Making sense of sustainable mobility – compact cities, sedate households or clean vehicles?

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Abstract

This article addresses the interaction effects between consumers and the characteristics of their living environment, with special reference to mobility, transport performance and transport emissions. In transportation research the issue of interactions between urban characteristics, residential preferences, and mobility patterns is receiving increasing attention. The assessment of mobility effects discussed here is carried out as part of a larger study in Finland (KulMaKunta), which addresses sustainable consumption in its entirety. The notion of the 'means of consumption' is important in this respect. This notion or assertion, having its origins in sociology, wants to underline that in a modern western society commercial success has become more dependent on organisation of sales and consumption than on production as such. In other words, how quickly can one reach as many customers as possible. When trying to operationalise the notion 'means of consumption' in (transport-) economic terms it implies that exposure to consumption opportunities and accessibility become key features. This article argues that one of the consequences of these typical urban conditions is a high passenger mobility per capita of urban dwellers. In turn this complicates the realisation of the – potentially – high eco-efficiency of a city.

Introduction

Energy efficiency holds an important key for the realisation of a sustainable transportation system. Total material requirement (TMR) studies for transport show that 80% - 90% of the TMR in most transport systems is attributable to energy use (Bos, 1998). This means that distances should be short(ened), non-motorised modes promoted, fuel efficient vehicles developed (and sold), etcetera, in order to enable a transition towards a sustainable transport system.

The notion of short distances and higher modal shares for both non-motorised modes and public transport is usually translated in the recommendation to stimulate concentration in urban settlements (e.g. Nijkamp and Perrels, 1994). Yet, sustainability has to date not received explicit attention in the revived discussion on (optimal) city size in the context of the New Economic Geography (e.g. Fujita and Thisse, 2002; Anas, 2002). So, from a comprehensive sustainability point of view the usual urban concentration argument cited above still lacks rigorous underpinning. Nevertheless, several articles (e.g. Høyer and Holden, 2003; Maat, 2003) have already indicated that the recommendation is of doubtful validity when it remains too generic. It has to be realised that cities usually fulfil centre functions for a larger area. The larger the city the larger the surrounding area will be that the city serves, possibly including other cities and/or less hierarchical networks abroad. The centre role usually generates appreciable amounts of traffic. Another aspect is that even though transport is an important factor regarding the sustainability of a city, it is not the only factor. Structure, quality and density of the building stock have enormous repercussions on the attainable energy efficiency for heating

and/or cooling as well as on the materials efficiency of the volumes of infrastructure needed per citizen or per m^3 building (e.g. Harmaajärvi, 2003). Furthermore, from an overall sustainability point of view it is important also to assess what is produced and consumed in a city and how. A further complication is the demographic and social-economic dynamics in a city which practically rules out the feasibility of a unique optimality. Especially with respect to city infrastructure with a long lifetime the key is to find robust solutions, i.e. having at least a fairly good sustainability performance over a longer time span.

This article addresses the interaction effects between consumers and the characteristics of their living environment, with special reference to mobility, transport performance and transport emissions. In transportation research the issue of interactions between urban characteristics, residential preferences, and mobility patterns is receiving increasing attention (e.g. Schwanen and Mokhtarian, 2005). The assessment of mobility effects discussed here is carried out as part of a larger study in Finland (KulMaKunta), which addresses sustainable consumption in its entirety. The KulMaKunta project runs from May 2004 to December 2005 and is carried out in a consortium of four institutes (Government Institute for Economic Research, National Consumer Research Institute, National Technical Research Centre, Statistics Finland). A pre-study was carried out in 2003 (Perrels et al, 2004). The KulMaKunta project is part of the national Environmental Cluster programme[1].

Elaborating on the notion of 'means of consumption'

Ritter (2001), when discussing sociological aspects of consumption, introduces the idea that the means of consumption are getting more important in modern western societies than the means of production. For commercial success often the production side does not represent the biggest challenge, but instead the consumption side does. In other words, how quickly can one reach as many customers as possible. In that context accessibility becomes a key feature, first via media from producer/supplier to potential client, next from client to supplier to facilitate purchase and physical acquisition. For largely the same reasons time use becomes important. If purchase and acquisition take too much time the throughput of sales (per unit of time) may be limited and thereby curtail commercial success. The solution is to improve the temporal efficiency of consumption (or at least of purchase and acquisition) by minimising the temporal transaction cost. Solutions are for example: spatial concentration of suppliers (shopping malls), automatic payment and credit facilities, and internet shopping. Even though reduction of transaction cost is as such welfare augmenting, the trends are at the same time also troubling both with respect to environmental impacts (more throughput per unit of time) and with respect to actual experienced utility of consumers. The utility of a consumer depends eventually on the enjoyment of a ready-to-consume good or service during a certain spell of time. Notwithstanding the positive utility derived from the sheer possession of goods, there is no reason to assume that enjoyment (utility) is always a monotonously increasing function of consumption intensity (see Winston, 1982). It reminds us of the 'harried leisure class' introduced by Linder (1970).

Next to compressing time, simultaneity is another solution, which allows consumers to produce more services and ready-to-consume commodities in a given time span, and hence enables producers to sell more in a give time span. Nevertheless, there are probably some upper limits in the amount of information per unit of time people's minds can sensibly process. Ruuskanen (2004) reports on the basis of an analysis of the Finnish time use survey that higher education levels seem to correspond with a higher likelihood of a more diverse free time activity patterns as well as with a higher likelihood of multi-tasking behaviour.

The KulMaKunta study also includes a set of in-depth interviews with selected typical households (families moving out of town to a detached house in the urban fringe and retired people moving to so-called 'senior-service homes usually in cities or regional centres). Apart from collection of general background information and investigations of the interest in new innovative possibly sustainability augmenting services (including ICT based) the interviews also provided some – unexpected – observations with respect to the idea of 'means of consumption' in conjunction with the kind of living environment.

Several participating households (who had been relocating out of the city) reported that the less consumption oriented diversions of a smaller community had an impact on the behaviour of their children, when comparing it to their earlier behaviour in the consumption focused atmosphere of a larger city. The allegedly decreased urge of children for purchasing new items or services was visible in the descriptive statistics of the interviewed families. This is an interesting feature as it ties in with signals from other studies about the interaction effects between types of neighbourhoods and types of dwellers. For example, Van Wee et al (2002) shows that supply of particular infrastructure does to some extent influence people's mode choice, but just as well the type of people selecting a neighbourhood with a particular transport profile shows selectivity effects too. Schwanen and Mokhtarian (op.cit) also demonstrate the effects of matches and mismatches of neighbourhood's infrastructure profiles and the transport preferences of dwellers. In addition Schwanen (2004) reports regarding time use for shopping in the Netherlands that (inner) city environments seem to incite extension of the shopping time budget. In the KulMaKunta study is found a similar correspondence (see in later sections of this article). The observation of the families moving outward the city suggests that the concept of the interaction with the infrastructure supply portfolio may be wider applicable. On the other hand the degree to which there is some sort of selectivity among the families that have moved out of the city, needs to be checked as well. All in all further study of environment induced changes in consumer

1. This is the 3rd period of the programme consisting of about 60 projects with 'the eco-efficient society' as the lead theme. See: http://www.ymparisto.fi/default.asp?node=11578&lan=en

behaviour would assist to substantiate the hypothesised increased significance of the 'means of consumption', even though the introducer of this term, Ritter, understood it as a much broader concept.

The analytical approach in brief

THE OVERALL STUDY

The KulMaKunta project seeks to identify and clarify the volume, characteristics and feasibility of a sustainability potential within the realm of household consumption. The study aims to take account of behavioural and institutional impacts by linking model exercises with case studies based on dedicated household survey information and stakeholder interviews regarding the innovations in consumption.

The main objective of the study is to outline and analyse models (examples) of eco-efficient consumption and production in Finnish living environments. The model system on the one hand serves the consumption-innovation case-studies with respect to the orientation of interview themes and on the other hand uses the results and insights from these case-studies for the evaluation of policies regarding their eco-efficiency effectiveness.

The models used consist of two main clusters. One is describing the physical living environment (dwellings, other buildings, infrastructure) in terms of its volume, composition, utilisation and environmental implications (spatial consumption, emissions). The other one, an economic model, is describing the evolution of household consumption, both in terms of expenditures and in terms of time allocation. Furthermore, the consumption model is linked to an input-output model extended with sub-matrices for emissions. Figure 1 provides an overview of the consumption and input-output model cluster. The model components are based on econometric estimations , technical-economic identities and an input-output matrix system. This model also contains the social-economic and demographic scenario data. The economic model is somewhat similar to a sustainable consumption model developed in Austria (Kletzan et al, 2002).

The scenario modules are linked both to the economic model and the physical environment model. Both models receive detailed dwelling stock scenario data from a common dwelling stocks simulation covering the period 2000-2030. It provides detailed cross-tables per type of area of the number of homes simultaneously distinguished by type of dwelling (3), household size (4) and the number of rooms (6). Areas are distinguished by degree of urbanisation, with an own categorisation for the conurbation around Helsinki. The models also exchange information on car ownership, appliance ownership and mobility.

MOBILITY ANALYSIS

The mobility analysis on which this article focuses is based on a time use study survey held in 1999 and 2000 by Statistics Finland. The micro-dataset contains observations of about 5 400 individuals having reported their time use on two consecutive days by ten minute intervals[2]. The 5 400 individuals come from about 3 500 different households. The record basis is person day, totalling to 10 500. In the analysis discussed here no interaction effects (synchronisation) have been taken into account, as this is assumed to be of less importance for time budget allocation, whereas it would seriously complicate the analysis (see e.g. Zhang et al, 2005). The definition of explanatory variables has been harmo-

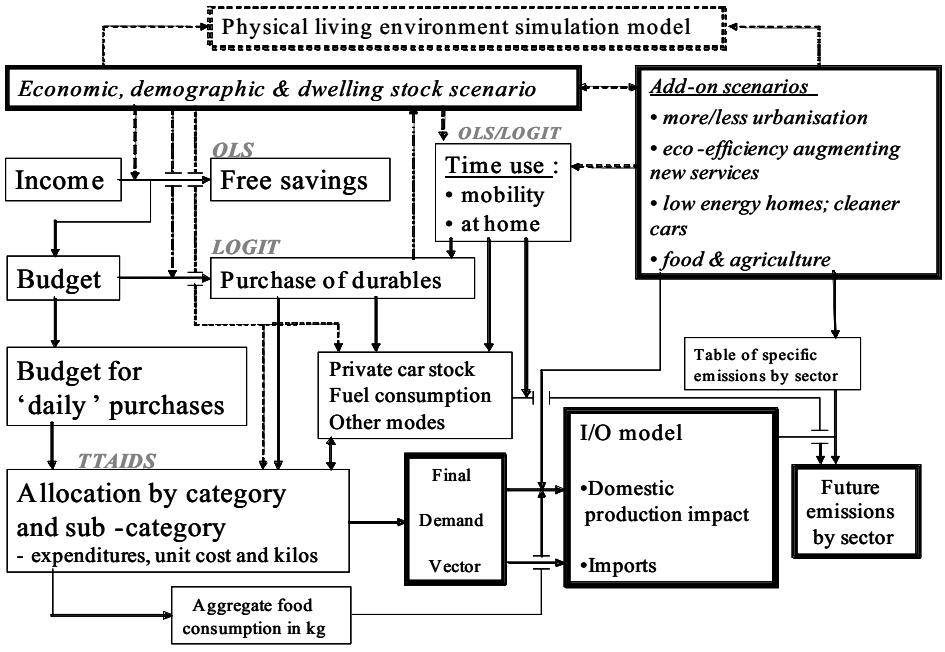

Figure 1. *The consumption and input-output model cluster.*

2. Of a few hundred participants only one day is available.

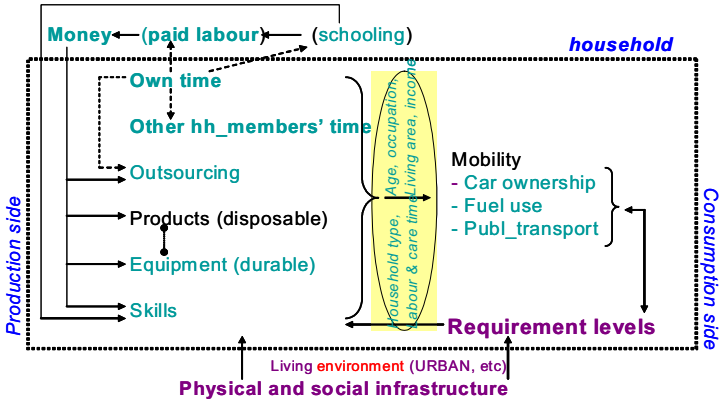

Figure 2. *Production and consumption of ready-to-consume products for a household - transport as example.*

nised with the variable definition in the consumer expenditure model (based on econometric analysis of the expenditure surveys of Statistics Finland). At group level the expenditure and time use data have been merged to assess expenditure intensity in some sub-sets of consumption and time use. A complication in the merging of both data types is that the basic record for expenditure datasets is the family, whereas for time use it is the individual household member. The joint analysis of time use and expenditures remains untouched in this paper, even though it also ties in with the attempts to operationalise and test the notion of the means of consumption.

The analysis is based on the theory of household production and consumption (e.g. Gronau, 1977; Winston, 1982). It means that households, in order to be able to actually consume (enjoy) something, will often need to produce a ready-to-consume product or service by combining time, skills, purchased consumables and durable goods. They have a certain leeway in choosing the mix of these inputs. In a number of cases it is also possible to totally outsource the production of a ready-to-consume product (e.g. a restaurant meal or take-away service). In the background household members have to make preceding choices and fine tuning decisions with respect to the amount of time to be devoted to paid labour and the balancing of paid and unpaid labour between involved household members. Figure 2 summarises the structure of the process. A selection of usual factors influencing the decision on the mix of production factors is mentioned in the oval area. In addition the typical requirement levels of a household (and its members) and the physical and social infrastructure (including norms and exposure to advertising) influence the process of setting requirement levels and choosing a factor mix – both at operational and strategic levels. Operational levels correspond to the efficiency and effectiveness of fulfilling tasks. The strategic level ties in with the division of roles in a household as well as with the basic 'orientation' of the adults, i.e. choosing for career and wealth or homeliness and self-reliance or personal development.

The above explanation, summarised in Figure 2, can be recast in a formalised representation. In this case we focus it directly on mobility services in a household by stating that the production of the required (demanded) mobility services is a function of the endowments and limitations that enable the actual supply of mobility (the factors at the left hand side of Figure 2 and the environment features). Given the similarities with conventional economic production theory a Cobb-Douglas function is a plausible option to be chosen as initial functional form, e.g.

$$T = \alpha . \prod_i \{F_i^{\beta i}\}$$

Equation (1)

where T denotes time use for a certain function, F_i are the relevant influence factors, and β_i are parameter values of the influence factors [3].

By taking the logarithms at both sides a fairly straightforward function is obtained, which can be easily estimated thanks to the linearity in the parameters. That means the function to be estimated assumes the following form:

$$\ln T = \alpha + \sum_i \{\beta_i . F_i\}$$

Equation (2)

Apart from the usual characteristics such as income, working time, gender, age, education level, household size, degree of urbanisation, some constructed 'typecasting' variables were included. The large amount of detail on activities enables the definition of types of respondents in terms of inclination to a certain type of activities. In this case the following types of free time patterns were identified a ''sports type', a 'cultural type', a 'hobby type', a 'societal active type' and a 'low profile type'. The first four types imply that the involved respondents scored fairly high to high frequency ratings on activity participation in the relevant category, both in terms of frequency *and* diversity [4]. The low profiled type does neither rate fairly high nor high in any of these other categories. This should not be interpreted as if the low profiled types were barely engaging in any of these of activities, but rather that the low profiled types engages in these activities – yet *only* up to a moderate extent. Later on in the analysis results hinted at a slight above average amount of working hours for the non-profiled, whereas otherwise this type of person is slightly more sedate (home bound) than the others. The category 'societal active type' is rather small and therefore not further taken into account in the regression analysis. The sports type and cultural type correlate clearly with above average overall travel time, also after controlling for other variables. The non-profiled ('sedate') group and to a lesser extent the hobby group (whose activities are partly more home oriented) rate below average

3. Since substitution between time use categories can occur there can be no a priori upper or lower limit on the sum over all parameters β_i . Only if a kind of 'complete' model, also involving all other time uses besides travel, would be estimated, a valid interval such as $0 <_i \beta_i < 1$ may be possible.
4. This information is not based on the 2 x 24 hours time use report, but on statements of the respondents when answering questions on their behaviour in the past 6 to 12 months. Per type of event, active sports type, hobby, etc. was asked how often it was practised.

Table 1. Fractions of the population by type of residential area representing a certain type of free time profile.

	sedate	hobbies	culture	sports	societal
City *	55 %	26 %	21 %	11 %	6 %
Semi-urban *	66 %	22 %	9 %	9 %	6 %
Countryside *	69 %	18 %	7 %	6 %	9 %

*) Fractions to be understood by row. Some respondents belong to more than one active time profile, therefore rows do not exactly add to 100%.

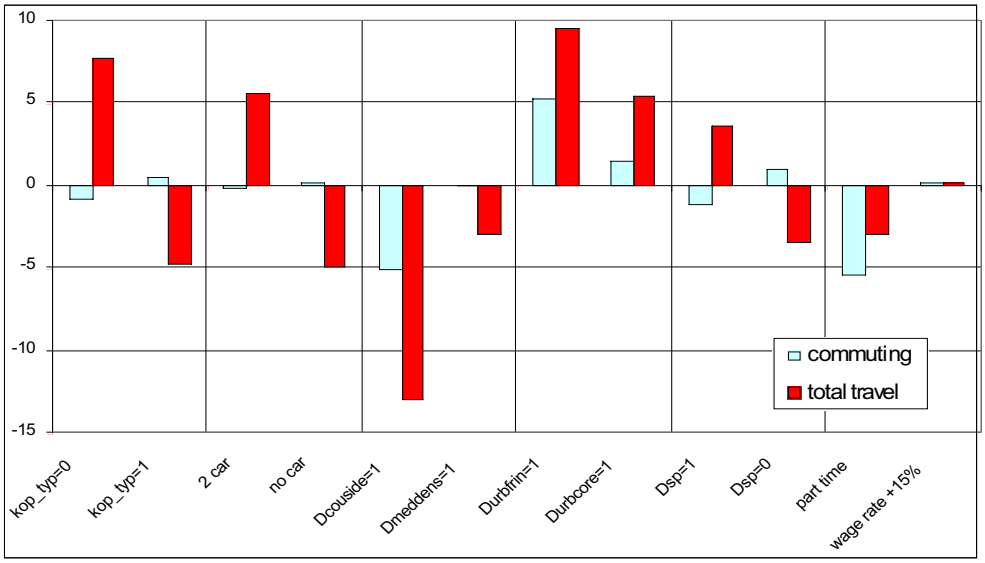

Figure 3. *Impacts of deviations in selected variables on the time budget for commuting and total travel effort (in minutes per day compared to a reference level)*

kop_typ = low free time profile (work oriented/sedate);
Dcouside = dummy for countryside residence (1=yes; 0=no)
Durbfrin = dummy for residence in the urban fringe (1=yes; 0=no);
Durbcore = dummy for (inner) city residence (1=yes; 0=no)
Dsp = gender dummy (1=male; 0=female);
part time = half of the average daily full time working hours
wage rate+15% = increase of the own (hourly) wage rate by 15%

in terms of travel time, also after controlling for other variables such as income and age. A fraction of the respondents fulfilled the criteria for more than one typical free time pattern, for example some are both strongly sports and cultural oriented.

Table 1 shows the occurrence of free time activity profiles by type of municipality as observed in the micro-dataset (covering 1999/2000). With the exception of societal involvement decreasing urbanity coincides with lower shares of people being strongly profiled in at least one category of free time activities, and hence the share of so-called 'sedate' people increases with decreasing urbanity. This feature is only mildly influenced by age structure, income, etc., which means that urbanity plays a role as such.

In order to be able to specify scenario pathways for the free time activity profile indicators binomial discrete choice models (Logit) have been estimated using other personal and household characteristics to explain the probability of belonging to a certain type of free time pattern[5]. Thanks to the discrete choice functions the evolution of the occurrence of the different free time profiles can be endogenised in the scenario exercises later on the KulMaKunta study. The degree of urbanisation is a significant explanatory variable in the Logit-estimations for all groups.

Travel time allocation and mode choice

Estimates (OLS based) have been made for total travel time, total travel time by age group (under 21; 21-64; 65+), commuting, commuting by age group, commuting by car, free time, free time by age group, and free time by age group and car. Variables that almost invariably rate high in significance tests are: age, gender, working time, own net wage rate, number of household members, (co)ownership of a summerhouse, (inner)urban residence dummy, and the low-

5. Orientation towards a certain profile does not exclude the possibility to fit to another active profile as well (as is corroborated by the observations) hence multinomial choice models are not an option. Possibly nested models are a valid alternative. Anyhow, the binomial models function well enough, considering the purpose of the estimations.

profile free time pattern dummy. In addition, fairly often significant variables are: sub-urban residence dummy, countryside residence dummy, and the number of cars owned. Occasionally also the various free time activity type dummies (cultural, sports), education level and the net wage rate of the partner appear to be significant. Appendix 1 contains a summary of the estimations results.

Figure 3 displays an overview of the changes in average total travel time and commuting time respectively due to consecutive single variable deviations when applying the estimated models. In other words the actual average travel time per day is just over 68 minutes. The deviations from that reference level (represented by the zero line in figure 3) are shown. So, from figure 3 can be inferred that having two cars (instead of one) adds approximately 6 minutes (~9%) to the daily individual travel budget, whereas no car would reduce the baseline by 5 minutes. The shown values for the simulated impacts of deviations of consecutive single variables represent the averaged results of various estimated models. The outcomes of alternative single variable impact simulations vary about a factor 2 at most, and often much less.

The most important determinants of commuting time are only partly the same as those for total travel time. The commuting time budget of the average employable adult is 35 minutes per day, covering all seven days. The average total travel time per day for all respondents (not just employable adults) is about 70 minutes, including both weekend and work days. Residential location (Durbcore, Durbfrin, Dcouside, Dmeddens[6]) has a clear and substantial effect in both cases. The next most influential variable is the amount of working time. The effect of a part time (50%) job is shown in comparison to a full time job. The effect on commuting time is larger than for total travel time implying that (significant) working time reduction leads not only to reduced mobility, but also to a reorientation of mobility. Gender shows opposite effects for commuting as compared to total travel. This probably relates to the fact that women commute less by car than men (see next point on car ownership), while overall men travel more than women, except for teenagers.

Car ownership has rather limited influence on commuting time, but gets more important when total transport time is considered. As regards the impact on total travel time car availability means also more transport performance (pkm/year). This is different in the case of commuting, in which case the efficiency of travel seems to be important, hence a better availability of cars tends to lead to reduced travel time (with an approximately stable transport performance). In this respect it should be noted that road congestion is still a very marginal phenomenon in Finland compared to Western Europe. Nevertheless, the travel time reduces only modestly as not everybody, who could switch, would benefit from a switch. The typecasting variable kop_typ, indicating a somewhat sedate lifestyle, indicates that this type of person uses slightly more time for commuting, but overall needs less travel time. The average amount of working time for this type is slightly higher than for other types.

Sustainability implications

SUSTAINABILITY OF PERSONAL MOBILITY

From a sustainability point of view it is important to identify factors, in as far as addressable by policy, that reduce the need for travel and/or reduce car use. Car ownership is an obvious factor. Working time, especially if it would be extended to include also flexibility and self-determination (e.g. through teleworking as was indicated in the interviews), is also a relevant factor, though a tricky one. Generic modifications in working time can have significant ramifications for the economy, both in terms of labour productivity and in terms of household budgets. However, undeniably the time budget does just as well belong to the household endowments as the money budget does. It is perfectly in line with micro-economic theory that beyond a certain level of material wealth the value of non-working time increases sufficiently as to make people more interested in work time reduction. A second consequence of such a rearrangement of working time and free time is that average spending intensity per hour has to go down. This may cause shifts in the modal split, since car travel is a rather spending intensive activity.

The discussion in the previous section demonstrated that the living environment, represented by the degree of urbanisation, affects mobility substantially. Last but not least the personal inclination on how to spend free time, or more generally stated 'lifestyles', affect the level of mobility as well. Both urbanisation and lifestyle can be influenced by policies. However, there are some intriguing linkages between lifestyles, here represented by the free time profiles, and the degree of urbanisation. The consequence is that the policy recipes are not as straightforward as they sometimes are believed to be. That is to say, an urban environment does not necessarily produce the most sustainable transport performance per inhabitant. This is illustrated in figure 4 below, in which the travel time is translated into annual kilometres per person, distinguished by mode and for three area types (places of residence). Indeed city dwellers are travelling less by car, but are more than compensating that with substantial more travelling in most other modes. The figures do include business travel. If ferry, airplane and truck (+tractor in the countryside) would be left out the travel performance in the different areas would be converging, sub/semi-urban having the lowest travel performance.

The transport performance P_u has been assessed by place of residence of the traveller (degree of urbanisation u). It is the weighed sum of the product of travel speed by mode, purpose and degree of urbanisation v_{imu} [7]and travel time by mode by purpose T_{mi}.

6. Unlike the other urbanisation dummy indicators Dmeddens is only significant in the estimations describing commuting.
7. The speeds are derived from the travel surveys commissioned by the Ministry of Transport and Communication, with speeds information of the Finnish Road Administration as auxiliary information.

$$P_u = \sum_{im} \{v_{imu} T_{im}\}$$

Equation (3)

The emissions per passenger kilometre vary substantially over modes. Therefore the transport performance by residential area type of the traveller not necessarily represents the concomitant emission levels. Furthermore, it is debatable to what extent business travel and cross-border travel should be attributed to the area type or for that matter to the inhabitant of that type of area. To clarify this point also emission profiles have been assessed by inserting specific emissions[8] into equation 3. Table 2 shows

1. the relative emission levels per average traveller per day by place of residence of the traveller and
2. the eco-efficiency of travelling by place of origin of the traveller in terms of emissions per passenger kilometre.

The emissions caused by air travel and travels on (international) ferries are not included. From Figure 4 can be inferred that inclusion of the latter kind of trips would add more to the emissions per traveller from cities than those originating from other places.

(trips by ferry and aeroplane not included)

When both business and international travel are excluded the eco-efficiency of the urban citizen with respect to passenger transport seems on the whole to be worse than the sub/semi-urban citizen and often also the countryside resident. Inclusion of all forms of business travel tilts the picture in favour of cities. However, if the indicators were to include also international ferry and airline travel the environmental performance distinguished by place of residence would converge. Residents of (larger) cities report more international ferry and airline trips, probably both for push and pull reasons. That means both the easy accessibility *and* the inclination of urban residents cause this larger amount of trips. Furthermore, especially larger cities count more business activities with international relations (see the allusions to the city size discussion in the Introduction), causing their employees to engage in more international travel, whereas these employees live either in the same city or in adjacent urban fringe. With these considerations we return again to the issue of interaction between urban characteristics and the characteristics of the residents. It seems that urban environments have various characteristics that stimulate people to adopt more urban (that is active/contact rich/outgoing/mobile) lifestyles (see also table 1 in the sub-section 'Mobility analysis'). Vice versa people that do not favour urban en-

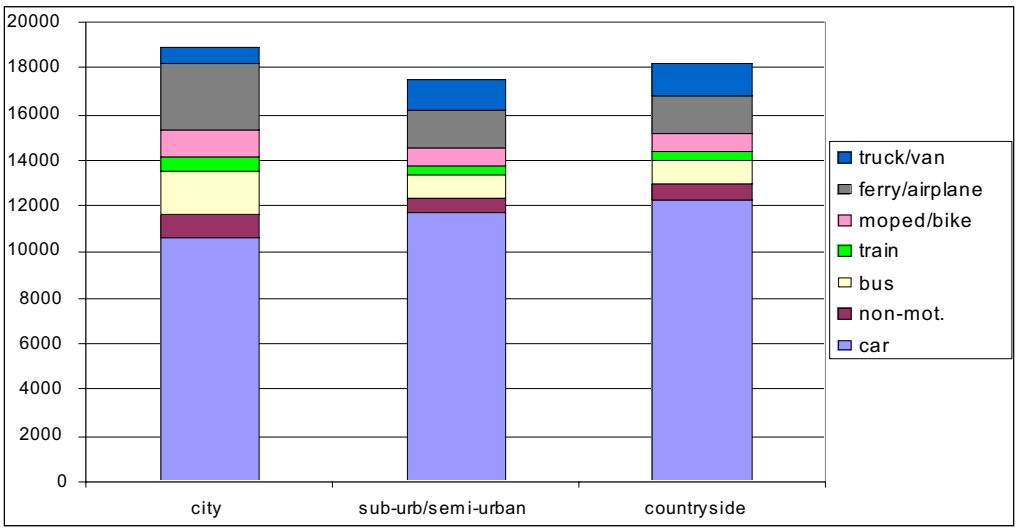

Figure 4. *Transport performance in person kilometres per year by area type and mode*

Table 2. Emissions per traveller by place of residence (origin) excluding/including business trips.

	City (=100)	Sub/semi urban	countryside
CO_2 emissions/car traveller	100	95/102	96/103
NO_x emissions/traveller	100	85/92	92/99
N_2O emissions/traveller	100	98/106	103/111
Particles emissions/traveller	100	94/101	100/108
NO_x emissions/pkm	100	87/92	90/96
N_2O emissions/pkm	100	99/107	100/108
Particles emissions/pkm	100	95/102	98/104

8. The values were derived from the Finnish LIPASTO transport emission model, developed by VTT.

vironments are probably underrepresented in the urban population.

In addition to interaction effects between urban lifestyles and augmented mobility patterns, cities can also be considered in terms of their spatial-economic functioning. The larger a city is, the larger will be the surrounding area with which it interacts. This results in a tendency that a larger share of the employees in larger cities is engaged in activities that involve more long distance travelling. In other words the observed differences in people's travel performance are to some extent also the product of the spatial-economic organisation of a country. Finland shows a tendency of continued reduction of the countryside population and a steady increase of the population of a small number of cities (or city regions), whereas other areas with medium densities and stand-alone medium-sized towns have by and large stable populations. The question arises to what extent centralisation is beneficial for the national economy and for sustainability and what is the leeway regarding these objectives when trying to manipulate the balance between the Helsinki metropolitan area and the other (principal) centres.

REFLECTIONS ON OTHER INFRASTRUCTURE, URBANITY, AND LIFESTYLES

The previous sections illustrated that urbanisation may not lead to more sustainable mobility patterns. The living environment of a household is not only affecting a household's sustainability performance through mobility, but also through the infrastructures for energy, water, and sewer have important impacts. Higher spatial density usually reduces the amount of energy and material needed per citizen. Current and earlier work of the Finnish National Technical Research Centre VTT (e.g. Harmaajärvi, 2003) shows that an optimal use of energy infrastructure produces eco-efficiency benefits, which are approximately as large as those of an optimised transport system and spatial lay-out[9].

However, also in this case some counter-trends and -effects may occur. Firstly, it is now possible to construct low energy houses, as for example terraced or semi-detached homes, with the same or even better energy performance standards as apartment buildings have. For example, apartment buildings often require more generic spaces and facilities (stair-houses, galleries, elevators and elevator shafts, etc.) compared to other types of residential buildings (detached, semi-detached and terraced houses). It is often also more costly to adapt a multi-story apartment building to – for example – energy system innovations such as solar collectors, in comparison to other types of residential buildings. This relaxes the stress on apartment buildings or other truly high density area planning, since district heat is not anymore automatically superior in terms of overall energy efficiency.

Due to the higher land value it is recommendable to build with higher densities in a city. This notion gets more challenging in terms of neighbourhood lay-out if a larger number of single family houses is to be integrated into an urban building project. This would improve the infrastructure efficiency of such a neighbourhood in comparison to the alternative further away from the (inner) city. And even if the design can be realised, the household interviews in the KulMaKunta project pointed at the issue that a part of the potential buyers may be only interested in a more spacious house in the real – more spacious – urban fringe. A way out of these problems might be to impose overall sustainability performance standards for new and thoroughly renovated neighbourhoods. This allows more flexibility regarding the various elements (transport, energy, etc.) to municipalities and planners, but strives to ensure that overall the sustainability targets are achieved. From the climate mitigation literature is well known that it usually pays off to allow flexibility in lieu of very precise prescriptions, e.g. Parry and Williams (1999) as long as overall targets are harder and adequately monitored.

With respect to the question whether different living environments significantly induce the choice of particular lifestyles, this article presented evidence with respect to mobility and the incitements to mobility. Since sustainability is a comprehensive concept it is important to check the interaction effects with other elements, such as energy use and supply. Also the expenditure behaviour and actual patterns of use of commodities require more scrutiny. Consumption patterns differ most probably between different types of areas, but it takes more study to be sure whether otherwise similar households in cities tend to be more consumption oriented (i.e. trying to earn enough for an ambitious level of consumption requirements) than households living in other – less urban –environments. In Perrels (2003) it is illustrated that people in Finland move to cities notably for reasons of expected higher incomes, which results in higher purchasing power despite the higher cost of living in cities.

Preliminary findings indicate that there may be some systematic differences in consumption behaviour between cities, semi-urban areas and the countryside attributable to the consumer supply infrastructure. For example, according to regression analysis the propensity to save is to some extent sensitive for the degree of urbanisation, implying that the propensity to save diminishes when the living environment becomes more urban. As regards expenditures by category the budget shares allocated to restaurants, leisure, personal care, tourism, and financial services tend to go up as the living environment becomes more urban. Conversely, the budget share for food purchases in shops is negatively correlated to urbanisation.

Also the time use analysis indicates that people living in cities tend to spend more time on shopping and on culture & entertainment compared to people living in other types of areas, at least for the years 1999 and 2000. The correlation between the occurrence of various types of free time profiles and urbanisation alludes to the same tendency. Even though the preliminary results seem to confirm the picture that an urban environment has some stimulating effect on private consumption, the additions in consumption seem to concentrate in services, which often have lower environmental impact per euro spent than the average consumption basket.

9. In those simulations of VTT behavioural developments, other than invoked by changes in average distance to work and services and changes in public transport supply, were assumed to be absent.

However, at the same time it concerns mostly services that presuppose travel, which may imply that the total environmental impact of the supplied and consumed service could still be considerable.

Conclusions

URBANITY AND MOBILITY

Counter to the usual expectations it turns out that urban dwellers at least in Finland not necessarily reduce travel performance compared to others despite the – potentially – shorter distances to services and work. On the other hand urban dwellers do have an environmentally more favourable modal split, especially when the higher share of travels by ferry and aeroplane are set aside.

Owing to their facilities, atmosphere and spatial-economic role urban environments do incite people to adopt more mobile lifestyles and/or do attract people with mobile lifestyles, resulting in an overall transport performance which exceeds those of other area types. It also means that in terms of eco-efficiency of travelling, city life in practice does not result in an evidently better travel performance, even though the potential for higher eco-efficiency may be technically present (thanks to public transport and proximity of services). Nevertheless, given an existing sizeable urban structure sprawl (represented in the analysis by urban fringe residence) has significantly more boosting impact on travel than more inner city residences.

In a dynamic setting, i.e. in significantly expanding cities such as the Helsinki metropolitan area, it is important to know to what extent people, who move from the central city to a suburb or semi-urban area, are imposing their urban mobility patterns on those new areas or conversely are adapting to less mobile lifestyles.

Observing that countryside – that is low density – areas in Finland seem to result in second to largest transport performance per person, the study results up to now suggest that reasonable densities but probably not too large urban units enable the most favourable conditions for environmentally sustainable passenger transport. Further checking of this is needed by means of more precise distinctions of living environments and settlement structures.

URBANITY AND CONSUMPTION

Cities tend to provide facilities and an atmosphere which stimulates engagement in activities that augment private consumption, as it shows in the time use and expenditure statistics of its inhabitants. The increments in consumption incited by cities tend to be concentrated in services, but with an increase of mobility as a significant side-effect.

The concept of the 'means of consumption', introduced by Ritter and in this paper argued to be a logical consequence of the ongoing quest for overall productivity increases, seems to provide also a fertile platform for assessing consumption and sustainability. Hence the concept deserves thorough operationalisation for the purpose of impact assessment.

METHODOLOGY ~ POLICY

The results indicate that the eco-efficiency, although very important, is an insufficient indicator to serve as the prime policy indicator. Favourable eco-efficiency can obviously be achieved even though the total rate exhaustion of natural resources remains high.

A more explicit account of all three dimensions of sustainability in the rapidly expanding New Economic Geography toolbox is dearly needed. So far sustainability in New Economic Geography means first and foremost economic sustainability.

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Appendix – estimation results for travel time

Table A1. Selection of OLS estimation results for total survey population (except disabled and seriously ill).

issue	total travel				issue	commuting		
population:	ALL RESPONDENTS except seriously ill/disabled				population:	ALL RESPONDENTS except seriously ill/disabled		
dependent var:	*logallmod*	*3,90375*	*logallmod*	*3,8473*	*logwallmod*	*2,54034*	*logwallmod*	*2,54034*
explan.vars:	parameter	t-value	parameter	t-value	parameter	t-value	parameter	t-value
intercept	-0,64110		-0,47674		3,45793	**	3,47064	**
Dsp	0,11525	**	0,06278	**	-0,05911	**	-0,05639	**
LOGIKA	2,98894	**	2,86638	**	-0,84661	**	-0,85089	**
LOGIKA2	-0,49165	**	-0,47644	**	0,11397	**	0,11422	**
LOGTYOAIKA	0,05817	**	0,06357	**	0,24282	**	0,24272	**
LOGOINC								
LOGPINC								
LOTUNPAL	0,02610	**	0,02540	**	0,04163	**	0,04192	**
LPTUNPAL	0,00220		0,00151		0,01063	**	0,01054	**
LOGHLKM	-0,11186	**	-0,07439	**	-0,06720	**	-0,06658	**
NCAR/Dcar	0,06368	**	0,17938	**	0,00689		-0,00669	
DURBCORE	0,15790	**	0,13270	**	0,09129	**	0,09061	**
DURBFRIN	0,18525	*	0,13767	~	0,17959	**	0,17972	**
DMEDDENS	0,06360		-0,01353		0,05419	*	0,05336	*
DCOUSIDE	-0,08234		-0,14463	**	-0,07974	**	-0,08110	**
ASALUE								
DVAPAIKAS	0,10428	**	0,09298	**	-0,04494	**	-0,04528	**
KOP_TYP	-0,15721	**	-0,15941	**	0,03321		0,03174	**
KOA_TYP	-0,05513		-0,06758	~	-0,00656			
KULT_TYP	0,08999	*	0,12429	**	-0,00549			
URH_TYP	0,04135		0,05495		0,02937			
DEDUC	0,07003	*	0,05571	*	0,02115			
R2	0,110		0,137		0,675		0,675	
N	8466		9798		8466		8466	

Significance category indications for t-values (% indicates probability of having a significant effect):
>90%: ~ >95%: * >99%: **
The estimated functions (of the form of equation 2 in the main text) have total travel time (logallmod) and commuting travel time (logwallmod) as dependent variables. The other variables are the explanatory ones.

Variables:

Logwallmod	natural logarithm of the travel time (in minutes) per day for commuting by any mode
Logallmod	natural logarithm of the total travel time (in minutes) per day by any mode
Dsp	gender dummy; 1 = male; 0 = female
Logika	natural logarithm of the age of the respondent in years
Logika2	square of the natural logarithm of the age of the respondent in years
Logtyöaika	natural logarithm of the reported working time (in minutes) per day
Logoinc	natural logarithm of the net annual income of the respondent
Logpinc	natural logarithm of the net annual income of the partner of the respondent
Lotunpal	natural logarithm of the calculated net hourly income of the respondent
Lotunpal	natural logarithm of the calculated net hourly income of the partner of the respondent
Loghlkm	natural logarithm of the number of house-hold members
Ncar	Number of passenger cars in the household
Dcar	dummy variable for car availability; 1 = at least one car available; 0 = no car Dcar is only used in the second – right hand – specification for total travel (logallmod)
Durbcore	dummy for (inner) city residence; 1 = respondent lives in (inner) city; 0 = lives elsewhere
Durbfrin	dummy for urban fringe residence; 1 = respondent lives in urban fringe; 0 = lives elsewhere
Dmeddens	dummy for smaller city residence; 1 = respondent lives in smaller or midsize municipality with medium density of the built up area; 0 = lives elsewhere
Dcouside	dummy for countryside residence; 1 = respondent lives in countryside; 0 = lives elsewhere
Asalue	living area category (more simple categorisation than previous dummies, not used here)
Dvapaikas	dummy for summerhouse (co)ownership; 1 = owns one or more; 0 = no summerhouses
Deduc	Dummy for education level; 1 = higher professional or academic education; 0 = otherwise
KOP_TYP	1 = respondent has low profile freetime patterns; 0 = not this type
KOA_TYP	1 = respondent has high freetime profile on hobbies; 0 = not this type
URH_TYP	1 = respondent has high freetime profile on sports; 0 = not this type
KULT_TYP	1 = respondent has high freetime profile on culture and entertainment; 0 = not this type