Comparison of policies for increasing sustainable transport mode shares in Swedish cities

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The EU is currently promoting sustainable mobility in its cities. This promotion can take the form of subsidies for cycling and public-transport infrastructure. This paper compares existing Swedish policy instruments for promoting more sustainable transport: government subsidies to infrastructure for sustainable modes in the form of city environmental agreements (CEAs), congestion and parking charges and a hypothetical incentive to reduce the mode share of cars. Analyses of the CEAs indicate that they do not reliably affect mode choice. The results for congestion and parking charges, on the contrary, indicate that these have a substantial potential to shift mode choices and improve welfare by pricing external costs. The outcomes of the hypothetical incentive based on achieved effects will depend on the extent to which cities are willing to use externality pricing and to which citizens are willing to change modes. The management and evaluation of this hypothetical incentive poses considerable requirements on data and estimations of a counter factual outcomes without incentives, and its necessary costs. Provided these requirements can be met, the incentive model appears to be a possible instrument for stimulating cities to move faster towards sustainable transport.

Keywords

Sustainable transport; cities; mode shares; policy

JEL Codes

R48, R49, R51, H23, H54, H71, Q5

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1 Introduction

Cities around the world have been struggling for some time to find effective and acceptable tools to improve the environment and the livability of the city. This inevitably involves coming to terms with increasing demand for car traffic. For example, two Nordic countries, Norway and Sweden, have chosen to implement state funded subsidies to stimulate cities to take action for moving towards, what is stated to be, sustainable transport; walking, cycling and public transport.

The Swedish city environmental agreements (CEA), inspired by the Norwegian City Growth Agreements (CGA) were first proposed by a Swedish commission (SOU 2013:84) and later enacted in the Act on Subsidy for sustainable city environments 2015 (SFS 2015:579). The stated goal of the CEAs is to increase the share of sustainable transport in the form of public transport and cycling and to stimulate the building of new sustainable housing (the first three years cycle infrastructure was not eligible for subsidy). However, this system covers a smaller part of city infrastructure and the amounts spent are considerably smaller than in the Norwegian system.

The introduction of the CGAs and the zero-growth target for car transport in Norway initially did not appear to have fast enough impact on the shares of car transport in cities. This inspired Norwegian researchers (Norheim et al. 2016) to thinking about more effective policies for shifting demand from car to sustainable modes and for attaining the zero-growth target for car use in Norway's largest cities (Jussila Hammes 2021). The idea came up that city regions could be stimulated by the state for moves towards the goal instead of getting new infrastructure funded by the state.

It has long been well known by transport analysts that increasing the quality and supply of public transport has smaller impact per spent euro than the corresponding social costs for implementing pricing on car use (SIKA, 1999). It is also well known that such policies are not popular among voters (e.g. Frey, 2003).

This paper is a part of a larger project[1] with the aim to study the question if local politicians would accept introducing pricing of car transport provided their municipalities were sufficiently compensated. The project has examined the willingness of Swedish and Norwegian municipal politicians and employees to introduce policy instruments that are costly to car owners, i.e. road and parking pricing. The findings (so far unpublished) are that politicians in both countries are reluctant to introduce policies that increase the costs of using cars in cities.

The aim in this paper is to compare the capacity of the current Swedish City Environmental Agreement (CEA) to congestion charges, parking charges, and a hypothetical subsidy from the state for achieved reduction in car use, to shift car use to other modes in cities[2], reduce externalities, and increase net welfare. The paper analyzes the possibilities for policies to have effects but does not present any statistical analysis of effects. The contribution of this paper is to bring together and synthesize recent evidence of the potential for different policy instruments for shifting mode shares in Swedish cities to sustainable transport and improve welfare.

The method in the paper is compilation of previous studies of CEAs, welfare optimal public transport supply, congestion charges and charges for parking. The observations from these studies are compared with respect to effects on mode choice and welfare. In addition, a policy instrument

[1] Modelling Incentive Schemes for Sustainable Urban Mobility (MISSUM) funded by the Sweden's Innovation Agency VINNOVA.

[2] The local administrative unit in Sweden is municipalities. Some municipalities contain cities and sometimes suburbs and rural areas around the city. Therefore, all Swedish cities belong to municipalities. I have therefore chosen to term cities as city municipalities.

suggested by Norheim and colleagues (2016) - a subsidy for achieved reductions in car traffic is analyzed and compared. A full examination of the hypothesis would require good measures of how the traffic and transport volumes changed and the initial marginal external effects and how these changed with changes in traffic volumes. As such data is lacking, the observations from earlier studies are used to formulate some preliminary findings on the relative merits of the four instruments.

Public transport – its design and possible trade-offs between patronage and coverage - is associated with distributive issues such as accessibility in rural areas and services for older and/or disabled persons with certain proximity and personalized needs. Furthermore, regarding city infrastructure and administrative policy instruments, there are many forms of regulations of street and parking space that can be used to influence traffic in cities. Such measures include pedestrian zones, cycle lanes, bus lanes, and parking restrictions. Further possible policies include parking taxes and tradeable parking permits. The above listed issues and the effects of such measures and their efficiency are not covered in this paper.

This paper is organized as follows. The second section summarizes important strands of literature constituting a background. The third section reviews the stated political intentions leading up to the proposal for the Swedish CEA-system and the stated goals of the system. The fourth section gathers early observations on the outcomes from the CEAs. The fifth section discusses how much welfare optimal policy instruments could contribute to reduced. The sixth presents a possible design for an incentive design to stimulate cities do take action towards sustainable transport. The seventh summarizes the comparison. The eighth section, finally, discusses and concludes.

2 Literature

This paper brings together five strands of scholarly literature. First, we present an overview of studies of welfare optimal policy instruments for cities. Second, we present the central idea from the welfare economic theory of optimal division of responsibility between national level on the one hand and lower administrative levels, regions and municipalities on the other hand, also called fiscal federalism theory. Third we present some central results from studies of acceptability of pricing of externalities primarily from car use. This leads to the fourth, where two papers analyzing political outcomes when voters influence policy are summarized. The fifth strand are Swedish studies of the CEA-system and the subsidy to transport infrastructure for public transport and cycling within the national planning of infrastructure.

Modelling of policy instruments in cities

The environmental challenges faced by cities have led researchers to ask questions about circumstances correlating with car use, congestion, air pollution and noise. The hope has been that building smarter cities can reduce car use and its negative effects making cities more attractive. A part of this literature (e.g., Ewing and Cervero, 2010; Stevens, 2017) focuses on the relationship between compactness of cities and car use. A central result was that the effect of compacting cities on car use “is generally small” (Stevens, 2017, p. 15). However, McIntosh et al. (2014) Buehler et al. (2017) and Kenworthy (2019) have argued that some European cities have successfully reduced shares of car trips, by implementing combinations of policy instruments.

Other papers developed models to analyze congestion charges and public transport fares and frequencies for large cities, for example, London and Brussels (Proost and van Dender, 2008), Washington, DC, Los Angeles, and London (Parry and Small, 2009), Paris (Kilani et al., 2014), Sydney

(Tirachini et al., 2014), and London and Santiago de Chile (Basso and Silva, 2014). There are also papers reviewing studies of interventions to reduce car use.

Graham-Rowe et al. (2011) review mostly experimental studies on quite theoretical interventions while Kuss and Nicholas 2022 review a wide range of studies of real-world trials of policy instruments. The first paper does not, however, report on how the methods used are designed to control for other factors influencing the outcomes. The latter paper reports that congestion charges are the most "effective" to reduce car use but that this policy gets assessed not be feasible. Neither, of these papers consider economic efficiency in the sense of a benefit-cost-ratio for the achieved reductions.

Swedish policy formulations frequently imply a short-term perspective where all increases of public transport use are assumed to imply a welfare improvement for the population. A welfare economic perspective acknowledges that this may indeed be so, but also that the opposite may be true. If for example a small increase in public transport demand is gained at high costs the net social benefit may be negative. It then follows that it may not suffice for the regional public transport authority to plan for a demand increase but that it may be necessary also to ensure a net welfare increase.

The stated aim of the CEA-system is to increase the mode shares of sustainable transport (walking, cycling and public transport) and reducing the share of car transport. It is still the case that the externalities[3] of car use in Swedish cities are largely not internalized[4] (Trafikanalys, 2019) while car use in rural areas is over-internalized by fuel taxes.

The lack of internalization implies a cost-efficient potential both to reduce costly externalities and to shift transport demand in a sustainable direction, by pricing these externalities in cities. Recent research suggests that there is a potential to use road and parking pricing to shift transport demand from car to walking, cycling and public transport in socially welfare improving ways in models calibrated to Swedish cities (Börjesson et al. 2017 and Asplund and Pyddoke 2021). These and other papers (Börjesson et al. 2019 and Asplund and Pyddoke 2020) have also examined the welfare optimal supply (prices and frequencies) of public transport in models calibrated to Swedish cities. These studies found that the supply of frequencies and fares sometimes were above welfare optimal level, implying that welfare could be improved by reducing both fares and frequencies.

The long run welfare effects of higher pricing of car use will be dependent on the availability of attractive long term substitution possibilities. If car users have attractive alternatives their inclination to shift will be higher. Therefore, presence of such attractive alternatives will be associated with a higher long term price elasticity of demand for car use. This in turn will imply lower welfare losses from price increases for car use than would cases with lower long run elasticities.

Studies of acceptability of policy instruments to reduce negative externalities from car use

Several studies in different countries find low levels of acceptability of road pricing or congestion charges in cities prior to implementation, and acceptance depending on design of the proposal and increasing after (Baranzini et al., 2021 and Jaensirisak et al., 2005). Baranzini et al. (2021) summarize four stylized facts on acceptability of pricing of negative environmental externalities. The first is that

[3] The term externalities is here used in the welfare economic sense of external effects. These are effects from an agent consuming a good that will also generate positive or negative effects on other agents that the first agent will not automatically consider. By increasing the price for the first agent these effects can be brought to the first agent's consideration.

[4] If full pricing of an externality cost has been achieved this cost is said to be internalized. This means that an agent causing an externality is brought to consider the costs inflicted on other agents.

the costliness of a charging system is negatively correlated with public support. Second, there is a tendency to overestimate the disadvantages of a proposed environmental tax and to underestimate the advantages. Third, the second point can have the effect that public support may increase if the policy is tried. Fourth, public support may be increased by earmarking the revenues for public transport for example, from this otherwise not popular environmental tax (Baranzini et al., 2021, p 424).

Fiscal federalism

In a comparison of CEAs in Sweden and city growth agreements (CGAs) in Norway, Jussila Hammes (2021) draws on fiscal federalism theory in conjunction with infrastructure in cities. The main idea is that services that mainly concern the inhabitants in smaller area (e.g. a city) could be handled by its local government. The importance and desire for local self-determination is expressed in the first paragraph of the Swedish constitution (Regeringsformen 1:1). When substantial effects spill over between areas, this becomes an issue and may motivate cooperation between municipalities or even intervention and funding from the national level. The national level concerns itself with issues that have the property of public good to the whole nation, e.g. defense and foreign policy. The Swedish state also includes a wide range of issues where insurance and redistribution are mixed in. In the case of roads, the national network frequently passes outside smaller cities. To the extent that national roads pass through cities in Sweden they are the responsibility of the national level. For most other roads within urban areas, these are the responsibility of the city municipality. Given these perspectives it may seem plausible that public transport and cycling infrastructure are regional and municipal concerns. It is not obvious what the national interest would be. Jussila Hammes (2021) summarizes this: “The state finances local investments [through the CEA program] that lack spatial spillovers.”

Political economy of transport policies in cities

Economists have started to take an interest in how and why politics may deviate from what appears to be welfare optimal results. In a paper on road pricing, De Borger and Proost (2012), build a stylized model to show both that a majority may accept road pricing when revenues are used to increase the supply of public transport rather than to lower taxes. The model also explains why a majority can be against before and for after. In another paper on public transport pricing and supply De Borger and Proost (2015) use a stylized model to explain some observed tendencies in public transport in Europe. They find plausible conditions where most car owners are in favor of public transport fares below marginal costs and where majorities are likely to choose decentralized systems implying increased fares. A pressure on budgets also leads to higher fares.

Studies of the Swedish city environmental agreements and similar policies

The Swedish studies of CEAs and similar policies are so far quite few. A preliminary study (Isaksson and Knaggård 2019) presents observations on the design and the results from a small number of interviews with employees. Larsson and Svensson (2021) present a compilation of data from the cities on the outcome from the CEA projects co-funded by the state. The authors, courteously but openly, admit that this has been a slow and frustrating experience. Nevertheless, they present some data and calculations. The data and corresponding calculations are mostly few and are presented as uncertain, and therefore appear to be a shaky ground for assessing the effects of the CEA-projects.

The CEA subsidy to cities is not the only subsidy to infrastructure for public transport and cycling to municipalities. The national planning of infrastructure is partly for national, generally interregional receive state funding (under law SFS 2009:237) for the building of regional infrastructure including

regional road, rail, public transport terminals, bus stops, cycling infrastructure along national roads and partial funding of public transport and cycle infrastructure in municipalities. This planning is regulated by a government directive requiring the plans to be constructed in accordance with the national transport political goals, regional system analyses, and agreements from the Swedish national negotiation on housing and infrastructure (Sverigeförhandlingen).

A review by the Swedish National Audit Office (SNAO) of the regional part of the national planning process was conducted in Riksrevisionen (2004). The aim of this review was to examine if the regional plans accorded with the directive. The findings were that the plans were designed more in accordance with regional perceptions of what was important and were well confirmed with regional stakeholders, but it was not transparent if the chosen projects were the most efficient for moving towards the national goals. In Riksrevisionen (2021) the SNAO re-examined co-funding of public transport. Again, the SNAO finds that the state government does not ensure that its co-funding of the regional infrastructure is in accordance with national transport political goal. And again, the SNAO criticizes the government for not ensuring that sufficient cost-benefit information guides the choice of projects for the plans.

3 Analysis of goals for the Swedish City environmental agreements

The design of a hypothetical incentive for sustainable transport can be informed by an understanding of the political goals of the current policies. The goals of the CEAs as proposed by the Swedish Transport Administration (Trafikverket, 2015) and stated in the legislation (SFS 2015:579) are explained on its web site (Trafikverket, 2022). This is the agency responsible for administering the CEAs. The main stated goal of the CEAs is to increase the share of sustainable transport in the form of public transport and cycling. This goal was not related to a particular starting level or goal level. The system was designed as subsidy given by the state to city municipalities for investments in infrastructure for sustainable modes to reach for the goals and in return the city municipality is required to either fund similar infrastructure or build housing. Increased supply of housing is therefore a complementary goal of the state. No requirements were, however, enacted for a minimum counter performance. It was therefore compatible with the legislation to require only a modest counter performance. In Transport Administration's proposal for the legislation (Trafikverket, 2015) it was explained that counter performances could also come in the form of policies to reduce car use. This indicates that the authors of the proposal ultimately aimed at reducing car use and CO_2-emissions.

Later national, regional and municipality assemblies in Sweden have also formulated such goals. The Swedish national goal for the share of person kilometers done by public transport, cycling and walking is that it should be at least 25 percent in 2025 (Regeringen 2018). The regional goal for Stockholm (Region Stockholm 2018) for the sustainable modes (the combined mode share of walking, cycling and public transport) is set to be at least 70 percent of person-kilometers to 2030.

A previous analysis of the goals (Isaksson and Knaggård, 2019) noted that the choice of the goal of an increased share of sustainable transport in cities was not obvious, and it was lively discussed. A problem with this formulation is that it is silent on what the goal for car transport is. The authors assess this to be due to that a stricter formulation on car use was not politically realistic by the employees of the Swedish Transport Administration. In the motivating texts the goal to reduce CO_2-emissions appears to be more important than the goal to create socially and environmentally sustainably built environments (Isaksson and Knaggård, 2019, p. 11).

This formulation of the goals of the CEA-system also avoids the issue of cost efficiency as policy instruments to reduce car use can achieve the goals at lower costs than increasing the supply of infrastructure and public transport. The prime purpose of introducing the CEA-system appears to have been to stimulate a shift from car to public transport (initially) and later also to cycling, by shifting parts of the costs for this transition from the city to the state. The Transport Administration is also bound by the Swedish national transport policy goals, of which the overarching goal is to "ensure an economically efficient and sustainable transport system for the citizens and businesses in the whole country" (prop 2008/09:93). The terms economically efficient can be interpreted in welfare economic sense as the result that maximizes the net of the value of the services minus their total costs and sacrifices needed. The sustainability part is intended to cover environmental, economic, and social dimensions. Finally, the phrase "citizens and businesses in the whole country" intends to cover a distributional aspect between different citizens and different regions. Further, all state organizations are bound by the budget law (SFS 2011:203) to be efficient.

There is therefore an apparent overlap between the purposes of the regional planning within the national infrastructure planning and the purposes of the CEA-system. In the proposal for the City environment agreements from the Swedish Transport Administration (Trafikverket, 2015) it was argued that the existing forms for co-funding of infrastructure in municipalities within the process for national planning of infrastructure is not "suitable for the intended purposes for the CEA-system" (Trafikverket, 2015 p. 13). The indicated purposes were the intention to require counter performance in terms of the construction of similar infrastructure and housing.

In addition, the Swedish parliament has decided (prop. 2016/17:146) that CO_2-emissions from domestic transport except air transport should decrease by 70 percent compared from 2010 to 2030. For the time being, agencies are expected to propose actions that makes it possible to reach the goal. The Swedish Climate Policy Council is commissioned to evaluate whether current policy is sufficient to reach the climate policy goals. A recent assessment from 2021 (Klimatpolitiska rådet, 2021, p 28) was summarized as follows. "The decrease of (CO_2) emissions in 2019 was 2,4 percent …. Is not even close to the decrease of 6-10 percent per year needed to reach zero net emissions in 2045".

There are many further initiatives and decisions stating the Swedish Parliament's goals. The listing here will be limited to three further stated goals concerning public transport, walking, cycling and housing. In 2015 the Swedish parliament decided (2014/15:TU13) that the government should contribute to preconditions such that the goal of doubling public transport ridership to 2020 could be attained. In 2018 the previous goal was substituted when the government of Sweden stated a new goal (M2018/01093), "the share of person kilometers done by public transport, cycling and walking in Sweden should be at least 25 percent in 2025 and moving towards a doubled share in the future." The third goal concerns built environment. "The overarching goal for built environment and housing is to give all humans in all parts of the country a good living environment, where a sustainable economy is promoted and where housing construction and economic growth is facilitated. The goal is also to have well-functioning housing markets in the long run where consumers demand is met by a supply of housing corresponding to needs." Retrieved from the Swedish government's web the 2022-01-11.

The ambition here is not to do an in-depth analysis and interpretation of these goals. Suffice it to say the following: Implied by these goals are several goals and directions. Economic theory tells us that markets do not automatically give politically desired results. This is true also for procured services. Economic efficiency in the sense that all services for which willingness to pay for outcomes is larger than costs will not be forthcoming without policies aiming at reaching such goals. Furthermore, distributional goals implicit in the formulation of goals in terms of social sustainability may

potentially require more ambitious means than voters and parliamentary majorities are likely to agree on.

The most pressing issue is if the CEA-legislation opens for projects that are economically inefficient in the sense that calculable benefits of chosen projects are much lower than calculable costs. This may well be the case as there are both economically inefficient projects and efficient ones. Examples are on one hand the new tramway line in Lund subsidized by the CEA-system was calculated to generate a substantial loss of welfare (Wilhelmsson et al., 2015 and Thyrén, 2015), and on the other hand Börjesson's unpublished analysis of proposed cycle infrastructure projects in Stockholm indicating many cycle projects to give welfare gains.

The issue of housing politics carries difficult goal conflicts. One the one hand, politicians want to stimulate construction of new housing and preferably for low rents and in city plans decrease car use. And on the other hand, these desires conflict with market forces caring for high income buyers and demand for detached housing creating urban sprawl. The issues of localization of housing lie close to transport planning and research and its effects have been examined. Nordic planners have argued that new housing should be located close to strong public transport corridors, preferably in apartment buildings in densely planned urban areas (Boverket 2014). While much of housing demand is for detached housing at low cost, which drives urban sprawl. The environmental planning goals, therefore, appear to clash with the desires and preferences of housing customers. So far politicians/legislators in Sweden have been reluctant to tax the externalities created by urban sprawl.

A further issue related to the possible goal conflict between stimulating housing construction and incentives for sustainable transport is that negotiated policy packages like CEAs might be designed to "getting things done". The Swedish Agency for Public Management (Statskontoret, 2022) concludes that negotiation – CEA could be labeled as a way of negotiating which measures to be co-funded (see section below) – is a purposeful method of solving societal challenges. The decision-making process is accelerated. However, as Ronnle (2019) states, "[a] common denominator for the strategies [with a plethora of goals] is that they contribute to getting things done while they add considerable confusion in terms of finding out what to do. They do this by increasing ambiguity and reducing clarity." (Ronnle 2019, p. 59).

4 Observations from analyses of the City environmental agreements

Design

Isaksson and Knaggård (2019) note that CEAs are not strictly a contract as the city municipalities apply for a subsidy and then receive it conditional on the criteria. The Swedish Transport Administration was required to state how data for follow up of effects and accounting of costs should be done (SFS 2015:579). Brundell Freij (2019) suggested outcome measures that could be used. In Larsson and Svensson (2021) some observations on the design of the policy are given. The plans for data collection and the intention to be strict on the requirements for follow up appear to have been lax. There appears to have been a lack of requirements to produce relevant measurements of the desired outcomes in the regulation. The problem appears to have been aggravated by a lack of awareness of the lack of already existing data in many cities and a corresponding lack of capacity to produce such data. This has led to large gaps and difficulties in producing accounts of outcomes.

The statistics that have been used in Sweden so far are local and national travel surveys supplemented with local measurements of traffic flows. Both these sources are associated with deficiencies. The travel surveys in Sweden have seen a significant drop in participation rates reducing

their reliability of the measurements (Eriksson et al. 2018). The measurements of traffic flows are costly and neither frequent in time nor space reducing their reliability as measures of traffic (see e.g. Lund trafikrakningar-och-olyckor-2019.pdf (lund.se) and Örebro Trafikdata – trafiken i siffror – Örebro kommun – fördjupning (orebro.se)). Both these disadvantages need to be addressed in separate order if policy makers want to avoid disputes over true development.

The use of cycling is particularly ill known, partly due to the deteriorating quality of national travel surveys and partly to that counting equipment for cycles is used only in few locations and therefore estimations are associated with large uncertainties. Existing data, however, suggests that cycling has increased in the largest Swedish cities but decreased elsewhere (Pyddoke, 2018, Trafikanalys, 2015 and Trafikverket 2020, p 21.). This suggests that the demand for, and value of, improved cycling infrastructure will be increasing over time in large cities. Furthermore, the scarcity of space in streets makes it difficult to free up street space for cycling without encountering political resistance from car users. In a short time perspective, city planners may be able to find creative solutions but these opportunities are likely to be harder to find over time.

Potential effects

Although Isaksson and Knaggård (2019) do not aim at reporting measurements of effects, they present two important observations about what effects the CEAs can have achieved. The first observation is that among the initial projects most were selected among projects that were already planned and decided by the city. This implies that the city had also committed to fund the project. Interviewed city employees and politicians, however, claim that the subsidy from the CEA-program may have speeded up the completion of projects (Isaksson and Knaggård, 2019, p 18). A possible explanation for this would be that CEA-funding allowed cities to use funds in a shorter time span. This commitment does not appear to have been included the original funding by the cities. There are no observations that cities expanded their investments as a result of the reception of funding.

In the choice between to appear to be able to act and to act in an economically rational way, observed choices seem to reveal a preference for appearing to be able to act weighing heavier than the abstract quality of economic rationality. Furthermore, many analysts appear to have underestimated the wish of civil servants to appear loyal to this ability to take action and overestimated the commitment to actually producing effects. An observation on this theme is that regional public transport authorities to a large extent lack the willingness to do and to use cost-benefit analysis (Vigren and Ljungberg, 2018). A further observation is that although management concepts from the private sector like contracts, are now frequently used, it is not clear that the whole concept gets imported to the public sector. The strictures of private contracting with follow ups and penalties for failure to deliver are frequently lenient in the public sector (compare Pyddoke 2020). Although the law requires projects and counter performances not to have been commenced and that these should be conditioned on producing mode shifts and increased building. Neither of these requirements appear to have been upheld. The desire to produce decisions appears to have outweighed the desire to uphold the requirements also.

Larsson and Svensson (2021) contribute further observations. Summarizing their conclusions that data are deficient, uncertain, and largely lacking. The data are only partly presented by city, so it is difficult for the reader to assess the observations. Some large shifts may be due to permanent or temporary rerouting. Other studies suggest varying trends in mode shares in different cities e.g. cycling (Trafikanalys, 2015 and Pyddoke, 2018).

Table 1 Changes in mode shares in percent. Selected outcome interval midpoints and intervals from Larsson and Svensson (2019)

	Car	Public Transport	Cycling
Summary	(-5,5)*	(8,8)*	(6,1)*
5 BRT cases, total outcome	(1,9)*	(6,6)*	(14,8)*
Better terminals and bus stops total outcome	(-11,8)*	(17,6)*	(0)*?
First year	n.a.	-7 - 12	n.a.
Second year	uncertain	4 - 39	uncertain
Third year	uncertain	-15 - 40	uncertain
Fourth year	-22 - 9	-24 - 20 (8,2)*	uncertain

* Interval midpoints in parenthesis

The results in Table 1 indicate that car movements have decreased on average in most cases, public transport on average has increased with some exceptions and so has cycling. These outcomes do not, however prove the effects. The reason for this caution is that other circumstances may have changed and affected the outcomes. Therefore, the results merely suggest that there might have been an effect from the CEAs.

5 What could welfare optimal pricing of roads or parking contribute?

Ideally welfare optimal road pricing would price all the marginal externalities generated by car traffic at specific times and places. Parking pricing could consider the alternative cost of the use of space and as a second-best policy for car use. If voters have preferences for just distribution – which they have – optimal taxation and pricing will have to account for that too.

Are incentives/subsidies needed?

There are four kinds of justifications for incentives to actors from a welfare theoretic perspective. First, there can be market failures, externalities for example. Second, when first-best pricing to correct market failures is politically difficult, a subsidy to a substitute for a good causing negative externalities could be an attractive second-best policy that still could be welfare improving. Third, there are distributional goals. Then from a political perspective, there are also, fourthly, policies that are attractive to some stakeholders and which to varying degrees can be made up to look attractive but for which it is difficult to construct a welfare economic rationale. Either because the benefits from the policy are difficult to measure, or the policy does not give a positive net benefit. In environmental contexts such policies tend to appear when politics tries to push environmental goals and avoid unpopular pricing policies. Below we will address all the four cases.

How can the goal for the CEAs be understood? Assuming the best intentions of its proponents the following could be a hypothesis. The proponents of the CEA may think about a future scenario with current policy and assess that this will yield an outcome with insufficient progress towards sustainability with a too small increase in the supply of infrastructure for public transport and cycling (and possibly housing). Therefore, a need for subsidies to stimulate progress is perceived. A system

of subsidies is constructed and liked by the parliament. This line of reasoning makes no pretension on the policies to be economically efficient.

An explicit account of possible scenario could help to identify possible changes in the preconditions for achieving the goal, and therefore necessitating intensified policies. Also, uncertainties concerning such preconditions may be identified and motivate intensified policies to ensure the achievement of the goals.

Observations on what increased internalization could contribute to sustainability and increased welfare

In the literature review it was noted that there are substantial non-internalized externalities from transport in Swedish cities. From a welfare economic perspective an incentive to cities for internalizing these externalities could therefore be justified. It will be argued below that such internalization would shift transport in a sustainable direction. It will however not be argued that what in short term is considered as internalization at current valuations of externalities will lead to long run sustainable goals, as uncertainties concerning many circumstances may change valuations, only that the kinds of policy instruments that internalization introduces are likely to give progress towards sustainability.

The current situation regarding congestion in streets, occupancy of parking spaces and public transport and cycling in Swedish cities is not well known. The pricing and congestion and parking may therefore both be too low and too high in different parts of the city. Based on recent studies the following stylized facts or hypotheses are formulated for a situation pre or post covid.

Large cities

- Local congestion in peak hours in streets and roads occurs.
- Local high occupancy of parking in peak hours occurs.
- High occupancy in peak hours in some bus lines occurs. Acceptable or low occupancy in peak in other lines and in peripheral parts of city.
- Locally unpleasant and unsafe cycling infrastructure in peak hours occurs.
- Conversely congestion, occupancy of parking and in public transport as well as congestion in cycle infrastructure may be low out of peak hours.

Medium sized cities

- A similar pattern to lesser but varying degrees.

The traditional way to address these problems has been to spend. First in roads, then in rail, then in bus infrastructure and to some extent in infrastructure for walking and cycling. For public transport the strategy in Sweden has been increased supply of bus and train services. Continued urbanization and therefore growth of population and income in cities will motivate increasing the supply of infrastructure for sustainable transport modes in cities. The main funders of public transport supply are the regions and to a varying extent the cities. For the infrastructure funding ranges from the state for national roads and railways, including subsidies to regions and municipalities for regional and municipal infrastructure in the form of urban streets, rail, terminals, bus stops and cycling infrastructure, to the city municipality for local infrastructure.

Large infrastructure investments in roads and rail are becoming more expensive and experiencing cost overruns (Trafikverket, 2021b, p. 195 and Nilsson, 2022). To a considerable degree this is because citizens no longer accept building motorways and new rail infrastructure on the surface of cities. Nevertheless, when such infrastructure is perceived as necessary it gets funded by the state. The rapidly increasing costs for public transport in Sweden (Nilsson, 2011) has also come to

increasingly motivate a stricter prioritization of capacity, with focus on the most demanded lines. For public transport it is confirmed in recent research (Börjesson et al., 2017 and 2019 and Asplund and Pyddoke 2020) that the subsidies for the supply of public transport in some Swedish cities are justified although possibly sometimes at lower levels than current. For cycle infrastructure it was noted above that proposed cycle infrastructure projects in Stockholm could be justified by conventional cost benefit analysis. So, from a strict welfare point of view increasing supply of infrastructure for cycling is likely to be justifiable based on cost-benefit analysis. Therefore, subsidies can indeed be justified. The main issue here is, however, if further incentives from the state are needed. The view formalized in the fiscal federalism theory is that this is a municipal task. Here the focus will be on if the state can influence the degree of sustainable transport in cities.

Observations on second-best options

It is well known that congestion pricing is a hard sell to voters (De Borger and Proost, 2012, Frey, 2003, Hårsman and Quigley, 2009, and Jaensirisak et al., 2005). Therefore, politicians and interest groups may be attracted to various alternatives that may be easier sells or that can be snuck past voters. Such policies frequently involve subsidies. Instead of pricing car use, public transport is subsidized. Instead of pricing carbon emissions from car fuels by fuel taxes, electric cars are subsidized. Such policies can be shown to be less efficient than their first-best counterparts. But this may be irrelevant for democracies who want to move towards identified goals. Welfare considerations may still be useful to avoid inferior second-best options.

Observations on distributional goals

There are several kinds of distributional goals that can be addressed by the design of public transport supply and built environment such as infrastructure for cycling and walking. Traditionally the provision and pricing of public transport has been associated with providing accessibility for individuals with low incomes. This motive still carries weight and can justify more analysis to ensure that these goals are achieved (e.g. Börjesson, Eliasson and Isaksson, 2019 and Asplund and Pyddoke, 2022). There are also national goals for improving infrastructure and public transport services for functionally impaired. An issue that is considerably more difficult to handle is the issue of accessibility in sparsely populated areas. Neither of these issues will be further pursued here.

Observations on policies with unknown costs and benefits

The CEA policy goal is given as a direction of movement of sustainable mode share and not as desired demand levels for the different modes. Neither is the design of the policy justified by connecting subsidies to possible effects on additionality in terms of expanded infrastructure, or on effects on demand. The housing goals and criteria are vague. The cities are required to do counter performances in terms of building, that are in “keeping with” the city’s plans. In practice plans for further housing were accepted as a performance. This may of course be legitimate from a democratic point of view. It is, however, not compatible with high standards of efficiency, as this practice does not ensure that the further performance is delivered.

It is already noted that growing populations are likely to increase the demand for public transport and therefore the economically justified level of supply. The issue appears to be a concern that Swedish regional public transport authorities will have insufficient incentives to adapt if state funding is not given. The fast increase in public transport boarding and costs in Sweden in the last decade appears to contradict this. A possibility to allow for more explicit assessment of a possible evolution of accessibility and transport in cities could be to produce some projections on likely scenarios and what kinds of policies cities envisage for promoting desired development. We return to this in section 7.

The likely effects of welfare optimal pricing of transport in cities

In Table 2 the results of some recent optimization studies of policy instruments for transport in and close to Swedish cities are summarized. These studies all indicate that there are substantial welfare gains to be won by imposing further internalization in Swedish cities by congestion charges and by optimizing public transport supply and pricing.

Car

Concerning pricing of car use in the form of road pricing these studies all indicate that car use is underpriced. This does not, however, simply imply that cities should introduce congestion charges as the technology for this may be quite costly. It may however indicate that parking could be priced higher, as these systems are already in place, as discussed in Asplund and Pyddoke (2021). First, optimal parking charges in Uppsala in peak traffic with no congestion charges are indicated to be more than 60 percent above current parking prices. Second, when optimal congestion charges are introduced the optimal parking charges in peak revert to current levels. Congestion charges and increased parking fees are therefore largely substitutes for each other in Uppsala Third, the revenues are about 4 times larger than the net welfare gain. There are some qualifications, all effects are short run and long run effects are likely to be larger, welfare gains from the policies in this model are dependent on the assumption that parking space can be converted to other valuable uses at low cost (e.g., bus or bike lanes), no health effects or aesthetic effects are considered.

The largest components of the welfare calculations from car use policies in Asplund and Pyddoke (2021) were: time savings of travelers and burdens of switching to a less preferred travel mode; increased revenues to the regional public transport agency; benefits due to increased revenues when considering the marginal cost of public funds; and wider economic benefits (costs) from decreasing (increasing) the costs of trips, while other effects such as environmental effects were small.

Table 2 Examples of mode shift effects from optimizing pricing of car use and public transport supply in Sweden

Paper and policy	Car	Public transport	Walk and Cycle
Asplund Pyddoke 2021 Uppsala			
Congestion tax	-10%	4%	2%
Parking charges	-7%	3%	2%
Börjesson et al 2017 Nacka Stockholm			
Congestion tax and optimal public transport	-24%	-5%	n.a.
Börjesson 2019 Karlstad			
Congestion tax and optimal public transport fares and frequencies	-20%	36%	Small increase
Asplund Pyddoke 2020 Uppsala			
Welfare optimal public transport fares and frequencies	-1%	6%	-1%

Although the studies in Table 2 give an indication of the potential for these policy instruments, that short term effects of optimal congestion charges is a decrease of car trips, and probably more in the longer term, while increasing public transport trips and walking and cycling trips and effects from optimal parking fees is somewhat less. The effects of these policy instruments are, however, not generalizable and need to be assessed for each individual city. There are, in addition, further possible motivations for politics to want more far-reaching effects. Such motivations may include a wish to

reserve some city streets exclusively for pedestrians and cyclists, therefore, going beyond what can currently be motivated by known welfare economic relationships. Further intangible values may be associated with less traffic. The reluctance of voters and politicians to adopt internalization prevents efficient pricing of road use, parking and public transport (De Borger and Proost 2012 and 2015). Thus, there appears, in some instances, to be a case for central government to incentivize cities to introduce policy instruments to reduce externalities of car use.

Public transport

Provided that the largest uninternalized externalities in cities are from car use then the state could prioritize incentivizing cities to internalize such externalities, e.g., by supporting road pricing in cities. When this internalizing starts having effects the demand for public transport will increase. This can lead to some increase in the supply of public transport if public transport authorities can adjust supply to demand. Ideally, the state could incentivize the city and the region to adjust public transport in a cost-efficient fashion. This could be done by supporting improved management methods, price differentiation and more efforts to tailor supply to occupancy, which would require a set of agreed KPIs.

Cycling

Cycling demand is also likely to increase in response to increased internalization the externalities from car use. Improvements in modelling of route choice and demand for cycling are quite recent (Liu et al. 2020) and much remains to be done. Currently, the national demand model only represents cycle demand summarily (Liu et al. 2020). This leaves planners in uncertainty about where cycling demand is likely to evolve. Current planning must therefore rely on extrapolation of recent trends. This calls for careful use of resources and focus on where demand may grow. As mentioned above it appears to be possible to find cycle infrastructure investments that give benefit-cost ratios above 1. The incentives to cities could, therefore, initially, and temporarily be in form of payments for increases in the number of cycles passing existing counting points.

Alternative cost of land use

A further issue for both parking and road space is the alternative value of the use of land. In so far as parking is a service provided by private firms, these firms will have to cover the capital cost of land use and will on average be aware of alternative costs. The welfare economic cost of land use for streets and roads in cities is however, not very well known (e.g. Solow, 1973, Duranton and Puga, 2004). Where Solow's (1973) paper shows that if congestion is not priced, market prices for land may be misleading indicators of the cost of land use. Therefore, I do not attempt to give an account of land use models here. Economists have argued (Brueckner, 2000, Brueckner and Kim, 2004) that taxing congestion and new housing could both reduce and increase sprawl. Also, failure to account for the value of open space or congestion could increase sprawl. Recent research (Ermini and Santolini, 2017) indicates that urban sprawl and increased density are affected by the pattern of real estate taxation.

What valuation of reduction of CO_2?

The Swedish government's ambitious goal for reducing carbon emissions from domestic transport by 70 percent to 2030 compared to 2010, requires a higher and rising valuation of CO_2 emissions from road transport according to the Swedish National Institute of Economic Research (Konjunkturinstitutet, 2019). The current valuation of CO_2 in the Swedish Transport Administrations official guidelines for cost-benefit analysis in the transport sector is 7 SEK (about 0,7 euros) per kilogram CO_2. The current CO_2 tax on fuels of about 0,114 euros per kilogram CO_2 implies a tax per liter of about (2,3x0,114=) 0,264 euros per liter. Including VAT (25%) this increases the price for car

users by about 0,33 euros. A carbon tax of 0,7 euros per kilogram would increase the fuel price by about 2 Euros a difference of 1,67 Euros.

In the Transport Administration's assessed price development to 2030 the real prices in 2017 price level are assumed to increase by about 45% for petrol and 38% for diesel to 2030 including a 2% tax increase per year and effects from increased blending of biofuels into petrol and diesel. In the Transport Administration's scenario for electrification the average cost for CO_2-emission reductions is 0,2 to 0,4 Euros per kilogram CO_2 for the period 2021-2031 (Trafikverket, 2021a, p. 29). Given the above price assumptions and further policy instruments, this gives a reference level for which CO_2 calculation values can be reasonable for city planning.

A sensitivity analysis in Asplund and Pyddoke (2021) of how the optimal congestion tax and parking prices in the Swedish city of Uppsala are affected by increasing the calculation price of CO_2 from 1,14 SEK to 7 SEK per kilogram increases the corresponding congestion charge in peak hours from EUR 2.8 to EUR 3.1 and in off-peak hours from EUR 1,4 to EUR 1,6. The corresponding mode shifts are presented in Table 3.

A dramatic increase in CO_2-valuation has a modest effect on mode shares. This effect goes via the welfare optimal increase in the congestion charge, given an unchanged fuel tax. This indicates two things. First the effect on CO_2-emissions from increasing congestion charges are small. Furthermore, these will diminish with increasing electrification of car transport. Second, the largest effects from a congestion charge are on other externalities. Table 3 therefore suggests that climate justifications for

Table 3 Percentage change in mode shares of number of trips with CO_2 valuations at 0,11 euros and 0,7 Euros per kilogram

	0,11 Euros	0,7 Euros
Car	-10	-11
Bus	+4	+5
Walk and Cycle	+2	+3

Source: Asplund and Pyddoke 2021

congestion charges constitute a small part of benefits. Tougher pricing of car use in cities must therefore be justified by congestion, other externalities, or other possibly not measured benefits like the "niceness of the city". An implication of this is that the prime motive for charging lies with the city. The relevant spillovers are the car trips taken by individuals living outside the city. The Inhabitants of other municipalities can be priced for parking, but the municipality does not have the mandate to implement congestion taxes. The congestion taxes in Sweden can only be decided by the parliament as these taxes are borne by inhabitants of other municipalities also. Assuming that there are such motives, the value of these further motives must be larger than the costs that are laid upon car users by using the higher congestion taxes or parking charges.

6 A hypothetical temporary incentive system for speeding up the transition to a more sustainable mode distribution

A point of departure in this section is that the state is concerned about the pace in which cities are moving towards sustainable transport and wants to speed up a shift of modes from cars to walking, cycling and public transport, all assumed to be environmentally sustainable, compared to a base scenario (BS) with the set of policies currently enacted. In some cases, the means for mode shift include various forms of mobility as a service, e.g., car sharing. In this discussion the focus will be on

the possibilities to speed up mode shift. A goal is assumed to be set quantitatively and for a certain year for the increase in the mode shares of the sustainable modes and a corresponding reduction of the mode share of cars. In Sweden both national, regional and municipality assemblies formulate such goals. The Swedish national goal for the share of person kilometers done by public transport, cycling and walking is that it should be at least 25 percent in 2025. The regional goal for Stockholm for the sustainable modes is set to be at least 70 percent of person-kilometers to 2030[5].

The construction of the incentive

The idea here is for the state to give city municipalities an incentive to work towards the Swedish national transport political goals or more far-reaching goals for sustainable transport mode shares in cities. The novelty is to pay cities afterwards for each step approaching a nationally set goal for the mode share of sustainable modes compared to an expected development in the BS, without the incentive. This assuming that the state and the city agree to the objective and to the incentive payment level for a certain change in mode shares for each unit of aggregate change on a yearly basis.

The appropriate level of the incentive depends on the state's and the city's perception of how the mode share is going to change in the BS, how much the state wants to speed up the process, and how much the parties assesses that this will cost. The design could also incorporate provisions for a possible decrease in the shares of sustainable modes (increase in the mode share of cars), which could lead to earlier payments being reclaimed. A further issue is liquidity. If the city municipality has a tight budget, it may be asking too much to require the city to invest in mode shift with funds first forthcoming as car traffic drops. Therefore, some state subsidized finance may be needed. When the target is reached, the subsidy can be terminated.

The state can correct for factors affecting estimated outcomes in the BS that cannot be influenced by the city, like market prices for fuel, electricity and cars. If such factors deviate from the assumptions in the BS, this could be taken into account by the state. If for example the world market price for oil increases faster than expected this would reduce car use. If on the other hand electricity prices increase this could also decrease car use. This would, therefore, not be due to actions taken by the city. The city should therefore ideally neither be compensated for such outcomes, nor penalized for lack of outcomes due to such changes.

The state agency responsible for the incentive could set the level of incentive proportional to an estimated investment and operating cost for the measures necessary for achieving the agreed goal. Assume for example, that the agreed goal is a car use reduction, counted from the car use in a start year in 2025, is 5 percent for 2035. The estimated cost for the measures required for this is 4 billion SEK. This implies that giving an incentive of 0,8 billion SEK for each percentage unit of reduction of car use would just cover the costs for reducing the car use, provided that the estimate for the needed measures was correct.

In the example the total cost of the investment and operating costs are funded by the state. The cost to the inhabitants in the city will be the increase in state taxes needed to fund the project and the direct and indirect costs of the measures. Direct costs include higher payments for congestion taxes and parking prices. Indirect costs may be longer travel times with alternative modes and loss of accessibility. If the inhabitants of the city value the reduced externalities, there should be a

[5] The Stockholm region has set a goal for the combined mode share of walking, cycling and public transport to be at least 70 percent by 2030 (Region Stockholm, 2018). This compared to 59 percent in 2015.

bargaining possibility for the state, to make the city pay for some of the costs and thereby reduce the costs for the state.

Challenges for this design

There are three challenges for this design. The first challenge is to project how the mode share of the sustainable modes in the city municipality will move to the goal year without the further incentives (in BS). The second challenge is that, if the BS does not reach the goal, neither the state nor the city municipality is likely to know the further budgetary costs, or the sacrifices needed by citizens, businesses, and public sector to reach the goals. This makes the task to set the incentive at a level required to reach the goal uncertain and difficult. A part of this problem is that the state agency may not know the levels of investments needed to reach the goals. A yearly payment under a limited period may therefore not be high enough to cover all costs needed to reach the goals. The third challenge is to know, afterwards, how actual mode shares evolved towards the goal year. The payment of the incentives would ideally be based on undisputable measures.

The central result from welfare economics is that pricing externalities with marginal external costs (that are not already priced) is likely to improve the welfare outcome in the city. This implies that increased pricing of congestion and parking, if these are underpriced, will shift mode choices, and improve welfare. Our current understanding is that investments in infrastructure may be justified but that the welfare effects of these investments need to be examined. If mode choices change, this can justify changed pricing of public transport also (Proost 2018). Even if investments cannot be justified in cost-benefit terms, they may become motivated depending on an increase in demand. The cities will be best advised to proceed by assessing possible effects from simultaneous changes in pricing and supply with future changes in demand.

The outcome of the hypothetical incentive promised to cities will then depend on the mix of pricing of car use and the spending on sustainable modes the city municipality chooses. The more correct pricing of externalities the more likely desired mode shifts and welfare effects will be resulting. On the other hand, building more infrastructure is likely to give less welfare effects.

How can these challenges be tackled and what is the current situation? The first challenge of knowing how the mode shares are expected to evolve, could be handled with plans for infrastructure, policy instruments and modeling. City municipalities may hold projections of traffic development and plans and for the development of its infrastructure. The governing politicians in the cities are less likely to have long term plans to introduce and increase unpopular measures such as congestion taxes. The total welfare effect and the acceptability of this policy will be highly dependent on how the revenues are used (Baranzini et al. 2021 and Jaensirisak et al., 2005).

For parking prices, it is harder to be precise about the welfare effects. There are, however, cities e.g., Stockholm and Uppsala, that have adopted parking policies implying that parking prices should be increased when the occupancy of parking spaces increases above 85 percent. The bit about increasing prices is however not strictly followed. Assuming that important uncertainties are associated with the true alternative cost of land use at different locations, and about average valuations, the total supply of parking in cities, the occupancy, and the pricing of privately supplied parking, the welfare results may be sensitive to these unknowns.

In recent Swedish policy discussions (Holm and Kollman eds. 2021), the focus has been more on changing mode shares and less on forecasting and accommodation to growing populations, incomes and changing age and income distribution. Such changes may motivate reexamination of what levels of public transport supply will be politically desired. This choice can also be aided by modeling. For

large cities modeling of the total effects of new infrastructure, new and adjusted policy instruments may be motivated as these effects are difficult to foresee intuitively. For small cities it may not be realistic or necessary to model many changing circumstances.

The second challenge be helped by a pre-study of the city's goals and projections as well as its history of introducing policy instruments to reduce car traffic and spending on investments towards sustainable modes. Of course, political majorities may change. But the preferences for implementing restrictive policies for car use and spending on sustainable modes may be more stable.

Ideally a negotiation could be preceded by a commitment from the city for how much goal achievement it will produce and at what pace in BS. Such commitment would imply some plan of what policy instruments and what infrastructure the city is going to provide and a corresponding forecast of what effects in terms of car shares this is likely to produce.

The third challenge is to know how mode shares have evolved towards the goal year as the quality of travel surveys has deteriorated and local measurements of traffic flows may be lacking. If the incentives are sufficiently attractive, this could possibly improve the city's motivation to provide better data for follow ups and make it easier for the agency commissioned to administer the subsidy to require such data and measurements as a precondition for paying the incentive.

The need for better and more rigorous monitoring and evaluation while aiming for and achieving sustainable urban mobility has received EU attention. The EU Commission has proposed an initiative for better governance in Member States, regional and local authorities. The intention is to intensify support to local authorities to sustainable urban mobility plans, capacity building and training, and better urban planning. An important part of this is the ambition to stimulate a better collection of consistent collection of urban mobility data (EU Commission, 2021) by using the standards proposed for Sustainable Urban Mobility Plans (SUMP).

The likely effects of incentives

The mode share effects and therefore the total welfare effects of this incentive will depend on the mix of pricing of car use and spending on sustainable modes chosen by the city. It the city choses more pricing of car use the mode effects are likely to be larger, and if the city spends more on investments in sustainable modes the mode effects are likely to be smaller.

How much the city wants to shift from car to sustainable modes depends on what the decisionmaker's and the voter's perceptions are of the further social benefits and costs from shifting modes. If the goal is to reduce the car mode by, say 5 percent and to correspondingly increase the use of other modes, it is not easy to know what the efficient level of the means for achieving the goal is.

Consider the optimal choice for a city that is presented with an incentive scheme paying for each reduction of car use. If the city without the new incentive, expects population to grow, congestion and scarcity of parking to worsen, this will reduce the mode share of cars. If the city plans to counter this with increases in investments in public transport and cycling infrastructure expecting to increase the demand for these modes, but where few of these new users will come from the car mode, this may have only modest further effects on car use. The city will then have to consider using some complementary "sticks" in the form of other policies (e.g., road pricing or parking charges) to incite further reductions of car use. A simultaneous introduction, in this case, of the "carrots", in the form of expanded cycling and public transport infrastructure in addition to expanded public transport supply, is likely to be needed to achieve substantial shifts of modes.

In most Swedish cities congestion is not priced, and if optimal parking charges leaves less than 15-20 percent of parking spaces free, parking is likely to be underpriced in parts of cities during parts of the day. A survey of city politicians and employees conducted within this project indicate that these actors assess that these forms of pricing of car use not to be popular. An incentive will allow the city to offer compensations in the form of other forms of public services, which may contribute to the acceptability of the package of actions.

A search for studies evaluating the effects of national co-funding yielded some observations. A study of co-funding in the Swedish national infrastructure planning (Mellin et al., 2013) found that the contributions of municipal tax funds was minimal. What got shifted was revenues from congestion taxes that were collected by the state and other forms of state funding. An example is the contribution of the state-owned iron ore mining firm LKAB to new rail infrastructure who contributed funds from its profits. In this case, the alternative use of funds could have been other forms of state spending.

A similar question is how the sources of funding by national or regional taxation affects the level of spending on infrastructure. Kappeler et al. (2013) examine how the degree of funding from regional taxation and earmarked funding coming from the state level affect spending. The findings are that regional spending on infrastructure increased after revenue decentralization. This increase, is however, lower the higher the previous use of earmarked grants to fund infrastructure investment was. Jussila Hammes and Nilsson (2016) examine three alternative hypotheses explaining how state funds are allocated to municipalities. They find that the co-funding share of the municipality explains rail investments well, while a swing voter model explains road investments better. Benefit-cost ratios and proxy variables for lobbying are not found to correlate with plan choices. No further studies directly related to subsidies or co-funding of municipal infrastructure for transport or housing were found.

7 A summarizing comparison of the policy instruments for shifting modes to sustainable transport

We can now summarize the preceding analysis and present the analysis in Table 4.

Table 4. Comparison of the four policy instruments for sustainable mode shift in cities

	City Environ-mental Agreements (CEA)	Congestion Charges	Parking charges	Subsidies to cities for car use reductions
Time perspective	Some years	Ongoing	Ongoing	Some years to ongoing
Effects on mode choice	Varying and uncertain (small?)	Substantial	Substantial	Conditional on the use of sticks
Benefits	Small unless effects on congestion	Substantial if congestion	Substantial if congestion or valuable alternative use of space	II
Costs	Investment plus cost of public funds	Loss of consumer surplus for car users	Loss of consumer surplus for car users	II
Net welfare	Likely negative	Positive	Positive	II
Distributional effects		With many low-income car users, there will be a distributional issue	With many low-income car users there will be a distributional issue	II
Acceptability in cities	High	Low	Low	II

The idea with the CEAs is to enable more construction of infrastructure that could shift mode use from car to the sustainable modes. The data indicates that the projects may have contributed to a shift of modes in the wanted direction. The observed implementation of the CEAs does not, however, appear to have been successful in identifying choices that had the potential to shift modes reliably and effectively. The effects of CEAs will depend much on what projects get identified and nominated. The current program was launched in a hurry and cities needed to finish projects within a quite limited time frame. This possibly limited the scope to nominate more effective and efficient ideas for shifting modes. This implies that future CEAs may be more effective and efficient provided that the appropriate projects can be identified. But even if such projects get chosen, the efficiency in the reduction of externalities from car use are likely to be smaller than for congestion and parking charges.

The “sticks” of congestion taxes and parking charges, on the contrary, appear to be both effective and efficient. This efficiency comes, however, with large redistribution as the revenues from congestion and parking charges are much larger than the welfare gains. These payments are not counted as a cost in cost benefit-analysis, but certainly to individual car users, and will therefore not make it popular with the car users. These results do not appear to be well known among city planners and politicians. Neither is the prevalence or magnitude of externalities in cities well known among decision makers and voters. This constitutes an important barrier for convincing citizens that taxing congestion and charging more for parking may be good policies. The large revenues in proportion to the welfare gains makes it important for political decisionmakers to explain how

revenue will be allocated. If there are many low-income earners using cars in the city the congestion and parking charges may come to be considered as unfair.

The hypothetical incentive from the state to cities for reducing car use and consequently externalities from car use may be a promising policy as this will challenge cities to consider their options for future traffic in the city and reflect on the possible instruments available. The more, the city charges for congestion and parking the larger the effects on car use are likely to be. This will shift some demand towards walking, cycling and public transport, possibly requiring expanded infrastructure for these modes. Depending on the size of the incentive, it will be a possibility for the city to cover some of its costs for infrastructure or for compensating car users. The effectiveness depends on the city's willingness to pose the burdens of taxes and charges on its citizens. Such an incentive, however, requires considerable data collection to account for the results of the incentive.

In total pricing of congestion and parking appear to be both effective and efficient, but hard to make attractive. Subsidies to infrastructure for public transport and cycling are less effective and less efficient for reducing car use and car use externalities. The hypothetical incentive may be way to create packages of policy that can receive acceptance.

8 Discussion and conclusions

The aim in this paper is to compare the capacity of the current Swedish City Environmental Agreement (CEA) to, an introduction of congestion charges, an increase in parking charges, and a hypothetical subsidy from the state for achieved reduction in car use, to shift car use to other modes, reduce externalities, and increase net welfare. The goal of the CEAs was initially to subsidize infrastructure for public transport to increase the mode share of public transport in cities, later this was extended to also increase the mode share of cycling. One of the justifications for CEA system was the desire to attach requirements for counter performances in terms of further infrastructure and housing construction. But while this wish was central to the justification for the system, a strict requirement on city municipalities to increase the supply beyond what they had already planned was not systematically enforced.

There are indications of both uninternalized externalities in Swedish cities and that parking pricing is below alternative costs. Simultaneously there are indications of over-pricing of parking in parts of city municipalities. Welfare optimal pricing of externalities and parking are likely to have substantial short-term effects on car use and even larger effects in longer term. If correctly priced, this internalization improves welfare.

The CEAs are questionable as city transport infrastructure have previously mostly been an obligation for municipalities unless a part of the national network. Therefore, some justification is needed for moving the funding responsibility for this infrastructure to the state. The Swedish constitution grants municipalities and regions the right to fund the performance of their legal obligations by taxation. The constitution also states the importance of the self-determination (Regeringsformen 1:1). This is partly balanced by the desire of parliament to impose regulations of uniformity in the delivery of municipal and regional obligations. The definition of the duty to fund these obligations is however unclear as the state has taken upon itself to contribute funding to many of these obligations. This has created a "slippery slope" with increasing demands on the state to fund regional and municipal obligations.

The findings for the Swedish CEAs were highly variable and the general conclusion therefore uncertain. There are few compilations of benefit-cost ratios of Swedish city public transport

infrastructure investments. For national infrastructure in cities, the benefit-cost ratios are frequently below 1 in cities. A single unpublished Swedish study of the benefit cost ratios of cycle infrastructure in Stockholm indicates that many cycle infrastructure projects may have the potential to be welfare improving even if mode shift effects are small due to valuation of safer and more comfortable travel. If the initial mode share of car is large and public transport share is low. The diversion for from car from improving public transport is likely to be small in absolute terms (Dunkerly et al. 2018 and Jussila Hammes et al. 2016).

The observed mode choices following the investments funded by the CEAs are vary considerably and are stated to be uncertain, due to few measurements. The CEAs effect on car use can therefore not be said to have been proven and increases in sustainable modes may not necessarily be due to shifts from car use. This policy needs to be further evaluated with better data and modelling of counterfactual scenarios. If the policy is costly and gives small and uncertain effects, it may be called into doubt. Then the policy is likely to give a negative social net benefit and small effects on externalities.

Effects from congestion charges, on the other hand, have been shown to be substantial in Stockholm (Eliasson et al. 2012) and give a “significant social surplus” (Eliasson 2009). While in Gothenburg social returns have been stated to be low (Börjesson and Kristoffersson, 2015). For Uppsala in Sweden (Asplund and Pyddoke 2021) a hypothetical congestion charge was modelled to give substantial mode shift effects and potentially a social welfare gain.

For parking charges in Stockholm Cats et al. (2016) find that increased charges reduced parking demand, and Asplund and Pyddoke (2021) modelled increased parking charges in Uppsala also to give substantial mode shift effects and a social welfare gain. The conclusion is that increased parking charges have the potential to substantially reduce car use, to shift mode choice to sustainable modes and to increase municipal revenue and social welfare, whereas investment in public transport and cycling have lower potential to affect mode choice but lays a burden on public funds.

The sticks of congestion and parking charges are likely to be unpopular with wide groups of voters, explaining the political reluctance to implement these policies. They also run the risk of hurting low-income groups more, while the state funded infrastructure benefits transport users in the city with small costs to the citizens of the city.

The fourth alternative is the hypothetical subsidy to cities for reducing car use. The effectiveness and efficiency of this policy depends on the degree to which this policy is reached by pricing previously unpriced externalities. It therefore also depends on how accurate the administratively responsible agency can monitor the real effects of the policies and how accurately externalities are measured and priced. The paper discusses the demanding task of estimating effects of such policies. If this policy leads to measures combining “sticks”, street regulations (including pedestrian zones and reduction of parking space), and increased supply of cycling and public transport infrastructure, this may reduce demand for car use and correspondingly shift some demand to the sustainable modes. With more weight on the sticks this can produce a positive welfare net, while more weight on investments risks yielding a welfare loss. Congestion and parking charges are likely to be superior to CEAs both in mode choice and welfare effects.

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