

Policies tackling the “web of constraints” on resource-efficient practices: the case of mobility

Citation for published version (APA):

Dijk, M., Backhaus, J., Wieser, H., & Kemp, R. (2019). Policies tackling the “web of constraints” on resource-efficient practices: the case of mobility. *Sustainability: Science, Practice & Policy*, 15(1), 62-81. <https://doi.org/10.1080/15487733.2019.1663992>

Document status and date:

Published: 01/01/2019

DOI:

[10.1080/15487733.2019.1663992](https://doi.org/10.1080/15487733.2019.1663992)

Document Version:

Publisher's PDF, also known as Version of record

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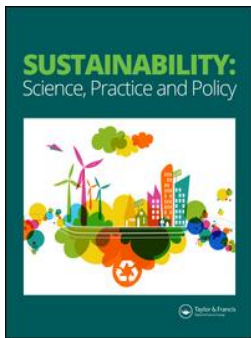
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To cite this article: Marc Dijk, Julia Backhaus, Harald Wieser & René Kemp (2019) Policies tackling the “web of constraints” on resource efficient practices: the case of mobility, Sustainability: Science, Practice and Policy, 15:1, 62-81, DOI: [10.1080/15487733.2019.1663992](https://doi.org/10.1080/15487733.2019.1663992)

To link to this article: <https://doi.org/10.1080/15487733.2019.1663992>



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Policies tackling the “web of constraints” on resource efficient practices: the case of mobility

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ABSTRACT

In practice, environmental policy is only moving slowly from a focus on promoting environmental technologies to a focus on greening socio-technical systems. Policy measures to stimulate resource efficiency (RE) typically address the national, sectoral, or company level. This article shows how an analysis addressing practices that citizens engage in, such as eating or mobility, can contribute to more effective RE policy. It is instrumental to highlight policy contradictions in the current mix of policies and offer suggestions for stronger policy synergies. We offer a conceptual and empirical analysis based on the results of a large-scale survey (1200+ respondents) in three countries (Austria, Hungary, and The Netherlands), focusing on one of the most resource intensive consumption domains: mobility. We apply a framework that includes the social context of resource consumption, addressing how practices that citizens engage in are shaped by both “collective” physical infrastructures, the business models of products, social meanings, and regulatory incentives, and also by “individual” knowledge and skills, values, and financial capabilities. Our “web of constraints” perspective on RE highlights the interrelatedness of individual actor and collective factors. It is instrumental for an integrative policy discussion, addressing a range of factors hindering RE, anticipating policy contradictions, to capitalize on synergies.

ARTICLE HISTORY

Received 23 June 2018
Accepted 26 June 2019

KEYWORDS

Resource efficiency; practices; mobility; web of constraints; policy mix



Introduction

Policy communities face major questions about how industrial economies can be radically decarbonized and how surges in resource efficiency (RE) can be achieved. Research on innovation and the environment over the last thirty years has emphasized the importance of assessing the level of technological systems and examining the link between technologies and the institutional settings in which they are embedded (Berkhout 2002). In practice, however, environmental policy is only moving slowly from a focus on promoting environmental technologies to a focus on greening socio-technical systems (Ashford and Hall 2011). This article seeks to contribute to this move by offering an approach that addresses practices that citizen-consumers engage in—so far largely neglected in RE policies—where people use resources more or less efficiently through activities such as eating, traveling, and working. The analytical focus on practices is important because, more than through technology alone, resource use is driven by people’s behavior and the ways that it unfolds within social structures and technical

infrastructures, which are to a significant extent shaped by policies.

Traditionally, most behavioral studies on the resource inefficiency of households are rooted in either economic theories (“economic rationality”) or social psychological theories (“attitude change”). Recent work, however, suggests that both approaches underestimate the importance of the social context and infrastructure. We, therefore, apply a framework that explicitly includes the social context of resource consumption, addressing how consumption behavior is shaped by both “individual-actor” knowledge, values, and financial capabilities and interacts with “collective” physical infrastructures, social norms, supply characteristics of products and resources, and policies.

Our broad approach is inspired by theories of social practices and offers new ground for the RE policy debate. Over the last three decades, innovation studies using system approaches have demonstrated that innovation emerges from the interaction of multiple actors. In terms of innovation policy, Soete and Arundel (1995) argued for a combination of policy instruments because a single policy is

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unlikely to address multiple actors and factors. More recent work on policy mixes has addressed the interactions of different policy instruments (Lehmann 2012), the ways in which policy design influences (long-term) policy targets (Kern and Howlett 2009), and the necessarily complex and messy “real-world context” of policies in which every new policy interacts with existing policies and undergoes a design process alongside other policies under development (Flanagan et al. 2011; Rogge and Reichardt 2016).

Although an emergent and more systemic focus of policy research and practice for the advancement of sustainability transitions are clearly visible, efforts appear unbalanced in terms of an overemphasis of the supply side (Kern et al. 2019). Among recent studies of various resource end-uses, this article seeks to address this gap by offering an empirical analysis of private end-users’ consumption patterns in the mobility domain. It revisits Soete and Arundel’s system approach to environmental innovation through the notion of a “web of constraints” on RE to highlight the interrelatedness of individual-actor and collective factors. This web-based perspective suggests a need for policy mixes, consistently addressing a range of factors hindering RE, to anticipate potential antagonistic effects among individual, supply-side, and infrastructural factors and to capitalize on synergies and counteract rebound effects. Accordingly, we do not aim to develop new policy measures as such, but offer insights regarding policy contradictions and suggestions for stronger policy synergies in the mix of current measures for RE mobility practices. In line with Kern and Howlett (2009, 395), we define policy mixes as “complex arrangements of multiple goals and means which, in many cases, have developed incrementally over many years.”

A focus on consumption practices nested within socio-technical systems indeed suggests a different approach to policy making, one that addresses additional factors beyond technological research, development, and deployment. This article seeks to contribute to the study of policy mixes by focusing on the “web of constraints” on RE practices. More concretely, the notion of “webs of constraints” allows us to highlight both conceptually and empirically possible contradictions as well as opportunities for synergetic effects among different policies targeting the same socio-technical system. In other words, the focus of this work concerns the consistency of policy mixes, which following Howlett and Rayner (2013, 174), can be defined as “the ability of multiple policy tools to reinforce rather than undermine each other in the pursuit of policy goals.” To this end, the results of a large-scale survey (more than

1200 respondents from Austria, Hungary, and the Netherlands) are combined with other relevant research findings to enable an exploration of (in-)consistencies in RE policies by means of a causal-loop diagram (Montibeller and Belton 2006; Enserink et al. 2010). Although the original survey addresses three of the most resource-intensive consumption domains, mobility (i.e., “the way people travel”), food, and energy-use at home, due to space constraints we focus only on the mobility domain and discuss how an analysis addressing practices in which citizen-consumers engage can contribute to more effective RE policy. The key question of this contribution is: how can policy mixes more consistently address the “web of constraints” on (more) RE mobility practices?

This article is structured as follows. In the next section, we elaborate our conceptual approach and method to study resource-intensive practices as driven or constrained by a number of interrelated factors. The third section discusses drivers and constraints on RE practices within the mobility domain as obtained through a survey in three aforementioned countries. In the fourth section, we offer a theoretical reflection on the empirical findings and the concluding section outlines the implications of a “web of constraints” perspective on policy for RE.

Conceptual approach

Understanding resource (in)efficiency in terms of individual behavior and social practices

Innovation scholars have developed systems perspectives on innovation, not to suggest that there is a consciously designed or smoothly functioning entity, but to argue that there is a set of actors, institutions, and technologies whose interactions (and not one of the parts) give rise to a certain level of innovation and sustainability (Ashford and Hall 2011). Similarly, our “web of constraints” view takes a system perspective but deviates from a focus on the country level (national innovation system or NIS), or region (regional innovation system or RIS), or technology (technology innovation system or NIS). These other approaches have been centrally concerned with the supply side (such as national, regional, or sectoral technological capabilities; see Nelson and Rosenberg 1993; Wieczorek and Hekkert 2012).¹ Our understanding, by contrast, foregrounds practices (i.e., the way people travel, eat, or live), yet acknowledges that practices are shaped by the supply side, including dominant and emergent business models, infrastructures, and policies (see Figure 1).

Since Lutzenhiser’s (1993) thorough and still widely cited review of social and behavioral aspects

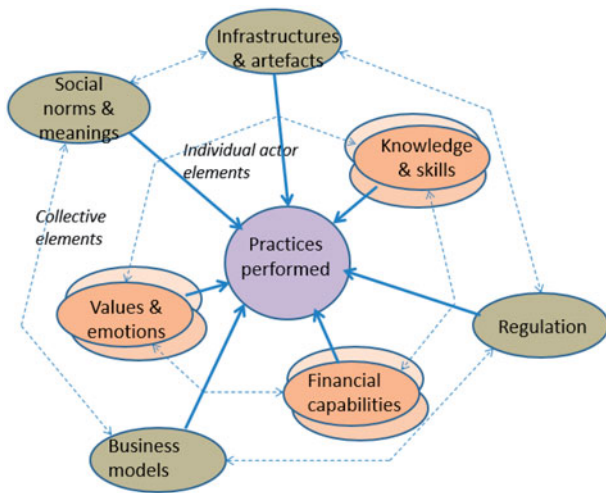


Figure 1. The “web of constraints” of individual-actor elements (orange) and elements in the collective context (brown) shaping everyday practices.

of energy use, which argued that the role of human social behavior has been largely overlooked both in economic approaches (“economic rationality”) and psychological approaches (“attitude change”) to understanding energy use, further research has corroborated this contention. For example, socio-demographic factors (income, household size, and age), have been shown to affect residential energy use most significantly (Abrahamse and Steg 2011) while information campaigns targeting attitudes and economic incentives to bring about consumption reduction show varying results at best (Wilson and Dowlatabadi 2007). These findings have contributed to calls for more integrated approaches to studying and influencing residential energy use. More specifically, variation in energy use and differences in responses to sustainability initiatives have led us and others (Wilson and Dowlatabadi 2007) to conclude that approaches that bridge more individually and more contextually focused schools of thought can provide more comprehensive insights and contribute more effectively to sustainability efforts.

Research in the fields of social and environmental psychology has drawn attention to the relevance of context and the role of habits (Steg and Vlek 2009), as well as to situational factors and unconscious processes (Gaspar 2013). Recent investigation pertaining to sustainable behavior has sought to identify the effect strength of different individual and situational barriers and constraints and given rise to the “intention-behavior gap.” Researchers have drawn a distinction between barriers and constraints as psychological factors that interfere with the activation strength of behavioral goals or that, alternatively, inhibit the activation of pro-ecological goals altogether. In addition, recognizing the largely unconscious relative weighting that occurs during

decision-making processes, internal, subjective constraints have been differentiated from external, objective constraints (Gaspar 2013). Yet, studies have identified factors such as household finance and the social organization of public life, including public spending, as the most significant factors shaping “well ingrained habits and practices among individuals and households” and thus determining resource consumption (Newton and Meyer 2013, 1211).

Sociological approaches to human behavior examine the embeddedness of behavioral patterns in more complex constellations of daily life settings and lifestyles (Brunner 2007), social interactions and networks (Middlemiss 2008), socio-technical systems (Shove and Warde 1998), social practices in general (Röpke 2009), and systems of provision (Seyfang 2008). Social practice theories understand the dynamic of social practices as based on the reproduction of praxis, thereby doing away with the distinction of structure and agency on which social psychological approaches rely. In this view, new social arrangements result from an accumulation of numerous individual decisions and behavioral strategies about how to act most suitably (Shove et al. 2012). Practice-based thinking has already been applied to various fields of pro-environmental change, such as daily consumption of food and energy (Gram-Hanssen 2011; Jaeger-Erben 2010; Jackson 2005); recycling (Hargreaves 2011), and sustainable housing (Shove 2003).

Social practice approaches are useful in understanding how resource consumption is a constituent part of people’s daily activities, yet largely inconspicuous (Shove and Warde 1998; Spurling et al. 2013). In contrast to behavioral approaches that highlight self-reflection and self-awareness as triggers of pro-environmental behavioral change, social practice understandings assume that only a “disruption” of the practice-performing-process or a change of settings will lead to a reflection on or change of current undertakings (cf. Jaeger-Erben et al. 2011). Social practice approaches highlight that individual (domestic) consumption practices are the result of people’s participation in social (collective) practices and settings. “It is the fact of engagement in the practice, rather than any personal decision about a course of conduct, that explains the nature and process of consumption” (Warde 2005, 138). Shove et al. (2012) argue in line with social psychological research, albeit from a radically different perspective, that much of the consumption that matters for environmental sustainability is habitual, recurrent, and ordinary. In other words, psychological and sociological approaches to sustainable consumption behavior agree that strategies designed to steer

activities in pro-environmental directions have to grapple with this routinized aspect.

Combining elements of social psychological and practice theoretical approaches discussed above, we adopt a conceptual framework for understanding (resource-inefficient) behaviors that combines several individual-actor features with insights from the collective context of actors in a “web of constraints” on RE behaviors (see Figure 1). On one hand, our framework builds on a widely used model of social practices (Shove et al. 2012) consisting of three types of elements: *materials* (that we label as “infrastructures and artefacts”), *meanings* and *capabilities* (that we split into “knowledge and skills” and “financial capabilities”). On the other hand, recognizing the relevance and explanatory power of psychological studies, we deviate from this model of social practices by distinguishing (individual-) actor elements from collective elements: in addition to the two types of capabilities previously noted, individual-actor elements also include “values and emotions.” In addition, we introduce two more collective elements: business models and regulatory incentives and disincentives as deployed through policies. In contrast to established practice approaches, our framework thus highlights individual-actor and collective structural elements in a balanced way, suggesting that, mutually shared context, including physical infrastructures, business-model structures for products and resources, social norms and meanings, and regulatory incentives “recruit” actors with matching knowledge, values, and financial capabilities. While we recognize the ontological tensions and epistemological challenges of our interdisciplinary perspective on “practices,” we have opted for this pragmatic approach to ensure that our focus on collective contextual elements does not imply forfeiture of the known importance of personal capabilities and limitations, as well as regulatory and business structures, the latter being neglected in current social practice approaches. From this perspective, the success of (policies for) behavioral change depends on a well-balanced mix of individual intents (as motivating factors) and shared contextual elements (as a stimulating system of provision).

Whereas current policies are still mainly centered on “simple substitution of or changes to product and processes, pollution control, energy conservation and finding new energy sources,” a new generation should concentrate on influencing consumers and suppliers to adopt sustainable practices (Ashford and Hall 2011, 10). The analysis in this article seeks to show that this framework can help to discuss and compose such (sets of) policies.

Table 1. Categories in conceptual framework and related survey questions.

Framework (see Figure 1)	Related survey questions
<i>Individual elements</i>	
Values and emotions (E1)	Environmental values, driving pleasure, health-related motivations, status of owning a car
Knowledge and skills (E2)	Knowledge of energy labels, fuel economy, driving license
Financial capabilities (E3)	Cost-related motivations
<i>Collective contextual elements</i>	
Infrastructures and artefacts (E4)	Access to/quality of public transport, cycling, and cars
Regulatory incentives (E5)	Role of subsidies, energy labels
Supply side/business models (E6)	Supply of rental cars, car-sharing
Social norms (E7)	Social (dis)approval

Methods

We operationalized the framework in the form of a survey that was inspired by the results of two focus groups, one in Hungary (twelve participants) and one in Austria (ten participants). Table 1 shows how we addressed each element of the framework by asking participants about particular aspects for the case of mobility.

The questionnaire centered on travelers’ knowledge, values, and financial capabilities in relation to shared physical infrastructures, the supply side of products and resources, social norms, and regulatory incentives. A survey allows for the generalization of findings to larger groups of people and, hence, adds to the scientific rigor of this study and the reliability of our findings. A shortcoming of this and other similar methods that are used to study people’s behavior and willingness to consider lifestyle changes is that the findings are inevitably based on *reported* preferences or behaviors. This implies the possibility of a social desirability bias, particularly among people who are rather knowledgeable about which answers are the “most appropriate” given the aims of the survey. Only ethnography allows for the development of data based on direct observation, but it is a highly time- and cost-intensive method. For these reasons, and since we wanted to obtain quantitative and more generalizable insights, we exercised care when interpreting our results and describe “reported behaviors” or “indicated preferences” to denote that our work is not predicated on directly observed behaviors or preferences.

In total, the survey comprised 147 questions. The overall target group for the survey, and hence the subsequent panels, consisted of adults living in Austria, Hungary and the Netherlands. The inclusion of these three countries gives us the opportunity to highlight potential differences and similarities in RE practices across geographically, historically, culturally, and politically different parts of Europe (Western, Central, and Eastern Europe) that are

roughly comparable in terms of population size and geographic area.² Since it was a web-based survey, only potential respondents with access to the Internet were able to participate.

Data analysis

The following sections on the influence of individual and collective elements on specific practices are primarily based on the results obtained from logistic regressions. In contrast to ordinal regression analysis, a different link function between the independent and dependent variables is assumed. According to the particular distribution of the dependent variable, either a logit or a negative log-log link function was chosen. We tested all regressions for model fit, outliers, multicollinearity,³ dispersion, and parallelity of lines (relevant for ordinal regressions only).

Sample characteristics and representativeness

The Dutch sample was stratified and is thus (approximately) representative of the general population of the Netherlands in terms of gender, age, education, and geographical region. The Austrian and Hungarian samples were, due to budgetary constraints, only stratified by gender and age. [Appendix 1](#) discusses the representativeness of the three country samples in more detail.

Constraints of pro-environmental behaviors

This section discusses drivers and constraints on more RE practices with a focus on interrelatedness of the elements (indicated as E1–E7, as in [Table 1](#)). As noted, we highlight here one particular domain, mobility, whereas findings regarding the food domain (Backhaus, Wieser and Kemp 2015) and resource consumption at home, as well as an analysis of behavioral (in)consistencies across domains, have been reported elsewhere (Kammerlander et al. 2014). Notably, our survey results substantiated an earlier study (Truelove et al. 2014) that also found low behavioral consistency across consumption domains.

Mobility practices performed: characteristics and differences

The general modal split across the three countries showed some similarities as well as a few significant differences in mobility patterns. In particular, the use of air travel varied markedly: 39% of the respondents in Hungary, 46% in the Netherlands, and 57% in Austria flew once or more per year. The

majority of people (75–85%) in all three countries flew for private reasons.⁴ Bicycle ownership was significantly different across the countries: while 90% of respondents in the Netherlands owned a bike, only 74% did so in Austria, and 65% in Hungary ($H(3) = 57, 130, p < 0.01$). Car ownership also showed notable differences across the countries. About 83% of the Dutch respondents owned a car or were part of a household that owned a car and the rate of automobile ownership in Austria (81%) was similar but considerably lower in Hungary (65%). In all three countries, very few people were members of a car-sharing club or organization: 5% in the Netherlands, 4% in Austria, and 7% in Hungary. In comparison, a considerably larger percentage of people—14% in the Netherlands, 16% in Austria, and 9% in Hungary—reported that a car-sharing platform was available in their neighborhood.

Mirroring findings on ownership and accessibility of different means of transportation, the survey revealed relevant insights for the 20–35% of the respondents without (access to) a car ([Figure 2](#)). Differences regarding walking and car-sharing were not large across the countries, use of public transport was moderately larger in Austria (87%) and Hungary (77%) than in the Netherlands (67%). A clear difference was noted between the Netherlands (81%), on one hand, and Austria and Hungary, on the other (31% and 24%, respectively), in the case of bicycle use. This finding suggests a comparably stronger cycling culture in the Netherlands, which corresponds with earlier studies (e.g., Pucher and Dijkstra, 2000; De la Bruheze and Veraart, 1999).

Distribution of the average distance that people who have a car available drive in a week evinced a fairly similar pattern in the three countries, as shown in [Figure 3](#). The statistical mode was highest for Austria (in the 50–100 range) and lowest for the Netherlands (in the 20–50 range). In this regard, it has to be taken into account that the Dutch population is twice as large but occupies a land area half the size of Austria. Although the distribution suggests that the average distance driven per person per week was highest in Austria and lowest in Hungary, the regression analysis did not indicate significant country differences.

How do car owners usually make short trips of 2–5 kilometers (km)? Here the difference in bicycle culture draws again a separation between the Netherlands, on one hand, and Austria and Hungary, on the other (see [Figure 4](#)). In the latter two countries, a small majority (51%) used its car for these shorter trips, whereas in the Netherlands a significant majority traveled by bicycle (65%) at the expense of the other three modes, especially public transport.

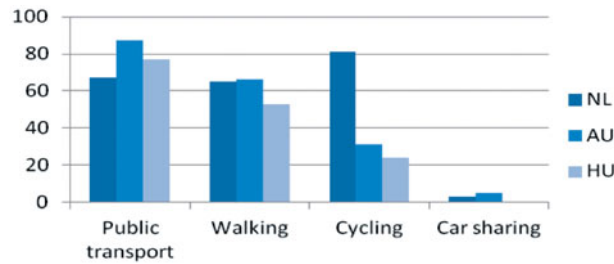


Figure 2. Mode of transportation across countries of respondents without (access to) a car (based on answers to the question: “Which means of transportation do you use more often—multiple answers possible?”).

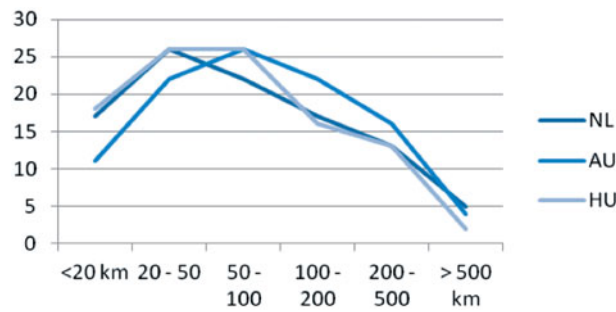


Figure 3. Average car distance driven per week across countries.

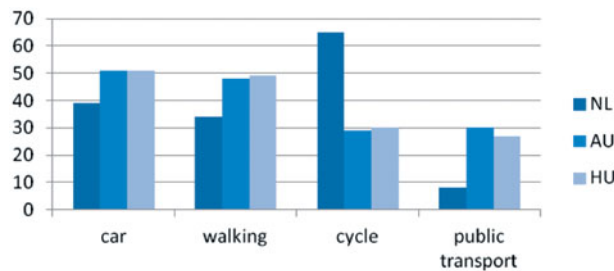


Figure 4. Modal split across countries for short distances (2–5 km).

Willingness to drive less

To develop insight into people’s inclination and motivation to reduce their car use, the survey asked respondents to indicate whether they would like to use their vehicles less frequently—and if so, why. The share of respondents indicating that they would like to drive less was 40% (Netherlands), 51% (Austria), and 58% (Hungary). The differences are statistically significant different across the countries ($H(3) = 19.961, p < 0.01$). Occupation is a strong predictor for why people would like to reduce their mobility ($H(8) = 15,399, p < 0.05$), with regular employees, managers, self-employed, and, surprisingly, retired people being less likely to willingly decrease their car mobility than stay-at-home parents and unemployed persons. Less unexpectedly, the first three groups also used their car significantly more frequently for business reasons and also drove more kilometers per week than stay-at-home parents.

The main motivations for why people would like to use their car less are shown in Figure 5. In all three countries, private/individual benefits are the

most popular reasons why reducing car mobility would be appreciated: less cost (which corresponds to element E3 of the framework, see Table 1)⁵ and more physical exercise (E1), also in that order of importance in all three countries. Benefits for the environment (E1, E2) were only third, indicated by 38% (Netherlands), 57% (Austria), and 28% (Hungary). Saving time was reported less frequently, possibly because of a more extensive road infrastructure (E4) that gives the car a time advantage. But the question may have been interpreted differently depending on whether people feel some trips are simply necessary or know which mode of transportation would in practice be the more time-efficient alternative.

Differences in motivations provided are statistically significant across countries (“to save money”: $H(3) = 63.898, p < 0.01$; “to get more exercise”: $H(3) = 31.324, p < 0.01$; “to protect the environment”: $H(3) = 35.758, p < 0.01$).

Beyond country variations, the difference in occupation type is statistically significant for the

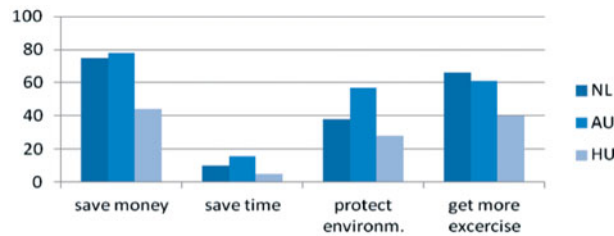


Figure 5. Main motivations for wanting to use the car less.

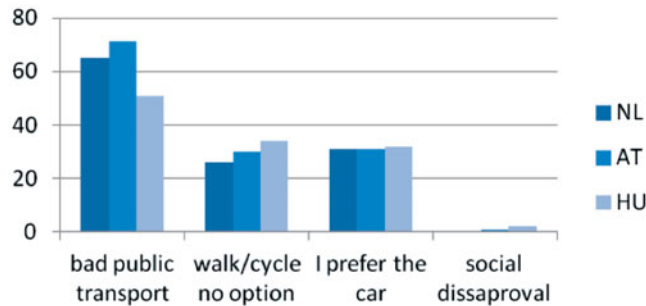


Figure 6. Constraints to further reduction of car use.

reason “to save money” ($H(8) = 18.072, p < 0.05$), possibly because managers, business owners and self-employed often do not pay for their trips themselves. Surprisingly, no significant differences with respect to income level were found ($p = 0.087$). Education level is the most significant variable explaining the variation in the reason “to save money” ($H(4) = 21.259, p < 0.01$), whereas age, city size, and gender are not significant.

For the other three motivations, “to save time,” “to protect the environment,” and “to get more exercise,” we did not find many significant social group-specific explanatory variables, except that variations in “to get more exercise” (E1) can be explained by education level ($H(4) = 19.843, p < 0.01$) and income (E3; $H(4) = 18.555, p < 0.01$).

Constraints on car-use reduction

Respondents who did not flag any interest or willingness to reconsider their personal car use were prompted to indicate the factor(s) keeping them from making adjustments. A share of 28% of all respondents indicated that they had reduced their car use already to a minimum, 38% in the Netherlands, 31% in Austria, and 16% in Hungary. Why was it seemingly so difficult to reduce car mobility further? Figure 6 shows the responses.

The experienced lack of good alternatives was the most frequently mentioned reason for “not being able to reduce car mobility further,” especially the quality of public transport (for 64% of the respondents; E4), but also that walking or cycling are not good options (for 29%). Another third of the

respondents indicated that they (simply) preferred car driving (31%). These findings correspond with other research that has found that a large majority of people are unwilling to invest time or money in “greening” their transportation choices (Gaker and Walker 2013). Social disapproval of not using the car (E7) does not seem to play a role in our survey results.

Across the three countries, responses are similar, especially the preference for car driving and with respect to walking and cycling not being seen as viable substitutes. Only the difference in appreciation of public transport as an alternative is statistically significant ($H(3) = 11.902, p < 0.01$). Surprisingly, despite the high-density public transport network in the Netherlands, and to a lesser extent in Austria, the rejection of public transport as an option is higher compared to Hungary. This finding may be explained by the expectations many travelers hold because people accustomed to a high level of convenience (of individual car mobility) may have less appreciation for public transport services.

More complete analysis of the motivations behind the statements for why people are unable to reduce their car use further revealed the following. For the reason “public transport is a bad alternative” (E4) only education showed significant explanation ($H(4) = 11.604, p < 0.01$). At first glance, it may seem peculiar that city size has no explanatory value, given the generally better public transport networks in larger cities. However, according to Dijst et al. (2002), this only holds for city centers, while in more suburban neighborhoods the service and

usability of public transport decreases. In these suburban areas, car trips are deemed more attractive (Schwanen et al. 2002).

Regarding “walking/cycling is a bad alternative,” occupation shows significant explanatory power ($H(8) = 20.739, p < 0.01$) and especially employers are much more likely to agree than retired people. Age is relevant to some extent ($H(6) = 13.286, p < 0.05$), which may be explained by some groups being especially fit for cycling and walking (students, young people), and others less inclined or unable to use nonmotorized forms of mobility (older/retired people; E2).

People with an explicit preference to drive were somewhat more likely to belong to higher income (E3) groups ($H(4) = 10.265, p < 0.05$) and gender also had some explanatory power ($U = 26740, 500, p < 0.05$).

Finally, the variation of social disapproval of not using the car (“others would find it strange”; E7), was partially explained by age ($H(6) = 11.741, p < 0.05$).

Motivations for not owning a car

An overall share of 24% of respondents indicated that they did not have access to a car (E4). As mentioned above (in the context of car ownership/access), this is 17% in the Netherlands, 19% in Austria, and 35% in Hungary. We asked why they did not own a car and Figure 7 shows the results.

The most reported reason was that not owning a car is cheaper (56%; E1, E3⁶), and a significant share simply did not have a driving licence (43%; E2). Other motivations such as “care for environment” (E1) and “not owning a car is more convenient” (E1) were chosen by 15% or less of the respondents.

As for country differences, “care for the environment” was significantly lower in Hungary (with 9% compared to 18–22% in the Netherlands and Austria; $H(3) = 7.7285, p < 0.05$) and “I can easily borrow or rent a car” (E4) was much higher in Austria with 22% compared to 7% in the

Netherlands and Hungary ($H(3) = 12.980, p < 0.01$). For the other motivations, we did not find any statistically significant differences.

Income is the single-most important individual condition that explains why respondents own a car (E3). People with an annual income below €10,000 were thirteen times less likely to own a vehicle than those with an income above €30,000 ($OR = 13.11, B = 2.574, p < 0.01$); households with an income between €10,000 and €20,000 were still more than three times less likely ($OR = 3.37, B = 1.214, p < 0.01$). Further, people in the lowest age group (18–25) were more than five times less likely to own a vehicle than those above 65 ($OR = 5.45, B = 1.695, p < 0.05$). Finally, respondents in settlements with less than 5000 and between 5000 and 20,000 inhabitants were two and a half to three and a half times more likely to own a car than those in a city with more than a million residents (respectively, $OR = 0.38, B = -0.964, p < 0.05$; $OR = 0.28, B = -1.272, p < 0.01$).

Few social group-specific variables explained the difference of appreciation of the three aforementioned motivations. For the reason “it is cheaper” (E3), only gender ($U = 8384, p < 0.01$) and age showed some significant explanation ($H(6) = 14.783, p < 0.05$), with the 46–55 age group being less likely to agree. The reason “care for the environment” (E1) was positively related to income level (E3; $H(3) = 8616; p < 0.05$), while “no driving licence” (E2) pertained more to women than to men ($U = 8694, p < 0.01$).

Buying a car

The share of respondents with new cars differed significantly among the three countries with 50% in Austria, 39% in the Netherlands, and 31% in Hungary. Austrians are almost twice as likely to own a new vehicle than the Dutch ($B = -0.571, OR (odds ratio) = 0.56, p < 0.01$). The difference between Austria and the Netherlands can be explained by a different level of VAT on new cars (E5). More recent models are generally more fuel-efficient than older

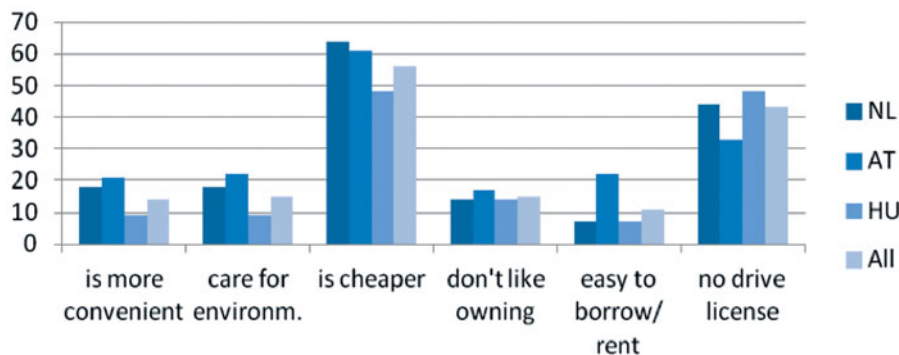


Figure 7. Motivations for not owning a car.

cars, but this is sometimes (negatively) offset by their weight: new cars are often somewhat heavier, which renders the fuel use roughly equal.

The Dutch tended to own smaller vehicles than Austrians and Hungarians. The share of small cars⁷ was 42% in the Netherlands, 21% in Austria, and 31% in Hungary. Further study on the national road tax (E5) would be interesting to see if this variable explains the significant differences ($H(3) = 23.480$; $p < 0.01$), especially between Austria and the Netherlands.

We asked respondents with new vehicles if they knew the energy label of their car (E2). Three-quarters of Austrians and Hungarians did not know (71% and 68%, respectively), while in the Netherlands only 34% did not know. The significant difference between Dutch vehicle owners and their counterparts in the other two countries is probably explained by VAT reduction or exemption schemes being linked to the energy label in the Netherlands. A total of 51% of those who did know their label in the Netherlands had an A or B label⁸ compared to 21% and 25% in Austria and Hungary, respectively.

Overall, 15% of respondents did not know the fuel use per 100 km of their vehicle (E2), but this differs significantly across countries: 23% in the Netherlands, 12% in Austria, and 6% in Hungary. More than three-quarters of participants in the survey (78%) reported that they took notice of the fuel consumption of their vehicle (71% in the Netherlands, 82% in Austria, 84% in Hungary) when purchasing a car and considered this criterion in the decision. Regarding the weight of the vehicle, the share was much lower (47%) and there was greater difference among countries: 56% and 59% in the Netherlands and Hungary, respectively, and 28% in Austria.

Similar to “buying a car,” income (E3) is also an obvious reason for owning a new or a second-hand car: higher income groups can be expected to buy newer, more expensive vehicles (E4). This was only partly confirmed in our survey: only the income groups below €10,000 are four times less likely to own a new vehicle than income groups above €30,000 ($OR = 4.04$, $B = 1.402$, $p < 0.01$). A possible explanation for the lack of explanatory value of the other income groups is the confounding influence of company vehicles that are generally new and not closely connected to a specific income group (but more linked to labor type/sector). Also, households with a certain budget for a car may prefer a larger, second-hand vehicle rather than a smaller, new vehicle of the same price.

Age was not a significant predictor for owning a new or second- (or older) hand car. The oldest age group (>65) was more likely to own a new vehicle than all other age groups. Regarding the size of the vehicle, we found that higher income groups were more likely to own larger vehicles ($H(4) = 22.698$;

$p < 0.01$). Also, gender played a role: men were more likely to own a larger vehicle ($H(2) = 14.328$; $p < 0.01$). Fuel use of the vehicle was related to income: the higher the income, the greater the fuel use ($H(4) = 9.789$; $p < 0.05$). Finally, women were less likely to consider the weight of the vehicle when purchasing a car ($H(2) = 12.159$; $p < 0.01$). Age proved to be a strong explanatory variable as well: older people were less likely to consider the weight of their car at purchase ($H(6) = 31.344$; $p < 0.01$). Values offer little explanation. The only statement that was significantly related to owning a car was “A career and status are important to me” (E1): the more important career and status were to people, the more likely they were to own a new vehicle, which is hardly surprising.

Consistency in mobility behaviors

Taking a closer look at the consistency of pro-environmental behavior within one particular domain (mobility), we find that many mobility practices were significantly related to one another (see Table 2). Also, correlation coefficients were within the same range, all but one being lower than 0.3. The strongest relationship appeared to be between the actual fuel consumption of the car and consideration of its fuel consumption at the moment of buying the car ($r = 0.316$, $p < 0.01$). The positive relationship indicates that people who take automotive fuel consumption into consideration are ultimately more apt to choose a car with lower fuel consumption and potentially also drive more fuel-efficiently. This consideration was also relatively strongly correlated to the calculation of the total distance and associated costs of a trip by car ($r = 0.237$, $p < 0.01$) and, as assumed, fuel-saving car-driving behavior ($r = 0.269$, $p < 0.01$). The significant relationship between calculation of the total distance and associated costs and the three practices related to fuel consumption suggests that this outcome was at least partly based on financial considerations (E3). The regression analysis reported above also revealed that the reason for driving fuel-efficiently is rather to be found in differences among income groups rather than in environmental concerns.

This analysis further suggests a weak correlation between car use and the frequency of flying ($r = 0.141$, $p < 0.01$). This positive correlation is probably due to people who travel mainly for business reasons. To test this supposition, we calculated a Spearman partial correlation which controls for the reasons for flying and driving and it showed a correlation coefficient of 0.059 ($p = 0.2$) that is clearly below the coefficient obtained above. This outcome can be interpreted as an indication that the

Table 2. Correlation coefficient matrix for mobility practices.

	Q56 flights per year	Q59 member car-sharing	Q64 car-energy label (E2)	Q65 informed fuel consumption (E2)	Q67 drive alone	Q68 car-use distance	Q70 car-fuel consumption	Q71 consider cost (E1/3)	Q74 save fuel driving
Q56	–								
Q59	–0.130**	–							
Q64	–0.046	0.086	–						
Q65	–0.042	0.020	0.088	–					
Q67	–0.007	–0.065*	–0.047	–0.109**	–				
Q68	0.141**	0.027	–0.074	–0.005	–0.201**	–			
Q70	–0.015	–0.043	0.115*	0.316**	–0.058	–0.031	–		
Q71	0.008	0.083*	0.024	0.237**	–0.179**	0.044	0.091*	–	
Q74	0.057	0.029	0.078	0.269**	–0.066*	–0.008	0.124**	0.216**	–

Note: A * (**) indicates that the coefficient is different from zero at a 5% (1%) level of significance; light grey areas indicate correlation coefficients between 0.1 and 0.3, dark grey areas indicate correlation coefficients above 0.3.

positive correlation between car and plane use might indeed be due to traveling for business purposes.

As expected, less knowledge of energy labels on cars was associated with higher fuel consumption ($r = 0.115$, $p < 0.05$). Furthermore, flying frequently and being a member of a car-sharing platform was negatively correlated ($r = -0.130$, $p < 0.01$), suggesting that people who fly frequently are less likely to make use of car-sharing.⁹

Discussion

Knowledge about climate change (E2), concern about resource consumption, and environmental values (E1) had extremely weak bearing on the behavioral choices that respondents reported in this study. In other words, behavioral change campaigns that aim to inspire lifestyle adjustments solely by offering more or better information about the environment—and resource-related challenges the world is facing—are unlikely to be effective (Gaspar de Carvalho et al. 2010; Kahan et al. 2012; Wilson and Dowlatabadi 2007). If asked to provide justification or motivation for RE consumption choices, such as less car driving, responses varied across different socio-demographic groups (see Kammerlander et al. 2014 for more details). While such findings have inspired calls for more tailored communication strategies targeting different population segments by means of personally more relevant and appealing messages (European Environment Agency (EEA) 2016), our study suggests that communication alone will have a little, positive effect unless it is paired with institutional and infrastructural changes.

Focusing on the mobility domain, our survey findings indicate that personal car ownership is the default option for the majority (83% in the Netherlands, 81% in Austria, and 65% in Hungary) and an aspiration for a third of those who currently do not own a car. Our regression analysis showed how car ownership is stratified according to income. Financial considerations also featured prominently as an explanation for considering less frequent car use, driving a smaller or

more fuel-efficient car, more economical driving behavior and forsaking car ownership in the first place. The much-heralded decline in car use among millennials is likewise more likely to be due to financial constraints than environmental concerns (Jaffe 2014; Bastian et al. 2016).¹⁰ Critical analysts might thus say that viewed from an environmental perspective, economic recession is a good thing. However, the (perceived) lack of suitable alternatives might be sufficient reason for policy changes or interventions that provide comfortable and convenient transportation for all. Our survey findings indicate that walking or cycling are considered poor alternatives, likely attributable to total distance or elevation to be covered or due to personal health, for about 30% of all respondents. Poor public transport, however, was blamed for not providing a suitable alternative by as many as 64% of the respondents.

Our broadly-scoped survey was not designed to tease out details of people's critique and in-depth interviews would have been more suitable for this purpose (cf. Backhaus, Wieser, and Kemp 2015). Framing consumption patterns as "by-products" of people's practices allows widening policies beyond mere information, economic incentives, or nudging (Reardon, Marsden, and Shove 2016, Umpfenbach 2014, Spurling et al. 2013). Our preceding focus groups were useful for discussing deeper structural issues of culture, education, and power. For instance, the traditional association of car ownership as a status symbol is still something participants recognize due to cultural factors and desirable media depictions. Also, the lack of awareness of resource problems was seen as widespread and, at the same time, information provision of RE mobility practices and opportunities was regarded as limited. Like the survey, the focus groups indicated cultural differences and the need to consider regional settings in policy development. For example, negative experiences in the country's political history and mistrust that others would exercise shared responsibility are apparently strong constraints toward acceptance and deployment of car- and bicycle-sharing schemes in

Hungary. In the next section, we put forward the notion of a “web-of-constraints” that helps to conceptualize relevant factors, their interrelations, and policy implications when thinking about RE policy.

The “web-of-constraints” and its implications for policy

We investigate in this section some of the policy implications for the case of RE mobility starting with a discussion of policies currently in place. Through the year 2000, in countries that are members of the Organization for Economic Co-operation and Development (OECD) policies affecting individual mobility were mainly associated with congestion and local air-quality issues (Banister et al. 2011). Local parking policies, national road taxes, and infrastructural policies, as well as European emission regulations before this year, were aimed at mitigating these two issues while refraining from restricting (growth in) travel. Concerns about expanding transportation demand were primarily framed as economic rather than environmental issues (e.g., Wachs 1993). The response to congestion, for instance, at the time was to increase the supply of infrastructure, especially for cars.

After the millennial turn, attention to climate change began to influence mobility policies, which often adopted sustainable development as a guiding principle. In many countries, policies had been too weak to counter the growing popularity of larger automobiles and the general increase in mobility. New regulations triggered improvements in vehicle-fuel efficiency but did not address the trend of buying cars with more power and weight (especially sport-utility vehicles), thus leaving fuel economy constant or increasing slightly since 1990. Moreover, at least until 2005, the impact of marginally reduced energy intensity was outweighed by greater travel activity and larger numbers of cars, meaning that overall resource use continued to expand (Millard-Ball and Schipper, 2011).¹¹ At the urban level, a growing number of major cities introduced congestion charging which generally had the positive effect of reducing congestion (de Palma and Lindsey 2011). Policies did not always work in the same direction, with outcomes with respect to one measure occasionally contradicting others. For example, although cities developed park-and-ride facilities to stimulate car drivers to switch to public transport, they also improved the parking infrastructures in city centers which in combination tended to maintain personal car use as the most attractive option (Dijk and Parkhurst 2014). Our approach helps to highlight these kinds of inconsistencies and to shed light on their policy implications.

The web of constraints on RE personal car use

Our analysis shows that RE pertaining to mobility depends on many elements in simultaneous operation and dynamic interaction. Elements affecting RE are part of causal loops involving positive stimuli and impediments, creating a “web of constraints” (or conversely, a “web of drivers”). The concept includes both individual-actor elements and elements related to the shared context including supply, business models, policy, social norms, and infrastructures—and highlights their interrelatedness. Figure 8 sketches the web of constraints and drivers for RE passenger mobility in a stylized way, incorporating various findings from our survey and focus groups. To keep the diagram readable, it simplifies the matter into car versus non-car options to focus on the question of how to decrease personal automobile use.¹² Appendix 2 explains the diagram in more detail.

For instance, one of the policy tools implemented to shape mobility practices (indicated in red) is the level of national taxes on car mobility, Figure 8 shows that this instrument moderately increases the cost of car driving. As the survey results showed, cost is the most significant factor for people’s willingness to drive less. An increased preparedness to reduce automobile use can increase the RE of mobility, the latter being the key policy criterion in the diagram. A trend to more RE mobility practices will increase the profitability of business propositions catering to them which triggers similar and complementary investments. Such a process will generally increase the range of RE vehicles and services, which will, in turn, expand RE mobility practices. The latter loop of this sequence connecting the green elements in Figure 8, from more resource efficiency to more resource efficiency, is an example of a reinforcing feedback loop (e.g., Sterman 2000).

Since environmental values are *not* a very strong driver for resource-intensive practices, the transition to RE cannot rely on a transformation of values. Nevertheless, there is a significant group that would like to reduce their resource use. In the case of car mobility, almost half of the respondents (49%) indicated that they would like to use their car less.

Implications for policy

To be effective, policy mixes must be internally coherent and consistent,¹³ with policy makers aware of the effects of policy interaction. The present multi-layer policy context does not offer an unequivocal push for increasing RE. Our analysis (as summarized in Figure 8) highlights an important contradictory effect in the current policy mix (see Figure 9). It shows three of the four key policies in place (P1–3)

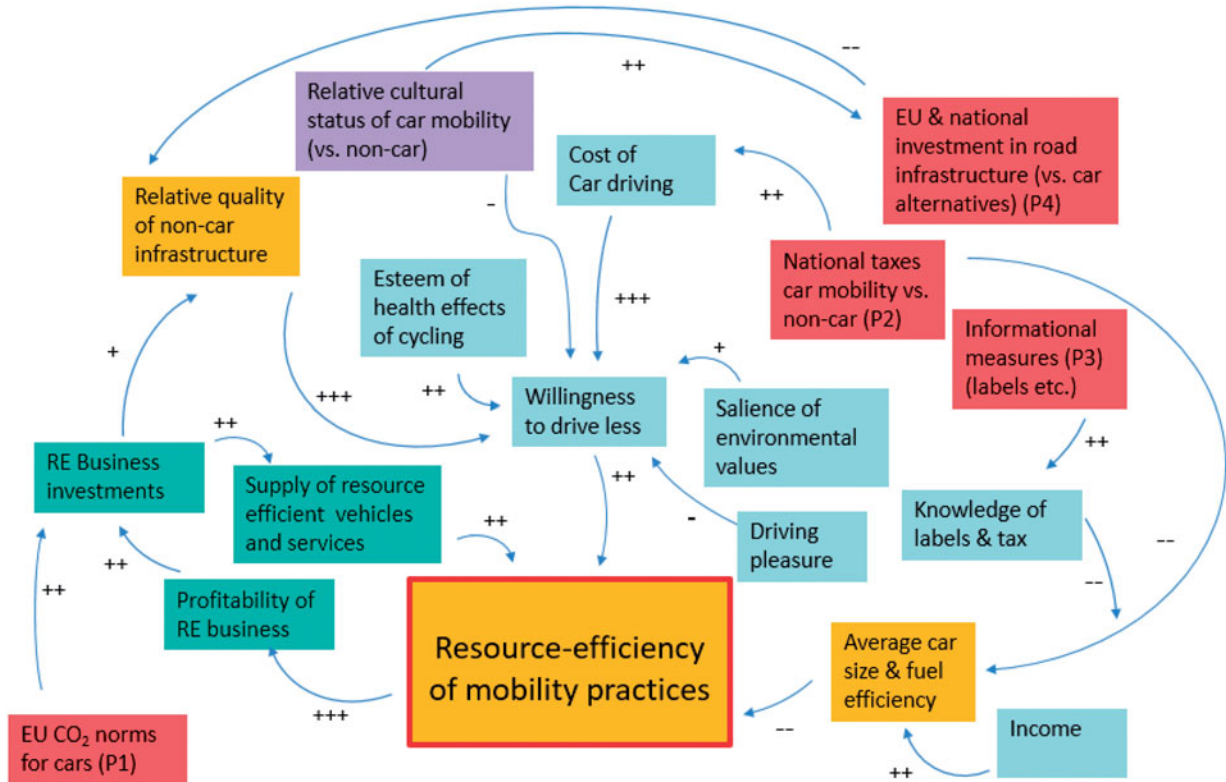


Figure 8. Cause-effect chains in passenger mobility. *Legend:* Individual elements (blue, E1-3) and collectively shared elements are divided into societal/infrastructural (orange, E4), policy (red, E5), supply/business elements (green, E6), and social norms (purple, E7). The relationships among the elements are indicated (as positive or negative, varying from - to +++). See Appendix 2 for further details.

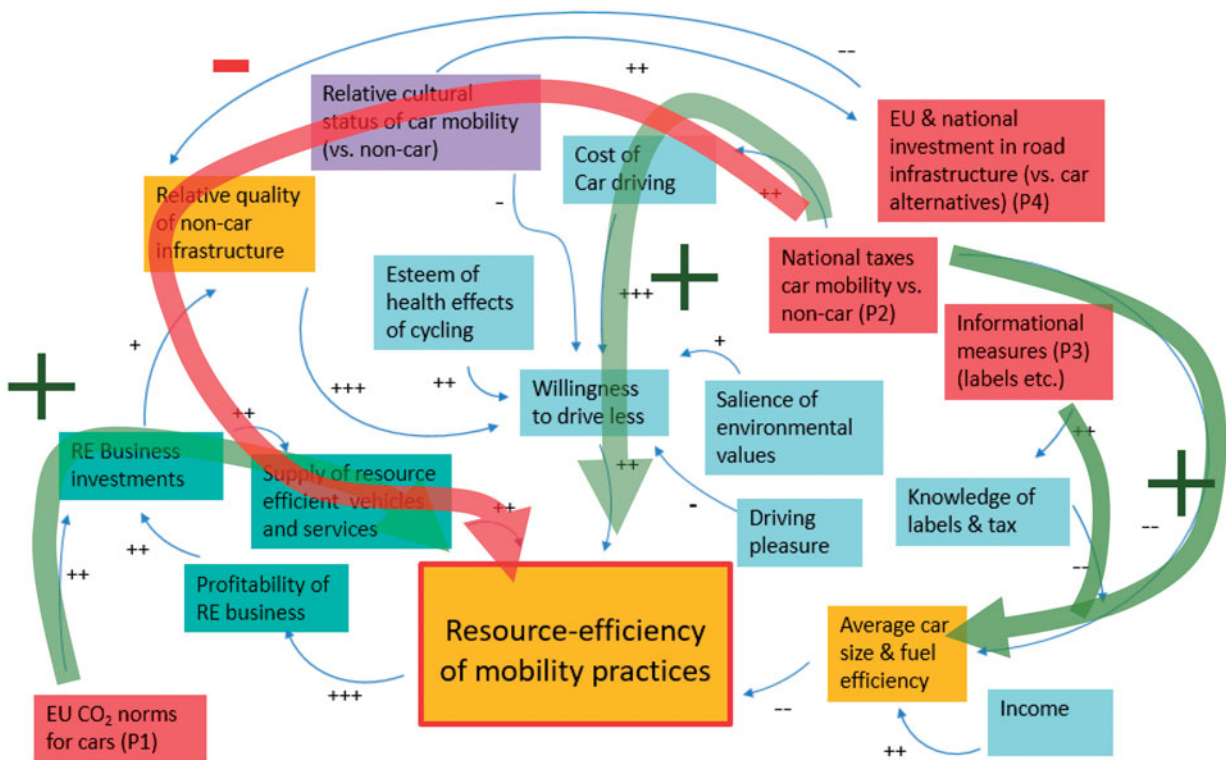


Figure 9. Highlighting the indirect effects of the four key policy instruments pertaining to the RE of mobility practices.

encouraging RE mobility to a fair degree, but one promoting the relative advantage of car mobility (P4). For instance, investments in road infrastructure (P4) in OECD countries have been higher than investment in public transportation and bicycling infrastructure, creating a competitive advantage for motorized personal mobility over alternatives. Rendering these particular options more inconvenient decreases people's willingness to drive less, which in turn obstructs the RE of mobility practices.

The challenge for promoting RE, facing a multitude of constraints, calls for policy mixes that turn vicious circles into virtuous circles of positive feedback—the generation of a “web of drivers.” For the mobility domain, our aforementioned web-of-constraints analysis can support this objective. It suggests that to do so, the policies already promoting RE (i.e., emission and tax regulation, informational measures; P1–3) need to be strengthened while infrastructural investments (P4) need to be redirected to change the contradictory effect into a synergistic effect. The overall rationale behind such a policy mix needs to be enabling and incentivizing a gradual modal shift from car mobility to non-car alternatives in coming decades, starting in urban areas. For the remaining amount of car-based travel, it will be necessary to reduce emissions per unit distance, and this will likely entail smaller vehicles and an increasing share of electric (and possibly hydrogen) mobility. More specifically, an effective mix of policies combines:

- P1: Implementation of policies at the level of the European Union (EU) that are in line with current emission targets to reduce the share of fossil-fuel vehicles and the average size of vehicles. These objectives will entail the adoption of vehicle-emission standards that lower the current EU-level norm of 130 grams of carbon dioxide (CO₂) per km to the (implemented) target of 95 grams by 2021, further decreasing toward practically zero grams per km by 2050 (consistent with the Paris Agreement).
- P2: Establishment of national policies to reduce car use and the average size of vehicles, thus addressing RE and importance of cost of car driving that we found. Achieving this goal will require a shift from tax on ownership (“road tax” or “vehicle tax”) to “tax on use” (this may be implemented on a budget-neutral basis). Such a “kilometer-tax” could be made dependent on the place and time of driving and CO₂ emissions of the vehicle.¹⁴ The highest tariff would be applied in city centers.
- P2: Adoption of a set of national policies to reduce the share of fossil-fuel vehicles, also

reflecting the important role of cost (on car purchase). We found a strong (e.g., 80%) tax benefit for full-electric vehicles (both for business and private drivers).¹⁵ Such policies should include gradual growth of the purchase tax on gasoline and diesel vehicles (connected to CO₂ emissions of the vehicle).

- P3: Implementation of stronger informational policies—not aimed at changing environmental values, but on making the coupling of tax levels and energy labels more widely known. (The Dutch case described above demonstrates the effectiveness of this strategy.)
- P4: Deployment of national and local (provincial, municipal) policies that increase the perceived and actual ease of using private cars less frequently and more efficiently. This includes investment in park-and-ride facilities on the outskirts of city centers and investment in high frequency and affordable public transport connections (including public bicycle schemes and public car-sharing systems), as well as smart technologies to facilitate the use and accessibility of alternative transportation and inter-modal options. Building on the recent success of ride-hailing platforms, cities may even consider assisting travelers by more effectively organizing the sharing of private cars (Sutton 2016).
- Formulation of policies that stimulate firms to invest in emerging markets for zero-emission mobility by reducing investment risks by, for example, providing subsidies from green innovation funds (e.g., 50% matching of research-and-development outlays) for electric mobility projects in businesses and knowledge organizations.
- Finally, policy makers should consider organizational instruments on public-private communication and possibly collaboration. These interventions should devote attention to the relevant role of the business community and may consist of public-private platforms that discuss and monitor progress with regard to the long-term goals (“RE mobility practices”), the effect of implemented policies, the expected impact of other possible policies, and so forth.¹⁶ The aim of the platform would be to align the initiatives of, on one hand, the business community (e.g., offering employees “mobility-cards” instead of company cars and installing shower facilities and changing rooms) and those of other relevant stakeholders (such as automotive dealers and leasing associations, public transport operators, and mobility-as-a-service entrepreneurs) with the public policies.

Conclusion

This article has addressed the problem that as a matter of practical implementation environmental policy is moving slowly from a focus on promoting environmental technologies to a focus on greening socio-technical systems. It has offered an approach that centers on practices in which citizen-consumers engage—so far largely neglected in RE policy—whereby people use resources more or less efficiently through activities such as eating, traveling, and working. For the elaborated case of mobility, we highlighted contradictions in the current mix of policies and offered suggestions for stronger synergies.

An important implication is that a broad range of elements—both individual-actor and collective—need to be addressed simultaneously and coherently. In other words, policies must constrain unsustainable practice (car mobility and especially fossil fuel-based automobiles) while supporting car-sharing, car alternatives, and electric mobility. A critical difference with the existing mix is that the relative quality of the non-car infrastructure must be enhanced. Road infrastructure may still be improved, but alternatives need to be augmented even more so that in a relative sense non-car alternatives become more attractive. We argue that policy instruments that do not address systemic interactions in resource use tend to be less effective and even antagonistic. They push down one spot of the waterbed (i.e., the primary effect), but the water simply flows to expand the surrounding parts (i.e., the collateral effect). As such, the average height of the bed (i.e., the net result) hardly changes. A key example of this effect in recent decades is regulations that have triggered manufacturers to improve vehicle-fuel efficiency, but consumers have responded by driving more or buying vehicles with more power and weight, thus leaving fuel use constant or even increasing. Therefore, there is a need for policy to be mindful of the web of constraints on RE, and to become more consistent.

A causal loop diagram that was applied is instrumental for highlighting these systemic interactions. However, a limitation of such illustrations is that the relationships among elements are “averaged,” neglecting the heterogeneity across social groups. We compensated for this situation to some extent by including the descriptive statistics from our survey in the discussion. Another limitation of such a diagram is that it neglects the distinct sub-practices of actors (travelers, planners, automotive dealers, leasing associations, public transport operators) and the varied ways that they are affected by new policies. Ideally, a systems analysis would be triangulated with some form of actor analysis and

stakeholder engagement before drawing policy conclusions.¹⁷

Economic instruments (such as the European Union Emission Trading Scheme (EU ETS) for CO₂ emissions or resource taxes) are key instruments for improving RE across the economy, but they are not sufficient in and of themselves. The strategic reactions of stakeholders and other uncertainties, interconnected in a web of split incentives, altered consumer preferences, information asymmetries, and so forth tend to prevent achievement of the full potential of particular instruments. A possible way forward is to engage with business, policy, and behavioral experts to anticipate collateral effects and pro-actively deal with them. This approach, as noted above, calls for multi-stakeholder platforms and coherent policy mixes, based on regulation, information provision, use of economic instruments and, especially in the case of sustainable mobility, the creation of infrastructures for more sustainable forms of travel to improve the service quality of bicycling, walking, and public transport.

By foregrounding practices more than other systems approaches to innovation while distinguishing individual-actor elements and the collective context of actors, this article has balanced social, technical, and economic factors and elaborated how an empirical analysis of mobility behavior can help to make policy mixes for RE mobility more consistent. The suggested policy mix is not intended as a panacea for all countries and would require further exploration (such as further corroboration with findings of other mobility studies, policy-interaction analyses to test coherency and consistency of the mix further, tailoring to the unique context of particular countries) before implementation. However, this approach can help to reorient current policy from a focus on environmental technologies to consumers and suppliers adopting sustainable practices.

Notes

1. Moreover, these other approaches primarily seek to explain innovative performance and, more implicitly, to explain (growth in) production levels (such as in gross domestic product). At the same time, their focus on interactions and relationships is similar to our own.
2. See [Appendix 1](#) for details on why we selected these three countries.
3. Since the variance inflation factor (VIF) never exceeded a value of 3, VIFs are not reported in the regression tables.
4. Note that we have not corrected here for different sample characteristics.
5. In principle, this finding may also concern value (E1, not willing to pay more) instead of capability

- (E3, not able to pay more). We lack data to discuss the relative roles further.
6. Evidence below confirms the role of E3, whereas we lack data to further discuss the role of E1.
 7. The following examples of a “small car” were given to survey respondents: Renault Twingo/Clio, Peugeot 107/208, VW up!/Polo, Nissan Micra/Note, Citroën C1/C3, Fiat 500/Panda/Punto.
 8. Here the A-label refers to “15% more fuel-efficient than average,” whereas B refers to “5–15% more fuel-efficient than average.”
 9. Other studies are inconclusive whether membership of a car-sharing scheme reduces car ownership (e.g., Graham-Rowe et al. 2011), partly because some people join with a discount, but hardly participate. Also, note that we lack data to include air travel in combination with customary car rental, although this could be interpreted as a kind of “car-sharing.”
 10. Clearly, the decision to own or not to own a car (among millennials) is much more complex than just environmental or financial issues. Lifestyle considerations—in particular urban living arrangements—may make ownership of a car under certain circumstances less compelling.
 11. At the same time, Millard-Ball and Schipper (2011) provide quantitative evidence that demand for travel is becoming saturated. In most of the (eight) countries studied, motorized travel demand by all modes has levelled out since 2005.
 12. As Banister (2005) notes, it is generally accepted that private car mobility is the least resource efficient form of surface mobility and this is especially the case with respect to primary energy consumption.
 13. We use the term coherent and consistent as synonymous, referring to the absence of contradictory effects of different policy instruments.
 14. The survey findings show that vehicle tax based on CO₂ has been an effective instrument in the Netherlands to promote smaller vehicles, and we assume that a km-tax will be even more successful.
 15. Renewable energy policy should be aligned to this objective (in order to drive electric mobility based on renewable energy), whereas environmental and resource issues with batteries should be anticipated with mandatory recycling of end-of-life car batteries.
 16. By “platform” we mean a group of stakeholders invited by policy makers to participate in an ongoing deliberative process because of their assumed roles in ensuring the effectiveness of eventual policies.
 17. Actor analysis consists of a range of methods and tools to identify and understand actors and actor relations (including perspectives, interests, formal and informal relations, strategic behavior, and strategic use of information). See, e.g., Hermans and Thissen (2009).
 18. To arrive at figures to compare the level of education represented in our sample with that of the general population, we contrasted the survey question asking about the highest education level achieved with official statistics. The survey-answer option “secondary school” (without A levels) was categorized as “low,” the answer options “A levels” and “vocational training” were collapsed to “middle” and “university degree or higher” was clustered as “high.” The population figures are based on

information published by Statistik Austria based on the micro census from 2009 (http://www.statistik.gov.at/web_de/statistiken/bildung_und_kultur/) and consider “tertiary” as “high,” “secondary” (with baccalaureate) as “middle,” and “without high school graduation” as “low.”

19. The figures indicating the education level of the general population in Hungary are predicated on the OECD’s “Education at a Glance” (2013 edition). The table on which these figures are based reports on educational attainment of 25–64 year-olds (OECD, 2013, 35). Corresponding with the groups formed to compare the Austrian sample with the general population, “low” has been equated with pre-primary, primary, and lower secondary education; “middle” comprises upper secondary and post-secondary, non-tertiary education, and “high” is defined to include all tertiary education.

Acknowledgments

We thank Moritz Kammerlander and Edina Vadovics for their contribution to the focus groups and for translating the questionnaire into (Austrian) German and Hungarian, respectively. The article is based on the results of a project named “Policy Options for a Resource Efficient Economy” (POLFREE), which has received funding from European Union’s FP7 under grant agreement No. 308371. We would like to thank the reviewers and editor of the Special Issue (Maurie Cohen) for many useful comments.

Disclosure statement

No potential conflict of interest was reported by the authors.

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Appendix 1: Details on survey method

Overview

The survey aimed to assess respondents’ views on resource matters, their current consumption practices in several domains (namely food, mobility, and space heating), as well as their willingness and perceived barriers to change. In addition, a few questions were included to infer interest in environmental issues and knowledge about the environmental impact of particular behaviors.

A shortcoming of this and other methods used to study human behavior and willingness to consider changes is that any findings are based on reported and, hence, only indirectly observed preferences or behaviors. This situation implies the possibility of a social desirability bias, particularly among people who are rather knowledgeable about which answers are the “most appropriate” given the focus and purpose of the survey. Only ethnography conducted on the basis of extended and embedded

participant observation allows for the collection of data based on direct contact but this is an extremely time and cost-intensive method. For these reasons, and since we wanted to obtain quantitative and more generalizable insights, we took care to interpret results carefully and to speak about reported behaviors or indicated preferences to denote that our findings are not based on immediately observed behaviors or preferences.

The inclusion of a large-scale survey in the array of methods enabled us to identify and analyze behavioral barriers to RE and allowed for the statistical generalization of our findings. Since its main purpose was to collect data for statistical analysis and elaborations, and discussions were captured during interview and focus-group sessions, the survey was conducted online and only included closed questions. Conducting a survey in three European member states allowed a cross-country comparison of results.

Survey development and implementation

The survey was developed over ten weeks between early October and mid-December 2013. We designed the questions to collect information about respondents' views, experiences, and practices in relation to resource consumption, taking into account recent studies. In addition, as discussed in the previous section, grappling with the broad field of people's behaviors and consumption patterns led to the utilization of three different conceptual frameworks (the stage model of self-regulated behavior change, social practice theories, and society-nature relations) which served as another source of inspiration during development of the questionnaire.

The survey was reviewed and tested by several experts and people both external to the project and to research to ensure unambiguous questions and opportunities to provide appropriate and understandable responses. In total, the survey comprised 147 questions, but depending on personal practices, preferences, and knowledge, different questions were posed to the respondents. The maximum number of questions directed to a single respondent was 134.

After finalization and translation of the survey (which was originally drafted in English) into German, Dutch, and Hungarian, and the programming of its web-based versions, administration began on December 23, 2013 when invitations to take part in the survey, including unique hyperlinks, were sent to 4150 potential respondents (1870 in Austria, 1605 in Hungary and 675 in the Netherlands). We reached the required number of responses (400 per country) within two weeks. Since the questionnaire was programmed to require respondents to answer all of the questions before submitting their responses and, where applicable, feasible minimum or maximum values were defined, it was not possible to skip questions or fail to fill in impermissible answers (Flycatcher, 2014).

Data analysis

The sections of the survey pertaining to socio-demographic characteristics relevant to specific behaviors were primarily based on the results obtained from logistic regressions. In contrast to ordinal regression analysis, logistic regression analysis assumes a different link function between the independent and dependent variables. Depending on the distribution of the dependent variable, either a logit or a negative log-log link function was

chosen. Since it is often difficult to identify whether the distribution is relatively equal or skewed, and there are no statistical tests on which to base this choice, we chose the link associated with a better model fit and consistent with the assumption of proportional odds. All regressions were tested for their model fit, outliers, multicollinearity, dispersion, and parallelity of lines (relevant for ordinal regressions only).

The results obtained from the regression analysis were supplemented in large part by descriptive statistics. Also, the questionnaire included a range of questions on the reasons for environmentally friendly behavior and for opting not to switch to more sustainable consumption practices. Besides descriptive analyses on the relative importance of the reasons, differences among socio-demographic groups are identified by means of Mann-Whitney U and Kruskal-Wallis tests. In the section on the desirability and perceived effectiveness of policy regulations, the effect size of a range of socio-demographic factors, values, and attitudes were calculated on the basis of non-parametric tests. In the case of binary variables, the effect sizes were obtained from Mann-Whitney U tests. If the variables had an ordinal scale, trends in the data were calculated by means of the Jonckheere-Terpstra test. Finally, the section addressing respondents' behavioral consistency across consumption domains was analyzed through Spearman bivariate correlations and partial correlations.

The three samples: characteristics and representativeness

The overall target group for the survey, and hence the panels that we assembled, consisted of people living in Austria, Hungary, or the Netherlands with a minimum age of 18 years. Since we conducted a web-based survey, only potential respondents with access to the Internet were contacted.

The Dutch sample was stratified and is, hence, (almost) representative of the general population in terms of gender, age, education, and geographical region. The Austrian and Hungarian samples were, due to budgetary constraints, only stratified by gender and age. Table A1 provides an overview and the following sections discusses the representativeness of the three country samples in more detail.

Dutch sample

In the Dutch sample, male respondents and individuals older than 65 were slightly overrepresented. As mentioned above, this did not affect outcomes of the regression analyses but was taken into account in other statistical tests (e.g., Mann-Whitney U, Kruskal-Wallis, and Jonckheere-Terpstra).

Austrian sample

The Austrian sample proved relatively representative in terms of gender, age, and education. The geographical region of respondents was not tracked and the representativeness of the sample in that respect cannot be assessed. Table A2, however, shows two peaks for cities with 10–20,000 inhabitants and more than one million inhabitants which may indicate that residents of Vienna and respondents from rural areas of the country are somewhat overrepresented.

Table A1. Overview of the three country samples and country populations with respect to gender, age, and education.

	The Netherlands		Austria ¹⁸		Hungary ¹⁹	
	Sample	Population	Sample	Population	Sample	Population
Gender						
Men	56%	49%	50%	48%	50%	48%
Women	44%	51%	50%	52%	50%	52%
Age						
18–24	6%	11%	13%	11%	12%	11%
25–34	14%	16%	16%	16%	23%	18%
35–44	16%	19%	20%	19%	20%	18%
45–54	19%	19%	17%	19%	15%	15%
55–64	20%	16%	16%	14%	19%	17%
65+	25%	19%	19%	22%	12%	20%
Education						
Low	35%	34%	20%	16%	8%	18%
Middle	37%	40%	68%	69%	42%	60%
High	29%	26%	12%	15%	50%	22%

Hungarian sample

Aside from slight overrepresentation of people 25–44 years of age and notable under-representation of people above the age of 65, the Hungarian sample was generally representative in terms of age and gender. This latter issue was due to the use of a web-based survey and the fact that Hungarians above the age of 65 rarely use the Internet. However, budget constraints did not allow for other, more time-intensive approaches such as personal or telephone interviews.

Respondents with “a university degree or higher” are significantly overrepresented in the Hungarian sample. The survey institute that carried out the fieldwork,

as well as the Hungarian research institute that translated the survey from English to Hungarian indicated that Internet access and use is highest in Hungary among younger and higher educated cohorts and the quickest respondents (i.e., the first who responded to the invitation via email) appear to come from that background. This issue also corresponds with the slight overrepresentation of younger age groups and may partially explain the 50% share of respondents holding a “university degree or higher.” Although regression analyses were able to correct for such factors, in all other types of analysis care was taken to discuss carefully the impact of education on findings.

Appendix 2: Details on relationships in Figure 8

Table A2. Explanations pertaining to relationships presented in Figure 8.

From	To	Explanation
Willingness to drive less	RE of mobility practices	++ because, as Banister (2005, 58) notes it is generally accepted that private (car) mobility is the least RE form of surface mobility
Supply of RE vehicles	RE of mobility practices	++ because when RE vehicles are offered across more vehicle classes, they experience higher sales (consumer studies show most people, when purchasing a vehicle, first choose size, brand, and so forth, while considering fuel efficiency only later (Nijhuis 2013)
Average car size and fuel efficiency	RE of mobility practices	-- because of the fact that smaller and more fuel-efficient vehicles are more RE
Cost of car driving	Willingness to drive less	+++ because survey results suggest cost is the most important driver for wanting to drive less (see Section “Constraints of pro-environmental behaviors” and Figure 5)
Relative cultural status of car mobility (vs. non-car)	Willingness to drive less	-- because focus group results suggested a strong cultural role of the car. Although survey results indicate social disapproval of not using the car is very low, relatively, the positive image of car decreases the likelihood of driving less.
Esteem of health effects of cycling	Willingness to drive less	++ because survey results suggest health effects of cycling is seen as an important reason for wanting to drive less (see Section “Constraints of pro-environmental behaviors” and Figure 5)
Relative quality of non-car infrastructure	Willingness to drive less	+++ because survey results suggest people mention (especially) the quality of public transport infrastructure and (also) “walking/cycling not an option” as the reason why they cannot more significantly reduce car use (Figure 6). Also, people see no time benefits of reducing car use (Figure 5), which we assume is partly related to infrastructure.
Salience of environmental values	Willingness to drive less	+ because survey results suggest environmental values are of some importance for wanting to drive less (see Section “Constraints of pro-environmental behaviors” and Figure 5)
Driving pleasure	Willingness to drive less	-- because survey results suggest driving pleasure is a factor of some importance in preventing reduction in car use (Section “Constraints of pro-environmental behaviors”)

(continued)

Table A2. Continued.

From	To	Explanation
Relative cultural status of car mobility (vs. non-car)	EU and national investment in road infrastructure (vs. car alternatives)	++ because focus group results suggest a strong continuing cultural role of the car that explains, at least partly, the policy priority toward road infrastructure (which we assume can be supported with EU and national budget data on infrastructure).
EU and national investment in road infrastructure (vs. car alternatives)	Relative quality of non-car infrastructure	- - because investments in transportation infrastructure over the last decades have created and maintained a far more extensive road network than a network for public transportation or cycling (which we assume can be supported with data on total road km's versus rail/bus line/cycle path kms).
National taxes for car mobility vs. non-car	Cost of car driving	++ because of the significant fuel tax (about 50% of the price per liter) and road tax in most EU countries.
National taxes for car mobility vs. non-car	Average car size and fuel efficiency	- - because, as discussed in Section "Constraints of pro-environmental behaviors": in NL VAT level is strongly related to vehicle size, which explains the significant larger share of smaller vehicles
Informational measures (e.g., labels)	Knowledge of labels and tax	++ because relatively strong knowledge of labels in the Netherlands must be explained by the Dutch regulation which connects VAT discounts to energy labels
Knowledge of labels and tax	Average car size and fuel efficiency	- - because survey results suggest (see Section "Constraints of pro-environmental behaviors") strong knowledge of labels in the Netherlands correlates with low average car size (and in Austria weak knowledge with high average)
Income	Average car size and fuel efficiency	++ because survey results suggest (see Section "Constraints of pro-environmental behaviors") higher income groups are more likely to own larger and higher fuel efficiency vehicles
Resource-efficiency of mobility practices	Profitability	+++ because more resource-efficient vehicle technologies or public transport services benefit from increasing returns to scale
Profitability	Business investments in RE	++ because profitable RE products or services in general trigger further business investments in research and development, production facilities, and sales channels
EU CO ₂ norms for cars	Business investments in RE	++ because stricter CO ₂ norms for cars will catalyze greater investments in research and development, production facilities, and sales channels of RE products and services
Business investments in RE	Relative quality of non-car infrastructure	+ because the focus groups suggested a quite important role of the business community is to promote alternatives to the car through wide-scoped employee mobility plans and offers (e.g., shower and changing rooms, free public transportation tickets, and car-pooling)
Business investments in RE	Supply of RE vehicles	++ because more investments in RE-related research and development, production facilities, and sales channels leads to more RE products and services