switching option, since the fuel used can be changed if altered market conditions makes gasoline more economic for car drivers than ethanol and vice versa. The switching option makes in fact the ethanol car more valuable to consumers compared to either a pure gasoline car or ethanol car.

3.3 Influencing producer behaviour

3.3.1 Regulation

One typical government intervention is by legal means forcing producers to adopt a certain technology. Van Wee (2006) finds that “most technological changes in vehicles that reduce emissions result from regulations”. However, regulation implies often high and unevenly distributed costs for producers since they cannot react flexible enough (O’Sullivan and Sheffrin, 2006). There is furthermore lack of incentives for producers to invest in research and development for new superior 'green' technology.

Since car industries are often important for their home nations, only international (i.e. European Union) solutions are expected to succeed. The German protest against the EU proposition with regard to certain emission standards for cars can act as a good example for the difficulties that policy makers might face (Herald Tribune, 07-01-31). Car lobby groups and the number of people employed by these industries will lead to a low political feasibility of such regulation since politicians care about getting re-elected.

3.3.2 Providing economic incentives for technical innovations by car producers

It is from an economic viewpoint better than regulation to prescribe certain emission levels for cars that car producers should implement at a given point in time (O’Sullivan and Sheffrin, 2006). This provides optimal incentives for car producers to create new technological solutions for reaching this level. As Lundgren (2003) points out, such BACT-solutions (Best-Available-Control-Technology) are often advocated by several environmental regulatory agencies over the world. Especially for the producers of luxury cars this implies a necessity to increase research efforts so that their customers even

in the future can travel with high status and business class standard without affecting the environment more than in a smaller car.

3.3.3 Reducing uncertainty

Building a low emission car is for car producers a large investment combined with a high risk. According to the theory of optimal investment timing (real option analysis), it is for companies optimal to postpone their investment if there is a large unresolved uncertainty (Dixit/Pindyck, 1994). Real option theory can act as an explanation (in addition to social dilemmas) for why car producers have not yet presented more environmental friendly cars. Recent research has shown that even in the presence of green goodwill (providing incentives for environmental investments), uncertainties regarding future consumer willingness to pay for green products, regulations and competitor actions will discourage green investments (Lundgren 2003). Compared to conventional products, we identify three additional uncertainties that exist when making an investment in green technology:

- Environmental technology development (discontinuities[2], network effects)
- Environmental legal regulation
- Consumer ecological norms and preferences

In order to reduce these uncertainties and thereby inducing more investments in green technology, the government could use the following possible measures for each of these uncertainties:

- Prescribing a certain ecological technology
- Transparency and long term commitment regarding ecological policy
- Ecological information

Technological development is often characterized by unexpected materialization, rapid advancements, so-called discontinuities. A certain environmental technology may therefore in short time become obsolete, leaving car producers with a risk of timing their engagement wrong. In addition, new propulsion technologies are characterized by network effects, that is, the consumer utility derived from a car with new propulsion technology depends on the number of users (Sartzetakis, 2004). In the presence of network effects, it is necessary to have a critical mass of consumers and this in turn often leads to certain industry-wide standards. The prescription of a certain technology will therefore significantly lower the technological uncertainty for producers. As stated above, this will lead to reduced incentives to develop new technologies that are better than the existing ones. For the government this implies a trade-off between a fast adoption of existing green technologies and the development of new technologies. Transparency and long term commitment to an ecological policy will reduce uncertainty for producers and provide producers at least with a guideline of what legal regulations to expect.[3] Consumers' attitude and norms concerning environmental problems are not constant over time and even if consumers state in surveys that environmental protection is an important product attribute, the perceived importance of environmental importance has even

significantly declined under a period of time in Germany (Kuckartz, 2004). The figure below shows the stochastic evolution of the perceived importance of environmental protection in the German population over time.[4]

Figure 3: Importance of environmental protection in Germany

[Figure 3]

A public policy plan about providing ecological information and education for large groups in society may reduce producers' uncertainty with respect to future ecological preferences and norms among car buyers.

3.4 Influencing consumer behaviour

One contribution to the solution of the problems resulting from private car use initially described would be to replace an aging car fleet with new environmental friendly cars (Marell et al., 2004). How to influence the consumer towards such a replacement shall be discussed in the following part.

3.4.1 Current research

At least four studies broach the issue of environmental concerns related to purchase decisions for private cars. Marell et al. (2004) show that the intention to buy a car are influenced by a change of aspirations for a new car or of a change of the perceived quality of one's car. The perceived quality has direct negative relationship, whereas the aspirations have a direct positive relationship to replacement intentions. The authors demonstrate that amongst others the age of the car influences the perceived quality and that environmental concern affects aspirations for a new car.

One aim of the study of Garvill et al. (2004) was to examine if information about the negative effects of car use influences consumers requirements for a new car evaluations for different car sizes. The results showed that the respondents were knowledgable about the adverse effects of the car and the economic consequences of bigger cars and that this knowledge and the provided information had no influence on the purchase intentions. Rather, the respondents' requirements for their car determined which size of car would be bought, the most important ones being security, riding quality and comfort for the driver. Moreover, the group in its entirety evaluated that a compact car would fulfill their requirements less than a medium or luxury class car and that the medium and luxury class cars did not differ in the fulfillment of their requirements. Two subgroups differed on the evaluation of medium and luxury class cars. Women, single people, persons without children under 18 and persons with a low income assess that both car classes fulfill their requirements in equal measure, whereas men, married, persons with children under 18 and person with higher income levels evaluated that a car in the luxury class would fulfill their requirements better. The authors conclude that

the environmental attitude of the respondents did not have an effect on the choice of car size.

Similar results were presented by Klocke (2000) in the longitudinal mobility study of 300 adolescents and adults in Germany. Especially with the former subgroup, economical considerations explained the choice of a more environmental friendly car.
Stenman-Johansson and Martinsson (2006) show in their representative survey in Sweden that when purchasing a car, most respondents considered their own concern for status to be minor in comparison with the status concerns of others. Comparably, the majority of respondents considered themselves to be more environmentally concerned compared to others. The study provides evidence that status value as well as environment performance is important to people buying a car, and that status concerns are much higher rated than concerns for the environment, even if people do not want to admit that.

How these findings can be used in order to evaluate which measure could be effective in changing the car fleet to a more environmental friendly one is discussed in the following section, separated in transport pricing, social marketing and uncertainty reducing measures.

3.4.2 Transport pricing

In the following, transport pricing is defined as financial-economic measures which aim at reducing the negative impacts of cars. One way to achieve an environmental acceptable quantity of road traffic is to artificially create a market by issuing tradable permits. The price mechanism will then secure that the people who want to travel much will have the opportunity to do this, but they will have to pay for it by compensating the people who travel less. Another way is to internalise the external costs, for example by increasing fuel prices. Facing the true social costs of driving, people will react by reducing car travels or buying fuel-efficient cars so that the social optimal level is reached. However, even if this is social optimal, in practise some problems are likely to arise. For example, it could be difficult to estimate the true social costs since the exact effect on the climate is not known. Further, the political feasibility and public acceptance will be low, because a higher fuel price has distributional effects (Ubbels and Verhoef, 2006). One solution is to substitute tax on labour with environmental taxes, so that the net effect for most households is zero but the households have incentives to change behaviour if they have feasible alternatives at hand (Just et al, 2004).[5]

According to Schuitema (2003) the effectiveness of transport pricing in order to influence transport behavior might be overrated by classical economists as being the most effective measure. However, this might be different for the purchase of a new car. Klocke (2000) demonstrates that economical attributes of the car rather than its environmental friendliness are the main reasons for buying a smaller, and therefore environmental friendly car. Consequently, fuel tax increases, gas guzzler taxes, feebates, efficiency-based annual

registration fees and scrapage programmes (Victorian Transport Policy Institute, 2007) could lead to the purchase of more environmental friendly cars. For an overview and brief explanation of the measures, see Table 2.

Table 2: Overview and description of transport pricing measures (Adapted from: Victorian Transport Policy Institute, 2007)

Measure	Brief explanation
Fuel Tax Increases	Over the long term fuel tax increases encourages motorists to choose more fuel-efficient vehicles. “A 10% price increase typically reduces fuel consumption by about 3% within one year and 7% over a five to ten year period. About one-third of the long-term energy savings result from reduced driving, and about two-thirds results from consumers shifting to more fuel-efficient vehicles.”
Gas guzzler taxes	“A Gas Guzzler Tax is a special tax on the purchase of new vehicles based on their fuel consumption rates, to encourage the manufacture and sale of more fuel-efficient vehicles.”
Feebates	“Feebates are a surcharge on the purchase of new fuel inefficient vehicles, with the revenue used to provide a rebate on the purchase of fuel-efficient vehicles.”
Efficiency based annual registration fees	“An annual vehicle fee based on a vehicle’s fuel efficiency rating (NRT, 1998). This can be implemented by modifying the structure of existing vehicle registration fees rather than imposing a new fee. These may induce some motorists to purchase less polluting vehicles.”
Scrapage programmes	“These programs involve the purchase and disposal of older, higher-emitting vehicles. [...] Such programs can be set based on vehicle age (i.e., vehicles must be 15 years or older), or vehicles that fail an emission test could qualify. There are potential problems with such programs, since many of the vehicles may be scrapped soon anyway, and some residents may even purchase an older vehicle from another region so it can be purchased through the program.”

The effects of transport pricing with regards to car ownership will typically occur in the long term (Steg and Schuitema, 2006). According to these authors a wide range of factors appear to be related to the acceptability of transport pricing, which is only briefly summarized here. An important precondition may be problem awareness. Moreover, transport policies are evaluated as more acceptable by people who are especially concerned about the environmental problems of car use compared to those who are more concerned about congestion. When the policies threaten people's freedom of choice and are perceived to be unfair, they are evaluated as less acceptable, while acceptability is higher when people believe the transport policies will be effective and benefit themselves. Low trust levels in governments can also negatively affect acceptability. Concerning the level of price increase, it can be stated that policies are most acceptable when they are sufficiently high to reduce problems, without affecting one's own preferred travel behavior. Another influencing factor is revenue allocation. Acceptability increases when revenues are allocated within the same domain. Policymakers are reluctant to implement transport pricing policies, as it is believed that such measures will decrease individual's quality of life. This does not have to be the case however. Consequently, policymakers seem to underestimate the support for these measures, similar to car users themselves, “who, on average, indicate they find transport pricing more acceptable than does the general public” (Steg and Schuitema, 2006, p. 10).

3.4.3 Social marketing

Social marketing is “the adaptation of commercial marketing technologies to programs designed to influence the voluntary behaviour of target audiences to improve their welfare and that of the society of which they are part” (Andreasen, 1994) and uses for example, communication and education (Thørgersen, 2006). According to Thørgersen (2006), plenty of evidence documents the effectiveness of the measure in TDM. It could be used to persuade people to purchase a more energy efficient and hence more environmental friendly car. Although Garvill et al. (2004) show that the provided information did not affect the purchase intentions, it could have been due to which information was provided. They suggest that car owners should be informed about that a car in the medium size class is as collision safe and comfortable as a car in the luxury class and therefore fulfilling their needs, so that they would choose a smaller car. Similarly, information about that a car in a compact car class is as collision safe and comfortable as a car in the medium class, could make car buyers choose a compact car and hence choosing a more environmental friendly car. In this way, social marketing would be based on a thorough understanding of “customers'” needs and wants as suggested by Thørgersen (2006).

While social marketing measures can be expected to be more acceptable by the public due to their voluntary character, their effectiveness remains uncertain (Thørgersen, 2006). Similarly, the requested change of type of information as brought forward by Garvill et al. (2004) seem doubtful, especially when considering the high status value of the car (Stenman-Johansson and Martinsson, 2006). Even if car owners would be convinced about similar comfort and security levels of compact and medium-sized cars, as well as luxury and medium-sized cars, they will probably still buy the bigger car due to the higher perceived status such a car brings with itself. Due to the uncertain effectiveness, political will to implement social marketing measures can expected to be low.

3.4.4 Reducing uncertainty

Applying real option analysis (Dixit/Pindyck, 1994) yields important environmental policy conclusions. The main conclusion as described above is that investments should be postponed if there is a large degree of uncertainty. Applying theories from psychology, one could argue that cognitive dissonances may play a role: contradictory information (e. g. research results) leads to tensions and consumers will search for strategies to relief this tension like ex-post rationalisation (e. g. finding a good reason not to act according to ones ecological norms) (Kröber-Riel/Weinberg, 1996). Kahneman and Tversky (1984) find that consumers prefer the status quo if they expect an uncertain outcome of a change. Interpreting the above findings, we can conclude that consumer will tend to delay a purchase decision or buy a

conventional car if there is extensive uncertainty regarding environmental cars. These uncertainties can be categorised as:

- Technological uncertainty (discontinuities, network effects)
- Informational uncertainty
- Uncertainty regarding the ecological effects

Uncertainty for the consumers can either be of pure technological character ('Is E85 good for the climate?') or of informational character ('Can I believe in that this car really has lower CO2 emissions as the manufacturer claims?'). The latter problem arises since the information is asymmetrically distributed among buyers and sellers, and this has been identified as important reason for not buying ecological products (Bänsch, 1993). Therefore, one could argue that public policy should focus on decreasing uncertainty so that producers invest faster in new green technology and consumers (assuming that a car purchase for consumers are similar to an investment) purchase greener cars. The actual discussion about E85 shows the disagreement about whether it really is more beneficial than conventional fuel, which provides either a rational reason (real option theory) or psychological reason ('good excuse') for not buying a greener car. A possible solution is the certification of green cars by an independent part to give a trustworthy signal about the ecological qualities and reduce informational uncertainty for consumers (Kuhn, 1999). As discussed above, there is increased uncertainty for consumers because of the network effects present in propulsion technologies. Consumers want a propulsion technology that many others use, since only this will guarantee a high service level and availability of fuel (Sartzetakis, 2004). In order to reduce technological uncertainty the government should both provide information and communicate research results in a comprehensive way or, if there is large discrepancy between various research results, the government should simply invest into further research. Taking network effects into consideration, prescribing a certain standard and building up a network of refuelling stations for alternative propulsion technologies may be necessary.

Even if it is now widely accepted that there are adverse effects of private car use (especially since IPCC, 2007), it is still difficult to estimate the exact relationship and their consequences for peoples everyday life. Additionally, some effects are far away both on the spatial scale and temporal scale. Moreover, consumers perceive that their own behavioural change only has a marginal effect on environmental quality. It is therefore important to focus on other impacts from cars on the environment which are less uncertain and closer to individual car usage. Research has demonstrated health impacts of particle emission (Vägverket, 2004) and noise (Miedema, 2006). Is has been shown that there are more emergencies caused by problems with the heart and lungs under certain conditions due to high emissions from car traffic. The following list summarizes the proposed measures for uncertainty reduction among consumers:

- Better communication of research results or further research
- Ecological certification of cars
- Focus on impact of car emissions on health

4 CONCLUSIONS

The current transportation system in OECD countries as well as in other countries in the world are not sustainable and constitute a prime example for a social dilemma, in which a conflict arises between a set of common interests like public health or living environments, and numerous individuals like getting to work fast and comfortable. In order to find a sustainable balance between individual and collective interests, and thereby solving the social dilemma, different strategies might be applied. Changing the car fleet into a more environmental friendly one is one of them (Vlek, 2006). The aim of this paper was to provide an overview of measures of how to achieve this and to briefly evaluate them according to key outcome variables. We find that social marketing measures although very likely to achieve rather positive attitudes in the public, has a low political feasibility due to their uncertain effectiveness and the high status value of cars. Transport pricing is a more promising approach; however it takes considerable time until the full effect is materialized. One reason for slow adoption of green cars by consumers are different kinds of uncertainties. Therefore we advocate measures to reduce this perceived uncertainty like certification, better communication of research results, and focus on health impacts. Considering the supply side, we find that it is promising to focus on prescribed emission levels per car and inducing green investments by reducing uncertainty via clear long term emission targets for car producers. When aiming for technology improvements, the 'rebound effect' needs to be taken into account. Advances in technology “may be offset by greater driving amongst individuals who feel they can drive more given the fact that their driving is not as harmful or fuel consuming as was once the case” (Loukopoulos, 2006). As a result, in order to assure effective environmental protection and a sustainable transport system, psychological as well as technological measures need to intertwine (Klocke, 2002).

Bibliography

Andreasen, A. R. (1994) Social marketing: Its definition and domain. **Journal of Public Policy & Marketing**, **13** 108-114.

Bänsch, A. (1990) Marketingfolgerungen aus Gründen für den Nichtkauf umweltfreundlicher Konsumgüter, **Jahrbuch der Absatz- und Verbrauchsforschung**, **36** 360-379.

Böttger, M. (1996) *Einführung ökologischer Produkte: Timing-Strategien - dargestellt am Beispiel der Automobilindustrie*, Frankfurt am Main.

de Blaeij, A., Florax, R. J. G. M., Rietvald, P. and Verhoef, E. (2003) The value of statistical life in road safety: a meta-analysis, **Accident Analysis & Prevention 35** (6) 973-986.

Dixit, A. K., Pindyck R. S. (1994) *Investment under Uncertainty*, Princeton University Press.

Just, R. Hueth, D., and Schmitz, A. (2004) *Welfare Economics of Public Policy*, Elgar.

Gärling, T., Gärling, A., & Loukopoulos, P. (2002) Forecasting psychological consequences of car use reduction: a challenge to an environmental psychology of transportation. **Applied Psychology: An International Review**, **51**, 90-106.

Garvill, J., Marell, A., Nordlund, A. (2004) Att påverka den svenska bilparken i miljövänlig riktning. Effekter av information och bakgrundsvariabler. Arbetsrapport, Transportforskningsenheten, Umeå universitet.

Gatersleben, B. (2006) Affective and Symbolic Aspects of Car Use, in: Gärling, T. and Steg, L. (Eds.), *Threats from Car Traffic to the Quality of Urban Life: Problems, Causes, and Solutions*, ELSEVIER, Amsterdam.

Gifford, R. and Steg, L. (2006) The Impact of Automobile Traffic on Quality of Life, in: Gärling, T. and Steg, L. (Eds.), *Threats from Car Traffic to the Quality of Urban Life: Problems, Causes, and Solutions*, ELSEVIER, Amsterdam.

Herald Tribune (2007) Retrieved from http://www.theherald.co.uk/, February 20, 2007.

IPCC (2007), *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Klocke, U. (2000), Bedingungen umweltrelevanter Mobilitätsentscheidungen: Umweltschutz durch staatliche Maßnahmen, bei der individuellen

Verkehrsmittelwahl und beim Autokauf, in: W. Scholl & H. Sydow (Eds.) *Mobilität im Jugend- und Erwachsenenalter*, Waxmann, Münster.

Kroeber-Riel, W. and Weinberg, P. (1996) *Konsumentenverhalten*, München.

Kuckartz, U. (2006), Umweltbewusstsein in Deutschland - Ergebnisse einer repräsentativen Bevölkerungsumfrage, www.umweltbewusstsein.de

Kuhn, M. (1999) Green Lemons: Environmental Labels and Entry into an Environmentally Differentiated Market under Asymmetric Information, in: *Thünenreihe Angewandter Volkswirtschaftstheorie*, Working Paper No. 20, Rostock.

Krüger, N. and Svensson, M. (2009), The Impact of Real Options on Willingness to Pay for Mortality Risk Reductions, **Journal of Health Economics**, **28** (3) 563-9.

Litman, T. (2003) The online TDM encyclopedia: mobility management information gateway. **Transport Policy**, **10** 245-249.

Loukopoulos, P. (2006), A Classification of Travel Demand Management Measures, in: Gärling, T. and Steg, L. (Eds.), *Threats from Car Traffic to the Quality of Urban Life: Problems, Causes, and Solutions*, ELSEVIER, Amsterdam.

Lundgren T (2003), A Real Options Approach to Abatement Investments and Green Goodwill, **Environmental and Resource Economics**, **25** (1) 17-31.

Marell, A., Davidsson, P., Gärling, T. och Laitila, T. (2004) A Panel Study of Factors Affecting Households'. Replacements of the Old Car. *Journal of Retailing and Consumer Services* Vol. 11, p. 1-8.

Matthies, E. and Blöbaum, A. (2006), Ecological Norm Orientation and Private Car Use, in: Gärling, T. and Steg, L. (Eds.), *Threats from Car Traffic to the Quality of Urban Life: Problems, Causes, and Solutions*, ELSEVIER, Amsterdam.

Miedema, H. M. E. (2006) Adverse Effects of Traffic Noise, in: Gärling, T. and Steg, L. (Eds.), *Threats from Car Traffic to the Quality of Urban Life: Problems, Causes, and Solutions*, ELSEVIER, Amsterdam.

Newman, P. and Kenworthy, J. (2006), Sustainable Urban Form: Transport Infrastructure and Transport Policies, in: Gärling, T. and Steg, L. (Eds.), *Threats from Car Traffic to the Quality of Urban Life: Problems, Causes, and Solutions*, ELSEVIER, Amsterdam.

O'Sullivan, A. and Sheffrin, S. M. (2006*) Economics – Principles and Tools*, Pearson Prentice Hall.

Ostmeier, H. (1990), *Ökologieorientierte Produktinnovationen: eine empirische Analyse unter besonderer Berücksichtigung ihrer Erfolgseinschätzung*, Frankfurt/Main u.a.

Sartzetakis, E. S., Tsigaris, P (2004) Network Externalities: Adoption of Low Emission Technologies in the Automobile Market.

Schuitema, G. (2003), Pricing policies in transport, in: Hendrickx L., Jager, W. and Steg, L. (Eds.), *Human decision making and environmental perception*. Groningen: University of Groningen, Department of Psychology.

Steg, L. and Gärling, T. (2006) Introduction, in: Gärling, T. and Steg, L. (Eds.), *Threats from Car Traffic to the Quality of Urban Life: Problems, Causes, and Solutions*, ELSEVIER, Amsterdam.

Steg, L. and Schuitema, G. (2006) Behavioural Responses to Transport Pricing: A Theoretical Analysis, in: Gärling, T. and Steg, L. (Eds.), *Threats from Car Traffic to the Quality of Urban Life: Problems, Causes, and Solutions*, ELSEVIER, Amsterdam.

Stenman-Johansson, O. and Martinsson, P. (2006), Honestly, why are you driving a BMW?. **Journal of Economic Behavior and Organization**, **60** 129-46.

Stern, P. C. (2000) Toward a coherent theory of environmentally significant behaviour, **Journal of Social Issues**, **56**, 407-424.

Stradling, S. (2006) Determinants of Car Dependence, in: Gärling, T. and Steg, L. (Eds.), *Threats from Car Traffic to the Quality of Urban Life: Problems, Causes, and Solutions*, ELSEVIER, Amsterdam.

T+E European Federation for Transport and Environment AISBL (2007) Regulating fuel efficiency of new cars – Background Briefing. Brussels.

Thørgersen, J. (2006) Social Marketing of Alternative Transportation Modes, in: Gärling, T. and Steg, L. (Eds.), *Threats from Car Traffic to the Quality of Urban Life: Problems, Causes, and Solutions*, ELSEVIER, Amsterdam.

Ubbels, B and Verhoef, E (2006) The Economic Theory of Transport Pricing, in: Gärling, T. and Steg, L. (Eds.), *Threats from Car Traffic to the Quality of Urban Life: Problems, Causes, and Solutions*, ELSEVIER, Amsterdam.

Vägverket (2004) Vägdamm och grova partiklars effekter på befolkningens hälsa, Vägverkets publikation 2004:136.

van Wee, B. (2006) Environmental Effects of Urban Traffic, in: Gärling, T. and Steg, L. (Eds.), *Threats from Car Traffic to the Quality of Urban Life: Problems, Causes, and Solutions*, ELSEVIER, Amsterdam.

Victoria Transport Policy Institute (2007) Online TDM Encyclopedia RetrievedMay 19, 2007, from http://www.vtpi.org/tdm/.

Vilhelmson, B. (2006) The Use of the Car - Mobility Dependencies of Urban Everyday Life, in: Gärling, T. and Steg, L. (Eds.), *Threats from Car Traffic to the Quality of Urban Life: Problems, Causes, and Solutions*, ELSEVIER, Amsterdam.

Vlek, C. (2003) Motorised Transport as a Commons Dilemma, "Hard" and "Soft" Strategies for a Sustainable Balance, report of OECD workshop on 'The role of soft measures in achieving Environmentally Sustainable Transport (EST)'.

Vlek, C. (2006) Societal management of Sustainable Transportation: International Policy Review, Commons Dilemmas and Solution Strategies, in: Gärling, T. and Steg, L. (Eds.), *Threats from Car Traffic to the Quality of Urban Life: Problems, Causes, and Solutions*, ELSEVIER, Amsterdam.

Notes

[1] We would like to thank Tommy Gärling and seminar participants at Karlstad University for useful comments.

[2] Boettger (1996) identifies technological discontinuities as an important risk for pioneer suppliers of green cars.

[3] This is in line with the demands from the European Federation for Transport and Environment about clear long term targets for 2016 and 2020 for the car industry (T+E, 2007)

[4] According to the 2006 survey the importance has increased to 25%.

[5] In addition this will promote labour market efficiency.