Carbon valuation in the transport sector: Reflections on the Swedish case

Jamil Khan, Environmental and Energy Systems Studies, Lund University

P.O. Box 118, 221 00 Lund, Sweden

jamil.khan@miljo.lth.se

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Abstract

Cost-benefit analysis is an important tool for decisions in infrastructure and transport planning. One effect that is calculated in cost benefit analysis is climate effects and for this it is necessary to make valuation of the social cost of carbon. There are different ways to calculate this cost and there is no consensus on what method to use. In Sweden the social cost of carbon that is used in cost benefit analysis in the transport sector is based on the Swedish carbon tax on fossil fuels which today is 1.14 SEK/kg CO2 (or approx. 114 €/tonnes CO2). Within economics there is a longstanding discussion on how to calculate the social cost of carbon, while the question has not been studied from a broader social science perspective.

The aim of this paper is to analyse how the valuation and use of the social cost of carbon can be understood from a political science perspective, and whether it can contribute to effective climate policies. Furthermore, the paper will discuss whether cost benefit analysis is a suitable method to assess the appropriateness of transport infrastructure (at least from a climate perspective), since climate effects have a marginal impact on calculation outcomes. The paper addresses three questions:

- To what extent can the present carbon valuation in Sweden, based on the carbon tax, be seen as a reflection of the current political estimation of the carbon value?
- To what extent does the present carbon valuation affect the outcome of cost benefit analysis, and how important is the cost of CO2 emissions in the calculation?
- How can the long term effects of CO2 emissions on the environment and on society be considered differently in transport and infrastructure planning?

The first question is analysed through a text analysis of three governmental reports on carbon tax in Sweden, from three different years (1989, 2009, 2016), where the focus has been to understand the motivations behind the level of the carbon tax and to what extent the level of the tax is linked to an estimation of the social cost of carbon. The conclusion is that the level of the tax is not linked to an estimation of the cost of carbon but rather to an estimation of what is needed in order to reduce emissions. Furthermore, other considerations are also important when the level of the carbon tax is decided, such as secondary effects, acceptance of the tax and interaction with other policy instruments.

Questions two and three are analysed mainly through a review of earlier literature and research. For question two, it is concluded that level of the carbon value tends to have a limited impact on the outcome of cost benefit analyses in the transport sector since other costs and benefits (e.g. travel time savings) have a comparatively higher value in the calculations than the costs of climate change. For question three, it is concluded that if climate concerns are to be given higher priority in decision making in the transport sector than today it is necessary to develop alternative planning approaches as a complement, or counterweight, to traditional cost benefit analysis. Two such approaches are to use climate scenarios as the basis for cost benefit analyses, and to specify climate and environmental criteria for projects that should be assessed separately from the cost benefit analysis and be given higher priority.

Key words: cost benefit analysis, climate effects, carbon price, transport planning, infrastructure

1. Introduction

Socio-economic cost analysis or cost-benefit analysis (CBA) is an important decision support in transport and infrastructure planning. The aim of cost-benefit analysis is to evaluate and compare all the effects of a measure in order to find out if the measure is socio-economically profitable, or to compare different measures with each other.

One of the effects that are measured in a cost-benefit analysis is climate effects and in order to do this it is necessary to make an estimation of the carbon value, that is, the cost of emitting CO2, which is measured as €/tonne or $/tonne (in Sweden SEK/kg CO2 is used). There are however different ways to estimate the carbon value and there is no consensus on which carbon value is the right one to use. In Swedish transport and infrastructure planning a carbon value of 1.14 SEK/kg CO2 (approx. 131 US$/tonne) is used, which is based on the current level of the Swedish carbon tax on fossil fuels (Trafikverket 2016a, 2016b). The carbon value has been decided by the Swedish Transport Administration through a working group called ASEK, which has as its task to recommend calculation values and analysis methods for cost benefit analysis in the transport sector (Trafikverket 2016a). Within the field of economics there is an ongoing discussion on the correct level of the carbon value and whether it is right to use the carbon tax as the calculation value for CO2 emissions.

However, the issue of carbon valuation, and the use cost-benefit analysis to consider climate effects, needs to be discussed from a broader perspective than a strictly economic one. The aim of this paper is to analyse how the use of carbon valuation as a decision support can be understood from a political science perspective, and whether it can contribute to adequate consideration of climate effects and effective climate governance. In order to address this aim the paper analyses the following three questions:

- RQ1. To what extent can the present carbon valuation in Sweden, based on the carbon tax, be seen as a reflection of the current political estimation of the carbon value?
- RQ2. To what extent does the present carbon valuation affect the outcome of cost benefit analysis, and how important is the cost of CO2 emissions in the calculation?
- RQ3. How can the long term effects of CO2 emissions on the environment and on society be considered differently in transport and infrastructure planning?

The paper starts with introducing the concept of cost-benefit analysis and discussing how it is used in Sweden today. After this the three research questions are addressed. First, a review of three public inquiries on carbon taxation is made in order to analyse how decision makers reason on the relation between carbon tax and the valuation of the cost of CO2 emissions (RQ1). Second, a review of earlier literature is used to assess the significance of different carbon values on the outcome of socio-economic cost analysis (RQ2). Third, a discussion is carried out on the role of socio-economic cost analysis in transport planning, and how climate effects are considered today. Then two possible alternative ways to strengthen climate considerations in planning are discussed and proposed (RQ3). Finally, the main conclusions of the paper are summarized.

2. Cost-benefit analysis and carbon valuation

The aim of cost-benefit analysis is to evaluate projects and measures from the point of view of cost-efficiency (Trafikanalys 2012, s. 8). In a cost-benefit analysis the goal is to compare all effects of a project in terms of costs and benefits. To be able to do this it is necessary that the effects can be quantified and measured and that they can be given a value in monetary terms. A cost-benefit analysis thus rests on the principle that all effects can be valued monetary and that they are interchangeable with each other. If the benefits outweigh the costs the project can be said to be socio-economically profitable (Trafikanalys 2012, s. 28). The method can also be used to compare projects and measures with each other.

2.1 Cost-benefit analysis in the transport sector

In the transport sector in Sweden cost-benefit analysis is an important decision tool to decide whether policy measures and infrastructure investments should be carried out or not (Trafikanalys 2012, Trafikverket 2016a). The Swedish Transport Administration (STA) spends considerable effort to develop the methodology on cost-benefit analysis and other evaluation methods in order to improve the decision support for transport and infrastructure decisions. The STA has developed a process to make an overall assessment of the effects of infrastructure investments were cost-benefit analysis has a central part. The process in short looks like this:

> The first stage is to make a *cost-benefit calculation.* First a traffic prognosis is made of the changes in traffic that the investment will lead to. Then a calculation is made of the socio-economic costs and benefits related to these changes. All effects that can be quantified and monetary valued are included in this stage, for example effects on travellers (travel time, congestion), vehicle costs, transportation costs, external effects (accidents, noise, emissions), and investment costs.
>
> The next stage is to complement the cost-benefit calculation with a *cost-benefit analysis*. Some effects are deemed not possible to quantify or give a monetary value (e.g. effects on natural habitats or cultural environments, and barrier effects). These are instead described in qualitative terms. The STA thus differ between what the call a cost-benefit calculation (strictly monetary) and a cost-benefit analysis (includes non-monetary effects).
>
> In a last stage an *overall assessment* of effects is made to include effects that are not covered by the cost-benefit analysis. This includes an assessment of distributional effects and to what extent the investment will contribute to the Swedish transport policy goals.

Cost-benefit analysis is an important decision tool in transport planning but not the only tool. The overall assessment implies that distributional effects and the absolute effects on the transport policy goals are considered separately. One such transport policy goal is that the transport sector should contribute to reduced climate impact, and this aspect can thus be evaluated separately for infrastructure investments.

2.2 Methods for carbon valuation

An important part of cost-benefit analysis is to quantify effects and give them a monetary value. According to economic theory, the best way to assess costs and benefits is to use market prices when this is possible. If there are no market prices for an effect, such as environmental effects, there is a need for methods to find shadow prices or fictive prices. According to a Swedish guide book on cost-benefit analysis in the transport sector the fictive price should be "a socio-economic value that reflects marginal value of the resource for its user, and/or its alternative value in the best alternative use of the resource" (Trafikanalys 2012, p. 39). Carbon emissions is an example of an effect that does not have a market value and were it is necessary to find methods to estimate a fictive price.

How to valuate carbon has been discussed for a long time in the literature on climate economics. There are three main possible methods to calculate the carbon value for usage in cost benefit analysis: the damage-cost approach, the measure-cost approach and carbon value based on climate policy instruments.

2.2.1 The damage-cost approach

In the damage-cost approach the aim is to calculate the marginal cost for the long term damage effects that carbon emissions will cause, also called the social cost of carbon (SCC). There are however a number of uncertainties connected to this approach since the long term effects of climate change are uncertain and difficult to quantify. In a calculation choices have to be made on which effects to include, were you can decide to include only more short term and certain effects (which will give a lower value) or also long term and more uncertain effects (which will give a higher value). Thera is also disagreement concerning other aspects such as which discount rate to use, how to consider loss of life in countries with different levels of income, how to account for future lives (see Trafikverket 2016b, s. 4ff for a longer discussion). Within the damage-cost approach different studies have come up with a carbon price that varies between 0.10 and 9 SEK/kg CO2, depending on what they choose to include and different methodological choices (Ackermann and Stanton 2012, Nordhaus 2014, Stern 2006, Sterner and Persson 2008, Tol 2009,). The IPCC conducted at review of the valuation of the social cost of carbon in different studies and found that there are large uncertainties:

> "Uncertainty in SCC [social cost of carbon] estimates is high due to the uncertainty in underlying total damage estimates, uncertainty about future emissions, future climate change, future vulnerability and future valuation. The spread in estimates is also high due to disagreement regarding the appropriate framework for aggregating impacts over time (discounting), regions (equity weighing), and states of the world (risk aversion)." (IPCC 2014, p.691)

The conclusion of the IPCC is that it is difficult to use the damage-cost approach to estimate a true social cost of carbon. As we shall see the same conclusion has been reached in Sweden for the carbon value used in cost benefit analyses.

2.2.2 The measure-cost approach

Another method to estimate the carbon value is to start out from the policy goals on carbon emission reductions and calculate the costs for society to reach these goals. In this way a "shadow price" for carbon can be found. To estimate the costs of carbon reduction measures you can either calculate the hypothetical tax level that would be required to reach the goal, or you can include all different types of measures and construct a marginal cost curve to reach the carbon value. The policy goals that are used can either be short term (e.g. the 2020 goals in Sweden) or long term (e.g. the 2050 goals). The longer the perspective the more difficult it will be to calculate the costs. A difference can be made between expert based and model based methods to estimate the measure costs, were the latter can be based on either technical bottom-up modelling ore economic top-down modelling. All approaches have their own methodological problems (see e.g. Grahn et al 2007, Kesicki and Strachan 2011), such as uncertainties regarding assumptions on future technical development and availability of energy sources, and the discrepancy that can exist between measure costs and the necessary levels of policy instruments in order to implement these measures, due to e.g. non-financial implementation problems and difference in socio-economic and private-economic calculation interests.

2.2.3 Carbon value based on climate policy instruments

A third method is to base the analysis not on the policy goals but rather on the actual policy instruments that are in place to reduce carbon emissions. In Sweden the main policy instruments are the EU emission trading scheme (EU ETS) and the carbon tax. The market price for carbon in the EU ETS has varied between near zero and around 0.30 SEK/kg CO2 since the system was introduced in 2005. The Swedish carbon tax has also varied and the level today is 1.14 SEK/kg CO2, which is used for fossil transport fuels and residential heating. For other areas, such as industry, the tax level is lower due to tax exemptions.

2.3 Calculation values in cost-benefit analysis in the transport sector in Sweden

In order to carry out cost-benefit analysis in a uniform and standardized way there is an ongoing work to assess and recommend method and calculation values that are to be used in the transport sector in Sweden. This work is carried out by a working group within the Swedish Transport Administration called ASEK, which continuously publishes reports with the updated calculation values. The latest report is from April 2016 and is called ASEK 6.0 (Trafikverket 2016b). The report is divided in different chapters that are devoted to calculation values for different types of effects. For example, Ch. 6 is on investment and maintenance costs, Ch. 7 on the value of travel and transportation times, Ch. 9 on traffic safety and accident costs, and Ch. 10 on noise. Chapter 12 in ASEK 6.0 is about the costs of climate effects and carbon valuation.

2.3.1 Carbon valuation by ASEK

Carbon valuation by ASEK has varied over the years, both regarding the level and the methods being used. The damage-cost approach has never been used since it has been deemed

to have too many uncertainties to be used in practice (Trafikverket 2016b). In the first report, ASEK 1, the carbon tax on transport from 1995 was used (which was 0.38 SEK/kg in 1997 price level). In ASEK 2 a shift was made to calculate the marginal measure-costs to achieve the short term goal of CO2 emission reductions for the transport sector, which stated that CO2 emissions for the transport sector in 2010 should be equal to the level of 1990. Based on this a carbon value of 1.50 SEK/kg CO2 was calculated. This method was used also for ASEK 3 and 4. In ASEK 5 a shift was made back to base the carbon value on the carbon tax, this time the carbon tax on vehicle fuels which at the time (2012) was 1.08 SEK/kg CO2 (in 2010 price level) (Trafikverket 2016b).

The recommendation in the latest report, ASEK 6.0, is to use the current carbon tax level for the carbon value, which is 1.14 SEK/kg CO2 (in 2014 price level). The carbon value should be increased by a growth factor of 1.5% per year. A recommendation is also made to use a higher carbon value for sensitivity analysis of 3.50 SEK/kg CO2 (2014 price level).

The main motivation to use the carbon tax for the carbon valuation is that "the carbon tax can be seen as a reflection of the political goal regarding the reduction of CO2 emissions" (Trafikverket 2016b, p.7). In the report a discussion is made whether the market price for carbon in the EU ETS would be a better base for the carbon value, but it is argued that this price is too low to be of relevance. Instead the Swedish carbon tax is used and it is argued that this better reflects the political ambitions in Sweden. Possible weaknesses with using the carbon tax as the valuation base are discussed in the report. On the one hand, the value can be too high since part of the tax could be fiscal and not only designed to curb emissions. On the other hand, the value can be too low since other policy instruments could also be included, such as the carbon part of the vehicle tax and the subsidy to environmental cars. In the end the report concludes that the carbon tax is a reasonable value to use (Trafikverket 2016b).

The carbon valuation by ASEK has been discussed from an economic point of view and has been criticized for being both too high and too low (see Riksdagen 2015, pp.57-58 for a discussion). Some observers argue that the carbon valuation should be based on the price of emission allowances in the EU ETS (which has varied between 0.05 and 0.30 SEK/kg CO2) since Sweden operates under this system. Others argue that the carbon value should be much higher since it is more reasonable to use the damage-cost approach and include all long term and uncertain effects of climate change. In this paper we do not engage in a question whether the current level of carbon valuation is correct. Instead we want to scrutinize the question of what the carbon tax really reflects in relation to the political ambitions on climate change and CO2 emission reductions.

3. Is the carbon tax a valid reflection of the current political estimation of the carbon value?

In ASEK 6.0 the carbon tax is used to define the calculation value for CO2 emissions that are used in cost-benefit analysis. The main motivation that is given is that it reflects the current political ambitions on CO2 emission reductions, and thus the current political estimation of the carbon value. It is important to note that the choice to use the carbon tax is made since

other methods to value carbon are deemed not suitable or possible to use. There is no claim that using the carbon tax is the ideal method to estimate the carbon value, or that it reflects the "true" costs of CO2 emissions. But there is a claim that the carbon tax gives a correct picture of the current political estimation of the cost of carbon, and that it therefore is the best figure we can use to make uniform calculation on the costs of CO2 emissions. In this perspective there is an openness that the carbon value can shift if the political ambitions shift, in this case if the carbon tax in increased or decreased.

The question that arises, and that this chapter addresses, is whether it is valid to view the carbon tax as a reflection of the political estimation of the carbon value? If not, which other concerns might also influence the level of the carbon tax?

It is not possible to give a clear answer to this question but it is possible to critically discuss and problematize the connection between carbon tax and carbon valuation. The method used is a close reading of three public inquiries, from three time periods, were the carbon tax has been discussed and proposals have been made on its level. We have looked at the principals that have been used to design the carbon tax and how the proposed level has been motivated. The following inquiries are included.

- SOU 1989:93 *Ekonomiska styrmedel i miljöpolitiken. Energi och trafik*. [Economic policy instruments in environmental policy. Energy and transport.] This was the first governmental report were a carbon tax was proposed. The report was used as a basis for the introduction of the carbon tax in Sweden in 1991.
- Ds 2009:24, *Effektivare skatter på klimat- och energiområdet*. [More effective taxes in climate and energy] This was the latest major inquiry on carbon taxes that has led to policy legislation. The inquiry was made by the Ministry of Finance and discussed the principal grounds for carbon taxes and how the current level can be motivated.
- SOU 2016:47 SOU 2016:47 *En klimat- och luftvårdsstrategi för Sverige* [A climate and clean air strategy for Sweden] This is the latest public inquiry made by parliamentary working group on environmental policy, which consists of a majority of the political parties in the parliament. The proposals of the inquiry are at present in the process to be converted into legislation. In the report there are general discussions on the carbon tax and more specific reasoning on how it should be developed in the future.

The three inquiries discuss to various degrees the principals for how to design carbon taxes and which considerations to take when the level of the carbon tax is determined. In the inquiry from 1989 there was a fairly long general discussion which is because this was the first time a carbon tax was discussed and no such tax existed at the time. In the inquiry there is also a detailed discussion on the level of the carbon tax and the motivations behind this. In the inquiries from 2009 and 2016 there are not the same general discussion since the carbon tax has been well established in Sweden for many years. Still there are some principal discussions also in these inquiries. The main text on the carbon tax is devoted to more specific questions such as how to determine the exact level of the tax.

Based on the three inquiries we shall cover five aspects on the considerations that are made to decide the level of the carbon tax. These aspects can be summarized in the following statements:

1. The level of the carbon tax is determined in relation to climate policy goals on emission reduction in the short and middle term.
2. The level of the carbon tax is not determined in relation to the environmental damage caused by CO2 emissions.
3. The decision makers do not see the carbon tax as the only policy instrument to reach climate goals, and other instruments are mentioned as important.
4. Other concerns, apart from the steering effect of the tax, are considered when the level of the carbon tax is determined.
5. Other factors not covered in the inquiries can influence the level of the tax.

Below each of the five aspects is discussed in more detail.

3.1 The level of the carbon tax is determined in relation to climate policy goals on emission reduction in the short and middle term.

In all three inquiries it is clear that the carbon tax is put in relation to the climate policy goals in Sweden. An important factor in deciding the level of the tax is that it should contribute to reaching the emission reduction goals in the short and middle term. The inquiry from 1989 does not relate to any specific goals but it is clear that the view is that the carbon tax should be designed to reach the climate goals.

> ”The level of the tax should […] be set so that the tax contributed to the reaching of environmental policy goals” (SOU 1989:93, Ch. 12.1.3)

The inquiry from 2009 relates specifically to the goal of 40% reduction of CO2 emissions in the non EU ETS sectors to 2020 (compared to 1990).

> “The level of the carbon tax should, apart from an annual adjustment according to the consumer price index, in the future be adjusted in an amount and pace that together with other changes of economic policy instruments gives a combined reduction of the greenhouse gas emissions outside the EU ETS of 2 million tonnes to 2020[1].” (Ds 2009:24, p.146)

In the inquiry from 2016 the carbon tax is related to the suggested goals for 2030 of 63% reduction of emissions in non EU ETS sectors (compared to 1990) and 70% reduction in the transport sector (compared to 2010).

> “The level of the carbon tax should in the future be adjusted in an amount and pace that together with other changes in policy instruments give a cost efficient reduction of greenhouse gas emissions in the non EU ETS sector, so that the goal for 2030 is reached” (SOU 2016:47, p. 157)

[1] This is equal to a 40% reduction compared to 1990.

It should be noted that the inquiries do not relate the carbon tax to the long term climate goals, for example the goal of no net reductions of greenhouse gases by 2050 (for the inquiry in 2009) and 2045 (for the inquiry in 2016). The idea is probably that the short to midterm goals (2020 and 2030) are seen as steps on the path to the long term goal and that the carbon tax therefore should steer towards the short term goals.

The conclusion is that there is a clear intention of the decision makers that the carbon tax should be determined at a level that is high enough to reach the climate goals on emission reductions in the short and middle term.

3.2 The level of the carbon tax is not determined in relation to the environmental damage caused by CO2 emissions.

As discussed earlier it is possible to determine the carbon value by using the damage-cost method and estimate the costs for the damage caused by CO2 emissions. In the inquiries there is a discussion that the price of carbon in principal should be determined at a level where it reflects the external costs of CO2 (i.e. the damages caused). But the inquiries state that this is not practically possible and explicitly choose not to use this method. In the inquiry from 1989 it is stated:

> "Environmental taxes should theoretically correspond to the societal costs for the environmental damage that is caused by e.g. polluting emissions […]".(SOU 1989:93, p.208)
>
> "It is however theoretically very difficult and practically impossible to calculate these costs. The cost benefit studies that have been done show results that cover very broad intervals". (ibid, p.208)
>
> "The basis for our consideration about economic policy instruments is the possibility of reduced emission, and thus not the requirement that the taxes should cover the socio-economic cost that the environmental damage causes". (ibid, p.214)

In the inquiry from 2009 a reasoning in the early part of the report goes like this:

> "Environmental taxes and other economic policy instruments […] shall *in principle* reflect so called external effects so that the households and companies consider environmental effects in a sufficient manner". (Ds 2009:24, p.133, italics added)

Apart from this statement there is, however, no discussion that the carbon taxes reflect the external effects and instead it is clearly stated that the tax is determined according to the principle of reaching the emission reduction goals.

In the inquiry from 2016 it is stated that the principle that "the polluter pays for his environmental impact has long been a guiding principle in Swedish climate policy" (SOU 2016:47, p. 107). Apart from this there is no discussion that the carbon tax should reflect external costs and the level of the tax is instead determined in relation to the emission reduction goals.

The conclusion is that the decision makers are of the opinion that carbon taxes should in principle de determined so that the reflect the actual external or societal costs of CO2 emissions, but that they for practical reasons have not set the carbon tax based on this principle.

3.3 The decision makers do not see the carbon tax as the only policy instrument to reach climate goals, and other instruments are mentioned as important.

In all three inquiries it is clear that the carbon tax is not viewed as the only policy instrument that steers, or should steer, towards the emission reduction goals. Instead the carbon tax is viewed as one of several policy instruments which in combination should lead to an achievement of the goals.

In the inquiry from 1989 a carbon tax of 0.25 SEK/kg CO2 is suggested and there is a clear reasoning that this level is not considered high enough to reach the desired emission reductions:

> "The tax levels that we suggest will not be sufficient to fully reach the environmental goals" (SOU 1989:93, p. 210)

On the contrary it was envisioned that, on the one hand, the carbon taxes would be gradually increased, and on the other hand, other policy instruments and measures would be needed. In the transport sector measures to increase public transport were specifically mentioned:

> "In the transport sector the availability of alternative transport modes is a limiting factor. We have judged that in the current situation it is, from a socio-economic and distributional perspective, not reasonable to set the taxes at such a level that the environmental goals are reached solely with the help of taxes. Therefore it is very urgent to increase the investments in public transport with low environmental impact" (ibid, p.210)

The inquiries from 2009 and 2016 do not explicitly discuss the relation between the carbon tax and other policy instruments, and there is no developed discussion regarding the question whether the level of the carbon tax is high enough to, by itself, lead to the emission reductions that are needed to reach the goals. From the two quotes presented earlier it is however clear that other policy instruments, and their role in combination with the carbon tax, are considered:

> "The level of the carbon tax should, apart from an annual adjustment according to the consumer price index, in the future be adjusted in an amount and pace *that together with other changes of economic policy instruments gives a combined reduction of the greenhouse gas emissions* outside the EU ETS of 2 million tonnes to 2020[2]." (Ds 2009:24, p.146, italics added)

[2] This is equal to a 40% reduction compared to 1990.

> "The level of the carbon tax should in the future be adjusted in an amount and pace *that together with other changes in policy instruments give a cost efficient reduction of greenhouse gas emissions* in the non EU ETS sector, so that the goal for 2030 is reached" (SOU 2016:47, p. 157, italics added)

It should be noted that the inquiries do not contain any specific discussion on how big the effect is from the carbon tax and from other policy instruments, and no attempts to quantify the respective effects of the policy instruments are made. It is only stated that the goals should be reached through a combination of policy instruments.

The conclusion is that the decision makers are not of the opinion that the carbon tax is determined at a level where it by itself will lead to the emission reductions needed to reach the goals. Instead the goals are reached with a combination of policy instruments.

3.4 Other concerns, apart from the steering effect of the tax, are considered when the level of the carbon tax is determined.

In all three inquiries there are discussions that other concerns are considered when the carbon tax level is determined, apart from its steering effect. One important general concern in all three inquiries is the international competitiveness of industry, which has led to tax exemptions on the carbon tax for industry.

Other concerns are also mentioned but there is little unity between the inquiries regarding which these concerns are. In the 1989 inquiry it is clearly stated that it is necessary to start from a lower level since it is not possible to introduce a high carbon tax from the start. It is viewed as particularly problematic for the transport sectors since there are few alternatives to petrol and diesel, and because of distributional reasons.

> "In the transport sector the availability of alternative transport modes is a limiting factor. We have judged that in the current situation it is, from a socio-economic and distributional perspective, not reasonable to set the taxes at such a level that the environmental goals are reached solely with the help of taxes." (SOU 1989:93, p.210)

In the inquiry from 2009 there is no long discussion on other concerns but it is stated that environmental taxes "should be designed with consideration of the capabilities of citizens, which means that distributional and transition effects should not be unreasonable" (Ds 2009:24, p. 133). It is further stated that:

> "If the adjustment of environmental taxes leads to considerable distributional effects it is generally better to handle the distribution effects with other measures instead of declining from adjusting the environmental taxes." (ibid, p.133)

Thus, other concerns such as distributional effects can affect the tax level but the intention is to handle these effects in other ways so that it does not affect the tax level.

In the inquiry from 2016 a number of aspects that should be considered when determining the tax level are brought up:

> "Which changes of the carbon tax that are justified should be considered continuously. Important aspects to consider are the effects of the complete climate policies, possible rebound effects, the international competitiveness of industry, how the market price for oil develops, how the international climate policy develops and which behavioural changes that occur." (SOU 2016:47 p.157)

The conclusion is that there are a number of other concerns that are considered by decision makers when the level of the carbon tax is determined. However, it is not clear exactly which these concerns are and how, and to what extent, they affect the determined level of the carbon tax.

3.5 Other factors not covered in the inquiries can influence the level of the tax.

Apart from what can be interpreted from the inquiries it is possible that other factors can influence when the level of the carbon tax is determined in the political process (following after the inquiries). Three examples of possible factors are bargaining between political parties, influence from lobby groups, and political perceptions on the public acceptance of higher taxes. It is however not possible in this study to say anything concrete about the importance of these factors, but this would require other methods such as interviews with civil servants and politicians that take part in the design of the carbon tax.

3.6 Summary

The question addressed in this chapter is to what extent the present carbon value used in Swedish transport planning, which is based on the carbon tax, can be seen as a reflection of the political estimation of the carbon value? The above reading of three public inquiries on carbon tax does not give a uniform answer to the question but the main conclusions can be summarized in the following way:

The level of the carbon tax can be seen as the political valuation of how the carbon tax together with other policy instruments can reach the short to mid-term goals (2020 and 2030). However, with the reservation that there might not be a correct assessment of whether the tax level is sufficient to reach the goals, and that other concerns can influence so that the tax is not set at the level that the decision makers really see as necessary.

The Swedish Transport Administration (2012) also admits that there are noticeable weaknesses in using a carbon valuation that is based on political decisions but that it can be necessary when no other methods are available.

> "To base the valuation on political decisions has a clear drawback since it breaches the basic welfare economic principle that individuals best determine how they value different activities. It is furthermore a kind of circular reasoning which reduces its

> informational values, if the decision support that the politicians request is based on values that comes from earlier standpoints of the politicians themselves. On the other hand it can sometimes be the only way to attain a value." (Trafikverket 2012, p.20)

Instead of trying to find the "right" value it may be better to focus on consistency in decision making, which means that the same value should be used in different decision situations so that the decisions are made on the same grounds. In this context it means that the decision makers should use the same carbon value in the transport sector regardless whether the focus is on energy efficiency of vehicles, alternative fuels or infrastructure investments. This means that the carbon value used in Sweden has no ambitions to correspond to the actual costs of CO2 emissions, it is just a pragmatic way to find a calculation value that everyone can use.

4. The importance of carbon value for the outcome of cost benefit analysis in the transport sector.

In this chapter the question of which importance the choice of carbon value has on the on the outcome of cost benefit analysis is addressed. There is a widespread view that the carbon value has a relatively small impact on the outcome of cost benefit analysis in the transport sector. Still this issue has not been studied to any large extent and there is a lack of academic studies on the topic.

In the work on the Swedish national plan tor the transport system 2014-2015, the Swedish Transport Agency, listed and analysed the sensitivity analyses that had been made for projects in the plan (Trafikverket, 2013)[3]. One type of sensitivity analysis is to use a higher carbon value of 3.50 SEK/kg CO2, instead of the regular value of 1.45 SEK/kg CO2[4]. In theory a higher carbon value should decrease the profitability of the projects (since they contribute to more CO2 emissions) while the rail project become relatively more profitable. The results of the sensitivity analyses however clearly showed that:

> "the effect of an increased carbon value on the calculated profitability was very small. For railroad investments the higher carbon value meant the a few project get very high profitability instead of high profitability. For the road investments there was a marginal effect on the weakly profitable and unprofitable projects". (Trafikverket, 2013, p.6).

The explanation why a relatively large change of the carbon value gives a small impact on profitability is that:

> "it is only newly generated traffic and shifted traffic [from other modes] as a consequence of the investment which gives net effects on the total volume of CO2 emissions. The existing traffic would emit CO2 irrespective of whether the investment is made or not. Since newly generated and shifted traffic constitutes a

[3] Sensitivity analysis from a climate perspective was made on a total of 35 projects (22 road, 12 rail, 1 sea).
[4] The reason why the regular carbon value is 1.45 SEK and not 1.08 SEK, which was the carbon tax at the time, is that the calculation is based on the value 1.08 SEK which is then increased by 1.8% in real terms over a calculation period of 40 years (Trafikverket, 2013).

> small part of the total transport volume for the projects that are evaluated, the change in CO2 emission will also be a relatively small part of the calculation results". (Trafikverket, 2013, s. 8).

In a Norwegian report that analysed the use of carbon valuation in cost benefit analysis for government investment projects, a similar result was found that the costs of CO2 emissions have a very small impact on the profitability of the projects (Holst Volden, 2013). This holds for transport projects in general and for road projects in particular. For road projects time savings constitute the main part of the monetary benefits of the project and the costs of climate effects only constitute a small part of the total benefits. In the Norwegian projects outside the transport sector are also analysed and for these the climate effects and the carbon valuation can have a larger importance. The report particularly mentions a project on carbon capture and storage (CCS) were the benefits of emission reductions had a large impact on the calculation results.

The conclusions of this chapter is that for transport projects in general and road projects in particular the cost of CO2 emissions (or benefit of reduced emissions) only constitutes a small part of the overall cost benefit results. Further, even fairly large changes in the carbon value do not have any considerable effect on the outcome of the cost benefit analysis or the profitability of projects.

5. Alternative ways to consider the effects of CO2 emissions in transport and infrastructure planning.

In the previous parts of this paper we have critically scrutinized the use of carbon value in cost benefit analysis in the transport sector and the extent to which cost benefit analysis considers climate effects. A general conclusion is that cost benefit analysis does not consider climate effects to any large degree and that it will in general not lead to a prioritization of transport projects based on climate concerns. There are several reasons for this. First, it is difficult for economic cost benefit methods to include all possible costs associated with climate emissions, which could have resulted in a higher carbon value. This has meant that, in Sweden, a choice has been made to use the carbon tax to find a common carbon value. However, this does not correspond to the "true" carbon cost, neither does it correspond to the political view of the costs of carbon, as was shown above. Furthermore, the carbon value is of limited importance and the cost of carbon has a small effect on the outcome of cost benefit analysis compared to other costs and benefits.

From an economic point of view, based on cost benefit analysis, it might be a perfectly valid conclusion that climate effects should not be valued or prioritized more in decision making. However, it is not certain that this situation is satisfactory from a broader political perspective or from the goal of reaching a sustainable transport system with low CO2 emissions.

In this chapter two issues are addressed in order to question the dominance of cost benefit analysis. First, there is a discussion of what role cost benefit analysis plays in the planning

process in relation to other considerations. Second, two alternative ways to strengthen climate concerns in the planning process are discussed.

5.1 The role of cost benefit analysis in transport and infrastructure planning today

As was previously discussed cost benefit analysis is an important part of decision making in the transport sector today, particularly when individual projects are being planned and evaluated but also in the long term infrastructure planning when a large number of projects are compared and prioritized based on different criteria. For policy instruments cost benefit analysis is also an essential part of the decision process.

Cost benefit analysis is however not the only decision support. For infrastructure projects an overall assessment of effects is made were criteria such as distributive effects and achievement of the transport policy goals are also included. It is the overall assessment that constitutes the decision base for infrastructure planning, but it is not clear how much weight the different parts of the overall assessment have.

In a study, by the traffic consultancy group Trivector, on how sustainability aspects were handled in the overall assessment of road projects in Sweden, it was found that the concept of a sustainable transport system is not wee defined and that the environmental aspects are not considered to any large extent (Trivector 2012, p.11). A consequence is that also projects that have a negative impact on the environmental aspects can be judged as sustainable in the assessment. An analysis of the Swedish national transport plan for 2010-2021 showed that there was:

> “a strong focus on calculating and presenting socio-economic effectiveness of measures in the transport system. A sustainable transport system, the other part of the transport policy goal, has been given a peripheral roll in this context”. (Trivector 2012, p. 12)

It is further shown that:

> ”In evaluations of the overall assessments in the latest transport plan it is evident that ‘sustainable transport system’ in several cases is equalled with ‘socio-economic effectiveness’. In those cases when the socio-economic profitability is positive this is generally used as a compelling argument to implement the measure. This is true even when environmental effects and other effects connected to a sustainable transport system are negative, and even though the cost benefit analysis does not consider all factors that affect a sustainable transport system”. (Trivector 2012, p.12)

Other studies have shown that the actual use of cost benefit analysis be decision makers can vary, even if it has a high priority in the rhetoric. Eliasson and Lundberg (2012) studied the actual use of cost benefit analysis in the prioritization of projects in the Swedish national transport plan for 2010-2021. The results show that the planners (civil servants) to a high degree based their prioritization of projects on the cost benefit analysis since projects with high socio-economic profitability were more likely to be included (ibid 2012). By contrast, it

turned out that the politicians do not base their decision solely on socio-economic profitability since there was a low correspondence between the investments that politicians decided on and the results of the cost benefit analysis (ibid 2012). The study showed that other concerns also play a role such as regional actors' views on which investments were important and a general tendency to prioritize infrastructure projects in bigger cities (ibid 2012). In her doctoral dissertation Karin Thoresson (2011) studied the use of cost benefit analysis in transport planning and interviewed regional planners and politicians on how they view its use. A clear result was that the politicians see cost benefit analysis as an important decision tool but state that they do not have a good understanding of the methodology behind the analysis. At the same time both planners and politicians stress that cost benefit analysis cannot, and should not, be the only decision basis but that there should be room for "local and experience based knowledge claims and political considerations and visions" (Thoresson 2011, p.208).

To conclude, cost benefit analysis can be seen as a very important decision criterion in transport planning. Still, empirical studies show that decision makers do not entirely follow the results of cost benefit analysis and there is scepticism to use it as the only decision basis. However, there is a lack of other decision basis that can be used as a complement, or counterweight, to cost benefit analysis, at least in the environmental fields. Climate and environmental aspects are represented (both integrated on the cost benefit analysis and in the transport policy goal analysis) but it has low priority in todays' planning. There is at present a lack of a stage in the decision process were climate and environmental concerns are analysed separately and given a possibility to affect the prioritization and direction of transport planning.

5.2 Alternative ways to consider climate effects in infrastructure and transport planning

In this paper there is no scope for a detailed analysis of alternative ways to give climate effects increased consideration in infrastructure and transport planning. Instead two possible methods are introduced which would have to be further developed in coming studies.

5.2.1 Use of climate scenarios for cost benefit analysis

In the previous chapter a report of the Swedish Transport Administration was referred to where they analysed sensitivity analysis from a climate perspective of cost benefit analysis of projects in the national transport plan for 2014-2025 (Trafikverket 2013). It was shown there that an increase of the carbon value to 3.50 SEK/kg CO2 only had a small impact on the socio-economic profitability of projects.

In the same report an analysis was also made of sensitivity analysis for the 21 road projects based on a different transport development than the one normally used in the forecasts of the Swedish Transport Administration (Trafikverket 2013). These sensitivity analyses were based on a climate scenario for the transport sector which accounted for a 20% decrease of car traffic and no changes in road based freight traffic (instead of an increase of both transport modes). The cost benefit analyses that were done with these conditions showed large changes in the socio-economic profitability of the projects. In the original analysis (based on

traditional traffic forecasting) 80% of the road projects were slightly profitable or better (and 63% profitable or better), while the result for the climate scenario was that 47% were slightly profitable or better (and 30% profitable or better) (ibid 2013, p.10). The reason for these large differences is mainly that the monetary benefits of the projects come from a reduction in travel and transport times, and that these benefits are heavily reduced with lower forecasts of transport development on road. The conclusion of the report is that there would be significant changes in the prioritization of projects, also from a cost benefit perspective, if climate scenarios were used as the basis for calculations instead of traditional forecasting (ibid 2013).

Today, sensitivity analysis based on lower forecasts of transport development on road, are used in Swedish transport planning, but it does not have much influence on decision making. A reform of the planning process in this direction would give higher weight to cost benefit analysis that uses climate scenarios with reduced use of car and road freight.

5.2.2 Increasing the weight of the transport policy goal analysis in the overall assessment

Another way to give higher priority to climate effects in transport planning is to increase the significance of the transport policy goals analysis in the overall assessment, and particularly make in clear what its role is in relation to the cost benefit analysis. As was shown in the study by Trivector (2012) there is today a deficiency in the handling of sustainability aspects in the overall assessment, while at the same time the cost benefit analysis is given most weight in decision making. One conclusion of the report is that there is a need for a clear and common definition of the meaning of sustainable transport system, and specified criteria for the different types of impacts, which can be applied in the same way in all assessments. For the climate aspect this could mean that a measure or project should contribute to a considerable decrease of greenhouse gas emission to be considered sustainable (Trivector 2012, p.23). Projects that do not live up to these criteria need to be motivated specifically if they are still to be implemented. A clear and common definition of sustainable transports and specified criteria would increase the importance of climate and environmental concerns in the planning process. However, this would require a clear statement from decision makers on the prioritized position of sustainability concerns and new planning routines to make it happen in practice.

6. Conclusions

The aim of this paper was to analyse the use of carbon valuation in cost benefit analysis in transport sector from a broader societal perspective and discuss if it can contribute to an effective climate policy. From the paper four main conclusions can be drawn:

- The main advantage of the carbon valuation used in Sweden today, based on the Swedish carbon tax, is that it enables a consistent valuation of the costs of CO2 in different decision situations. It is however not possible to view the carbon value as the present political valuation in Sweden of the costs of CO2 emissions. The carbon tax does not reflect the political view of the damage costs of CO2 but rather other concerns affect the level of the carbon tax.

- There are other methods to calculate a carbon values (such as the damage-cost approach and the measure-cost approach), but these are fraught with methodological problems and uncertainties which make them difficult to use in practice. Thus there is no single method that will give a “correct” value.
- The level of the carbon value tends to have a limited impact on the outcome of cost benefit analyses in the transport sector since other costs and benefits (e.g. travel time savings) have a comparatively higher value in the calculations than the costs of climate change.
- If climate concerns are to be given higher priority in decision making in the transport sector than today it is necessary to develop alternative planning approaches as a complement, or counterweight, to traditional cost benefit analysis. Two such approaches are to use climate scenarios as the basis for cost benefit analyses, and to specify climate and environmental criteria for projects that should be assessed separately from the cost benefit analysis and be given higher priority.

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