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Extending car-sharing to serve commuters: An implementation in Austria

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ABSTRACT

While representing an important element in the development of a sustainable transport system, car sharing, at least in its traditional form, is not useful for standard commuter trips during which vehicles remain largely idle throughout the day. In fact, such idling has been considered a crucial limitation in extending the potential of car sharing to date. We report the results of a national two-year field study on a commuter-adjusted version of car sharing. Here, a rail company offers (electric) cars to commuters in order to allow them access from their home to the nearest train station. At the same time, the rail company organizes the day use of the car by businesses such as postal services or mobile health care. We find the following evaluating costs, market potential, and environmental merits. The two previously separate users now share one car, with thus more efficient use of the capital stock "car" which allows covering of the additional overhead costs. The potential market is likely to be of sufficient interest for a national rail company operating in a country with a settlement structure such as that which exists in Austria. The environmental effect depends on the share of electric vehicles and the generation mix of electricity.

1. Introduction

In most countries transport is among those activities exhibiting the strongest rise in emissions, both in terms of greenhouse gasses, and in terms of local pollutants (OECD/ITF, 2013). This alone is sufficient to call for mitigation of transport emissions. However, a further reason leading to greater demand for such mitigation policies, is the relatively strong link that can be made between social fairness and transport policies, at least when compared to other areas of mitigation policy making (Büchs and Schnepf, 2013, for UK). As by far the largest fraction of transport emissions originates in road transport, technological as well as behavioral changes (or – even more effectively – some combination thereof; e.g. OECD, 2001) are clearly called for. New ways of organizing mobility and road transport, such as car sharing, have proven capable of providing relief, not only for the environment, but also for household budgets (e.g. Prettenthaler and Steininger, 1999). However, dealing with problems arising from commuter road transport has often been considered particularly difficult. A major concern when discussing economic policy instruments is the desire to avoid the imposition of any additional burden upon commuters, while the alternative approach, organizational innovations, often simply do not fit for commuters. In the present paper we thus analyze whether a particularly effective organizational innovation, car sharing, can be successfully expanded to cover the domain of commuting. Car sharing, at least in its traditional form, rests on the idea that car use is shared throughout the day. This is anathema to the practice of leaving the car standing the whole day at one's place of work, and is thus not compatible (i.e. too expensive) with standard use by commuters. However, as commuting accounts for a significant direct share of passenger road transport, it also (indirectly) fosters the ownership of cars that are then used beyond commuting and thus further shifts the overall modal split towards the use of private vehicles.

The results described here are linked to two strands of literature. First, the potential of car sharing is routinely found to be quantitatively limited as it is assumed that it cannot be used to tackle commuting. Earlier studies that focus on the traditional concept (and limitations) of car sharing include Doherty et al. (1987) and Steininger et al. (1996). A more recent example in the same vein can be found in Rabbitt and Ghosh (2013). New concepts such as Car2Go, with no specifically assigned parking spaces, only work in densely populated cities. They are not applicable to peripheral residential locations, where a significant fraction of long-distance commuters originates (see e.g. Firnkorn and Müller (2012)). This is also true for concepts where sharing is a question of private coordination, such as peer-to-peer car sharing (see Hampshire and Gaites, 2011). In peripheral locations population density tends to be so low that the concept becomes unviable. The second strand in the literature addresses the question of how existing commuter needs may be met while simultaneously promoting more

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environmentally benign forms of mobility. Recent research here covers issues such as the respective time demands of commuting mode (Batabyal and Nijkamp, 2013), perceived attributes and satisfaction (Eriksson et al., 2013), and factors fostering non-car commutes for specific groups (Zhou, 2012).

Here we report on a commuter-adjusted concept of car sharing and on the results of a two year field experiment on its implementation across Austria. On the basis of this real world example, we then draw conclusions with respect to the market potential, the economic and environmental viability of such an approach to commuting. On the one hand, this places us within the second line of research described above, in that we are able to add a new bundle of commuting characteristics which make the system economically and environmentally viable. On the other hand, we are also able to add to the first line of literature by proposing a workable organizational concept that expands car sharing in such a way that it becomes suitable for peripheral commuter locations. The concept thus overcomes one of the major constraints reported to date.

Section 2 explains the basic concept employed as well as the field study setting. Based on the field study, the market potential and environmental merits are then quantified in Section 3. The final section, Section 4, summarizes the main results and concludes the analysis.

2. The New Sharing Concept for Commuters and Related Field Study

The new concept, originally proposed by the Austrian rail company, works as follows: the rail company offers cars to commuters which give them access from their home (on the periphery) to the nearest train station, where they then switch to public transport (rail) in order to reach their place of work. The rail company also organizes the day use of the car by business users such as postal services or mobile health care. To foster an improved environmental balance, all cars offered in the system are electric vehicles. The model would work equally well with some other mobility service provider acting as the intermediary between rail service, commuter and daytime user.

Between 2012 and early 2014 this system was tested in actual implementation in Austria. It was termed electric mobility and rail, or 'eMORAIL' for short. The test period involved six commuters, respective daytime users and booking stations at the major train stations (such as Vienna and Graz). In this way the necessary know-how was gained for the intended permanent implementation in 2014 and beyond.

Core findings: it was less difficult to identify commuters than it was to find daytime users; while a flat rate for commuting trips was a sufficient incentive for commuters, in order to ensure economic viability, additional charges per kilometer need to be levied to cover the cost of extra trips (e.g. at weekends).

The implicit offer of a secured parking lot at the train station is a core incentive, particularly where the more centrally located train stations are concerned. Two types of change in mobility behavior could be observed. 1) A user group that previously had a mixed modal trip (car & train), replaced their own (fossil fuel driven) car by the system's shared electric vehicle. 2) A user group that had earlier driven the whole distance to work by car now shifted to a new split of public and private transport. The incentives appeared to be financial in nature, as well as a desire to shift to public transport (for the respective shares see below).

As a result of the test experience gained, possible market potential was then assessed as follows. Out of 1131 railway stations in Austria 365 were identified as offering sufficient operation quality, and 200 of these were identified as suitable for the eMORAIL system. The number of commuters living within the designated 25-km corridor around the 365 railway stations was identified at 457,334 (i.e. the relevant market). The average potential for daytime users was estimated at 3.5 per station. The initial potential was thus put at 700 commuters (3.5 cars times 200 stations). Of these, about 20% would previously have commuted fully by car, i.e. these represent new customers for the rail company. The average distance between commuter home and train station is 10 km, the average distance of new rail customers from home to work is assumed to be 45 km. Adding further assumptions on trip lengths (weekend use is assumed to be 3 trips of 25 km on each of 47 weekends per year; day users are assumed to use the cars on average five days a week out of 52 weeks a year for 50 km a day), results in the following modal substitution: the 700 electric vehicles of the new system and the rail service replace 16.3 million car-kilometers previously driven on a fossil fuel basis (of which 7.2 million had been driven by commuters, the rest by daytime users) 0.7 million electric car-kilometers are newly induced.

3. Economic and Environmental Viability

Having quantified the initial potential of this commuter-adjusted car sharing system, can we assess its economic viability? One way to approach this question is to assume that the new daytime users are willing to bear the same level of cost for car mobility as they did previously. This is irrespective of the fact that the car fleet is no longer their own property, but is now offered as a service by another agent. By doing this the operating costs and fleet maintenance costs for the daytime users are covered. This means that we then only need to assess the costs for commuters under the new (proposed) system and compare these to those obtaining under the current system. This is what Table 1 reports for the case of a system with 700 cars (this is what we identified as the initial user potential). Costs of the new system include those relating to the necessary booking system, overheads, higher acquisition costs for electric vehicles, the new infrastructure of electric vehicle charging stations and their operation. Estimating future costs is subject to a large element of uncertainty. Assuming a car fleet of 700 cars and related economies of scale in the production cost of charging stations, Table 1 indicates that total costs may be expected to be within the same range that commuters, collectively, currently have to bear now. The particular cost parameters reported in Table 1 indicate a slight cost decrease upon introducing eMORAIL of some €20,000 for the overall system relative to current costs (this actually denotes an average level for a specified band-width of uncertainty). Economies of scale in the production of electric vehicles are likely to be higher than those observable for conventional cars, particularly with respect to battery costs. Thus, using the current best guess of a 9% p.a. production cost decline for batteries up to 2020, we then find that the eMORAIL system with 700 cars leads to more significant cost savings of €170,000. This indicates that costs of such a system are already comparable to the costs of mobility modes presently employed, and in the future are likely to be significantly lower.

We can extend the above analysis to assess the impact on the national economy. Bachner and Steininger (2014) set out a computable general equilibrium model focusing on the transport sector in some detail (building on the model structure presented in Steininger et al., 2007),

Table 1
Per annum commuter cost comparison with and without eMORAIL (700 cars).

Current annual costs for commuters		
Car-kilometers driven that are replaced by eMORAIL, p.a.	7,246,750	km
Costs per kilometer based on Statistics Austria (2011)	0.36	Euros
Total costs	2.61	mln Euros
Annual costs under system eMORAIL		
Costs for rail transport	0.31	mln Euros
Overheads	0.73	mln Euros
Operating costs of electric charging stations	0.27	mln Euros
Investment costs charging stations (at railway station) and wallboxes (at home), depreciation p.a.	0.37	mln Euros
Operating costs electric vehicles	0.81	mln Euros
Additional costs in car acquisition	0.09	mln Euros
Operating costs of booking and charging system	0.02	mln Euros
Total costs	2.59	mln Euros
Cost reduction for commuters due to eMORAIL relative to current mobility costs, p.a.	0.02	mln Euros

Table 2
Emission of greenhouse gasses p.a. due to the introduction of eMORAIL at a scale of 700 electric vehicles, various evaluation methods, for 2013 and 2020.

	Evaluation method	Emissions [in t] CO_2e
2013	1) Operation only	−1136
	2) Life-cycle	−667
	3) Operation & PV	−2544
	4) Life-cycle & PV	−2076
2020	1) Operation only	−748
	2) Life-cycle	−375
	3) Operation & PV	−2157
	4) Life-cycle & PV	−1784

and identify the following three main impact channels and their macroeconomic implications: 1) savings gained are used for things other than transport services. This raises overall welfare (overall consumption expenditures are assumed to remain unchanged); 2) the additional build up of infrastructure raises the domestic capital stock; 3) the previously unpaid commuter driving activity is now replaced by market-traded labor in both the eMORAIL system and the rail system. The net effect of all these and the implied changes in final and intermediate demand structure result in a rise in value added (€1500 per car) and a slight increase in employment (a plus of 7 employees for the overall system).

By employing suitable emission coefficients (Wolkinger et al., 2012) for the various car technologies and modes of electricity production we can then draw a few conclusions concerning net environmental implications. Table 2 shows such an evaluation for greenhouse gas emissions, and distinguishes between four evaluation methods in terms of operation versus life-cycle emissions, and whether carbon-free electricity production is employed (photovoltaic (PV)) or not. As it is assumed that in 2020 conventional cars will be less polluting than today's cars, the expected emission reduction was adjusted accordingly.

4. Conclusions

We find the following on evaluating the respective costs, market potential, and environmental merits of the commuter-adjusted car sharing system. The ensuing overhead costs can be covered by the more efficient use of the capital stock “car” as two previously separate users now share one car. This means that the new overall mobility service is not more expensive than the earlier system. This is true even though an electric vehicle charging system has to be built up and financed. The size of the potential market is likely to be of sufficient interest for a national rail company operating in a country with a settlement structure such as that which exists in Austria. The new system may thus be capable of overcoming the commuter-participation limitation mentioned in connection with traditional concepts of car sharing. One remaining constraint seems to be the problems associated with the identification of daytime users. This does not apply to commuters, since an ample number are clearly interested in the new concept. The initial potential for Austria is quantified at 700 cars, stationed at 200 railway stations. Installed on such a scale, the effects on welfare, value added and employment are all found to be positive. The impact on the environment is determined by the prevailing share of electric vehicles and the generation mix of electricity. In terms of greenhouse gasses, the emission reduction per car employed in the system may amount up to 3.5 t CO_2e per year. This corresponds to more than one third of the annual per capita emission in a country such as Austria.

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References

Bachner, Steininger, 2014. eMORAIL impact on ecology and the economy. In: ÖBB Holding, Quintessenz (Eds.), eMORAIL Integrated eMobility Service for Public Transport, Final Report to the Austrian Research Promotion Agency (FFG) (in German with English summary).
Batabyal, A., Nijkamp, P., 2013. Ought a green citizen to bicycle or take public transport to work? Ecol. Econ. 86, 93–96.
Büchs, M., Schnepf, S.V., 2013. Who emits most? Associations between socio-economic factors and UK households' home energy, transport, indirect and total CO2 emissions. Ecol. Econ. 90, 114–123.
Doherty, M.J., Sparrow, F.T., Sinha, K.C., 1987. Public use of autos: mobility enterprise project. J. Transp. Eng. 113, 84–97.
Eriksson, L., Friman, M., Gärling, T., 2013. Perceived attributes of bus and car mediating satisfaction with the work commute. Transp. Res. A Policy Pract. 47, 87–96.
Firnkorn, J., Müller, M., 2012. Selling mobility instead of cars: new business strategies of automakers and the impact on private vehicle holding. Bus. Strateg. Environ. 21, 264–280.
Hampshire, R.C., Gaites, C., 2011. Peer-to-peer carsharing: market analysis and potential growth. Transp. Res. Rec. 2217, 119–126.
OECD, 2001. EST! Guidelines, Guidelines Towards Environmentally Sustainable Transport, Endorsed by the OECD Environment Ministers. OECD, Paris.
OECD/ITF, 2013. ITF Transport Outlook 2013. OECD Publishing and ITF, Paris. http://dx.doi.org/10.1787/9789282103937-en.
Prettenthaler, F.E., Steininger, K.W., 1999. From ownership to service use lifestyle: the potential of car sharing. Ecol. Econ. 28, 443–453.
Rabbitt, N., Ghosh, B., 2013. A study of feasibility and potential benefits of organised car sharing in Ireland. Transp. Res. Part D: Transp. Environ. 25, 49–58.
Statistics Austria, 2011. Verbrauchsausgaben — Hauptergebnisse der Konsumerhebung 2009/10. Vienna.
Steininger, K.W., Vogl, C., Zettl, R., 1996. Car-sharing organizations: the size of the market segment and revealed change in mobility behavior. Transp. Policy 3 (4), 177–185.
Steininger, K.W., Friedl, B., Gebetsroither, B., 2007. Sustainability impacts of car road pricing: a computable general equilibrium analysis for Austria. Ecol. Econ. 63, 59–69.
Wolkinger, B., Steininger, K.W., Damm, A., Schleicher, S., Grossmann, W., Türk, A., Tatzber, F., Steiner, D., 2012. Implementing Europe's climate targets at the regional level. Clim. Pol. 12 (6), 667–689. http://dx.doi.org/10.1080/14693062.2012.669096.
Zhou, J., 2012. Sustainable commute in a car-dominant city: factors affecting alternative mode choices among university students. Transp. Res. A Policy Pract. 46, 1013–1029.