TIME PIONEERS AND TRAVEL BEHAVIOUR

An Investigation into the Viability of 'Slow Motion'

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Abstract

This paper positions time in the centre of spatial economic analysis, with a particular view on transport behaviour. The conventional assumption is that there is for most people in our society a constant travel time budget, so that higher speeds tend to lead to longer travel distance. This development is at odds with the notion of sustainable transport, which would require lower levels of mobility.

Recently, the scientific construct of a so-called 'time pioneer' has been introduced. Such a time pioneer is prepared to give up part of his scarce time for other, as yet unknown purposes. This attitude might generate 'slow motion' behaviour.

The paper aims to critically review the concept of a time pioneer from a broad perspective on the socio-economic meaning of time in our globalizing society. It investigates the environmental burden of various travel modes against the background of their time consumption.

The viability of time pioneering behaviour is next empirically tested by means of an extensive survey among travellers in the Netherlands. Several modelling experiments, such as logit analysis and rough set analysis, are carried out. It is concluded that, while 'slow motion' is seemingly an appealing socio-psychological travel mode, the share of time pioneers among actual travellers is disappointingly low.

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1. Time and Human Behaviour

> *"Time perception, psychological time, mental time, personal time, subjective time, social time and cultural time are all denominations used to differentiate human time from physical, absolute, Newtonian, chronological time"* (Morello 1993, p. 31).

Time is often regarded as a 'passive' attribute or dimension used to denote the chronology of events or phenomena (see for a review e.g. Kirsch *et al.* 1988). However, time may also have a more pronounced and direct economic meaning in that performing human activities is based on deliberate and proper time management and subject to scarcity of time (cf. Morello 1994). This is clearly reflected in the following quotation: *"rather than being a 'container' in which human action unfolds, human existence is temporality in action"* (Thompson 1994, p. 80). This activity and scarcity feature of time is of decisive importance for contemporaneous human - and also spatial - behaviour. All economic activities take time and hence have to be undertaken in a time-efficient way. Analogously, travelling consumes scarce time which cannot be spent otherwise and hence travelling - as a necessary spatial movement - has to take place in the shortest time possible, while of course taking into account the (direct and indirect) costs involved in choosing for higher speeds. Alternative new ways of spending one's time, e.g., on additional activities, will normally be induced by the achievement of higher personal utility levels, so that time is having its indigenous shadow value in a scarcity context. This economic view on time is reflected in a great many time budget studies (see e.g., the 'classical' studies of Becker 1965, De Serpa 1971, Szalai 1972, or Winston 1982), and in particular in value-of-time studies in transportation research (see Downes and Emmerson 1983, Jara-Diaz 1990 or Supernak 1992). In general, there appears to be a high willingness-to-pay in order to gain extra time (reflected e.g. in speed limit violations).

This high time preference of many people forms one of the main backgrounds for the permanent tendency to increase travel speed, a tendency which is further reinforced by the competition between different modes such as car, train or airplane. It goes without saying that this world-wide trend has adverse, disadvantageous consequences for environmental sustainability and safety of the modern transport sector (cf. Fergusson 1994).

For the time being, the major performance criterion of a transport system in our society is **speed**, not sustainable mobility. Even though speed reduction can be shown to have demonstrable financial and environmental benefits, the drive towards an increasingly mobile society seems to be irresistible. The 'law of a constant travel time budget' suggests that higher speeds will even not lead to time savings on travelling, as these savings will immediately be used to make new or longer trips (see Rossi 1997 and Zahavi 1997).

High speed is thus the sales label of a modern developed economy and one may wonder whether a return to '**slow motion**' would ever be feasible and acceptable, even though the awareness is growing that a continuation of current trends may have devastating environmental impacts. Clearly, several environmentalists make a plea for a forced speed limitation for cars, trains and airplanes, but it is an open question whether a return to a 'snail society' would at present receive a broad social support (see also Rienstra and Rietveld 1996). There are, however, notable and illustrative exceptions, e.g., the phenomenon of **downshifters**, i.e., people who deliberately and voluntarily accept a lower position on the job ladder in exchange for more leisure time or a more relaxed life style (cf. Schor 1992). Although this group of '**time pioneers**' is for the time being relatively small, it makes certainly sense to investigate more thoroughly the motives of such time pioneers in order to examine the feasibility of a 'slow motion' policy,

based on the goal of a sustainable development of the transport system.

Against this background, the present paper aims to undertake an empirical research effort focused on the socio-economic viability of a 'slow motion' strategy by (i) identifying the characteristics of (groups of) travellers who in principle might be classified as 'time pioneers' and by (ii) exploring next the opportunities and bottlenecks involved in 'slow motion' behaviour for this dedicated group. The paper is organized a follows. After this introductory section, the next section (Section 2) will address in some more detail the role of time in (spatial) economic decision-making, seen from a historical perspective. Next, Section 3 will pay attention to different segments of the transport market which cover the needs of different socio-economic groups and which may have different environmental implications. The fourth section is devoted to a concise description of the empirical research base of our applied analysis framework, with a particular view on ‘slow motion’. Next, we will try to find factors that help us in identifying time pioneers. In this respect, socio-economic characteristics and preferences with regard to time behaviour and vehicle convenience are considered. For this purpose, a recently developed analysis method, rough set analysis , will be used. This method will be discussed in Section 6 and applied in Section 7. Finally, Section 8 will offer some strategic considerations and policy conclusions on 'slow motion' strategies.

2. The Restless Society: An Overview

Fast food, high speed, last minute bookings, quick and dirty decision-making and just-in-time transport: all these expressions mirror the fact that time has become a critical factor in modern societies (cf. Zoll 1988). Time is money! And this also applies to travel time (cf. Kraan 1996). But the preference drift for more speed has also its shadow sides: depletion of resources, environmental decay, decline in safety, and social tension. These social costs may be significant, even to the extent that sometimes an added value may be expected from a speed reduction. Such a drastic change in modern transport systems performance may have an aggregate benefit in resource and environmental terms, but needs to be supported by a change in individual behaviour. Of course, the question is whether and why travellers would prefer slower to faster transport modes. The answer to this question depends on whether there are clear individual or social gains involved. Such gains might be of a twofold nature: (i) slow modes of transport may offer an added value, if the travel time can be used in a productive way (or in case of leisure traffic in a consumptive way); (ii) high speed preferences may cause so much mental and physical stress, that a continuation of high time preferences may in the long run cause disutilities to the traveller (Wansink 1994). Historically, a reversal of speed trends does not seem very plausible, although this is of course not a decisive argument. To start with, we will give a concise historical overview of the role of time in (spatial) decision-making.

The perception of time as an 'active' component in human life to be optimized did hardly exist in traditional - nomadic or feudal - societies (Virilio 1995). The rhythms of seasons and nature were decisive for activity and mobility patterns of early mankind. Later on, the genesis of cities and the discovery of resources in other parts of the world created labour specialization and hence also trade flows, not only locally or regionally (e.g., from agricultural to urban areas), but also globally (e.g., between Europe and the East and West Indies). But - despite improvements in logistic systems and transport operations - there were 'natural' limits to speed and efficiency.

The Industrial Revolution has since the mid 1850's significantly changed the economic-geographical face of our society. The limits to speed - imposed by nature (e.g., wind, water) or horsepower - were drastically relaxed by the steam engine, so that unanticipated efficiency gains from much higher speeds could be realized, with the steam train taking the lead. The management of time in the emerging

industrial economy became a critical success factor in a competitive market system. Around the turn of this century the perception of space and time changed from a local to a global orientation (see Kern 1983), a tendency which was reinforced by the introduction of the fuel-powered car and - later on - of the airplane.

Acceleration of production, consumption and transport was once more encouraged as a result of Fordist modes of production and Taylorist ways of work organisation. The surprising rise in time efficiency did, however, not lead to a leisure society, but to a culture of 'work and spend' (see Cross 1993).

According to several authors (e.g. Giddens 1990, Van der Stoep 1995, Toulmin 1990) the roots of the drive towards efficient time use - and the consequent rise in mobility - has to be found already much earlier, namely in the beginning of the modern history (as of the start of the seventeenth century). In the transition from a pre-modern to a modern society, the traditional perception of space and time as an interwoven complex with the given cultural, political, religious and agricultural order was gradually abandoned. An active management of space and time allowed people to open entirely new horizons in the era of modernity (Ostör 1993). However, a real break-through had to wait until the nineteenth century, when combustion engines using fossil fuels provided the technological opportunities for the world-wide 'time-space distantiation' (Giddens 1990). The ever increasing travel speed caused a 'time-space compression' (Harvey 1989): *"As space appears to shrink to a 'global village' of telecommunications and a 'spaceship earth' of economic and ecological interdependencies (-) and as time horizons shorten to the point where the present is all there is, so we have to learn how to cope with an overwhelming sense of compression of our spatial and temporal world"*. Thus, both our world and our future horizon are getting smaller all the time. Clearly, there is for the time being no plausible argument that would convincingly tell us that this historical trend would come to a stand-still in the foreseeable future (cf. Van Doren 1991).

The impacts of the introduction of rapid means of transport have been formidable, not only on the industrial economy and on international trade, but also on patterns of living and working. Cities were rapidly expanding beyond their traditional walls. For example, the electric tram caused a doubling of the diameter of the cities which had introduced these vehicles (Lay 1992). The wide spread adoption of the car led even to far reaching spatial changes in terms of suburbanisation and urban sprawl (see Berger 1979 and Flink 1993). In the course of history, and in particular in the modern age of telecommunication and virtual reality, many people have lost their 'sense of place' and replaced it by a 'sense of flow' (Castells 1991). Modern activity patterns presuppose a synchronic management of time and space (cf. Carlstein 1978). For many people, the world as a whole has become the 'place of action' connected by various types of networks (cf. Ury 1995 and Waters 1995). The various modes of transport in the age of globalisation and mobility are partly complementary, partly competitive. This applies to both physical transport modes and telecommunication modes. Mobility has ultimately become an intrinsic feature and driving force of a modern economy.

The absolute winner in the competition between new vehicles since the Industrial Revolution has become the car, followed by the airplane. Public transport has not managed to acquire a market share of a significant size, apart from a few exceptions. Thus, the least sustainable modes of transport appear to have conquered the largest share of the mobility market. Unfortunately, the societal drive for higher speed and more time pressure has - in addition to numerous economic efficiency gains - created a variety of social costs, e.g. to the environment and human safety (Verhoef 1996).

Against this background we have to interpret the popular ideas on 'slow motion' characterized by an old wisdom: 'more hurry, less speed'. The environmental and socio-psychological stress of present time behaviour in a modern society has - in the eyes of many authors - become unbearably high, even to the extent that 'to hasten slowly' is sometimes advocated as a new mode of economic and social behaviour

(Rifkin 1987; Zoll 1988). In a recent study (see Hörning *et al.* 1995) the concept of a 'time pioneer' has been introduced and empirically investigated. In contrast to a restless society characterized by permanent hurry, these authors propose a new life style which is not only based on material welfare, but also on '**time welfare**'. Time pioneers are then economic actors who deliberately resist the high speed culture and are prepared to exchange part of their income for more time, without having immediately a new economic purpose for this new discretionary time. This means that, for instance, these pure pioneers do not 'buy time' for economic purposes, e.g. to give their partner the opportunity to work.

Table 1. Indicative operational features of transport modes

	Spatial range		Occupancy rate (%)	Cruising speed	Pre- and post-transport time (hours)	Travel costs (Dfl/person km)
	minimum (km)	maximum (km)				
Ferry	2	10000	50	39	3	0.2
Hovercraft	50	10000	60	75	3	0.3
Jet plane	300	30000	65	640	4	0.35
Turboprop	200	5000	65	360	3	0.35
Eco-airplane	200	10000	65	320	3	0.35
Zeppelin	100	1000	65	96	2	0.35
Car	0	2000	40	65	0.1	0.25
Eco-car (1:30)	0	2000	40	60	0.1	0.17
Electric car	0	2000	70	30	0.1	0.12
Taxi	0.5	100	17	40	0	1.5
Bus	0.5	20	15	20	0.3	0.25
Eco-bus	0.5	2500	30	30	0.5	0.2
Eco-train	4	2000	50	75	0.7	0.2
Bicycle	0	10	100	8	0	0.05
Innovative bicycle	0	100	100	45	0	0.1
Tram	0.5	20	22	15	0.25	0.2
Metro/rapid tram	1	20	22	30	0.4	0.2
Train	4	400	40	75	0.6	0.2
High speed train	150	2000	65	190	2	0.28
Maglev	200	3000	65	370	2	0.28

Real time pioneers derive their utility from a free choice regarding the additional free time. Thus, more flexible time behaviour (e.g., flexihours for departure time of trip-makers) is not the typical feature of time pioneers (see for a recent review of flexible time scheduling also Emmerink and Van Beek 1997). This would imply that time pioneers might also be prepared to accept longer travel times in transport. The question then is whether and how we can identify such pioneers. Which are their features; and is the group of time pioneers a small idealistic but negligible group, or is it a significant part of the travellers? These questions will be further investigated in our study.

We will focus in the next section on the various modes and vehicles which may be chosen by travellers and on the attributes of these modes and vehicles. In the subsequent part of the paper we will then address the issue of time-pioneering behaviour from an applied perspective.

3. Typology of Travel Modes

The transport market is a heterogeneous network configuration with different types of users, different modes, different quality and cost levels, and so forth. As mentioned in Section 2, the idea of time pioneering is mainly born out of the concern for the high (social and personal) costs of transport (see for a review Verhoef 1996). And therefore, it is conceivable that the various segments of the transport market are mainly distinguished according to their convenience and environmental aspects.

In terms of **modes**, the following illustrative distinction can be made for passenger transport:

- water: ferry, hovercraft, catamaran, water taxi etc.
- air: jet plane, turbo plane, helicopter, eco-airplane, zeppelin etc.
- road: conventional car, eco-car, electric car, taxi, bus, eco-bus, bicycle, innovative bicycle etc.
- rail: tram, light rail (metro, rapid tram), train, high speed train, maglev, eco-train etc.

This list is certainly not exhaustive, but in any case rather representative. The various transport modes listed above have significant differences in terms of their operational characteristics Some typical average data on these features are given in Table 1, while more details on environmental effects can be found in Baaijens *et al.* (1997). These data show large variations in the operational and environmental performance of the various modes. The actual use of these modes is partly determined by these features, and partly by the user needs, motives and characteristics. One important piece of information is missing in these tables, viz. the convenience of the various modes. This is particularly important, since many collective modes of transport require a transit of the traveller (including waiting time, which is normally very negatively valued). Such inconveniences are a common ground for the popularity of private modes of transport (in particular, the car).

It is also clear that the various modal types are sometimes competitive, sometimes complementary. They serve different market segments, depending on travel purpose, speed, costs, geographical range, environmental consequences, and other convenience properties. These attributes are, in general, not mutually dependent. For example, the **travel motives** may be distinguished as follows for the Netherlands (see Baaijens *et al.* 1997):

- commuting trips (with an average range in the Netherlands of 14 km)
- short business trips (average range 20 km)
- European business trips (average range 400 km)
- intercontinental business trips (average range 7000 km)
- personal care trips (average range 5 km)

- recreational trips (average range 100 km)
- European holiday trips (average range 500 km)
- intercontinental holiday trips (average range 7000 km)

Clearly, the combination of specific trip motives and the geographical action radius are largely decisive for the type of mode used by the traveller. But also the travellers are not a uniform group. They may be classified according to income class, profession, age, gender, household size/composition etc. Consequently, there is a need for a more thorough investigation into various user segments of the transport market. This may also be helpful in identifying specific groups, such as 'time pioneers'.

Figure 1. Ownership of cars and public transport cards

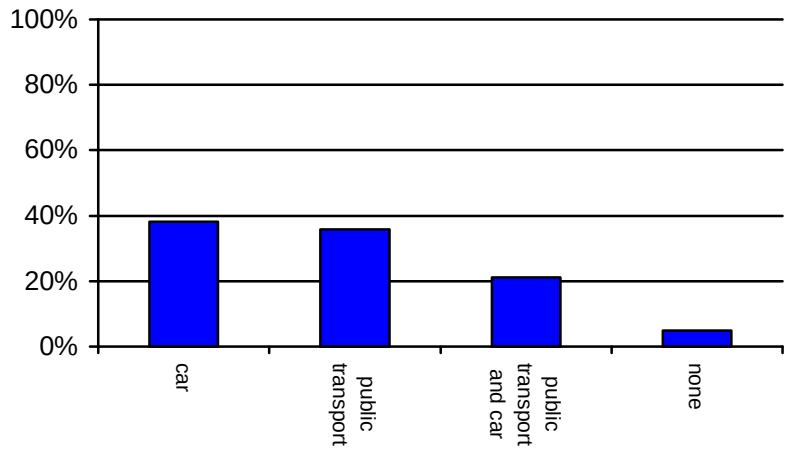
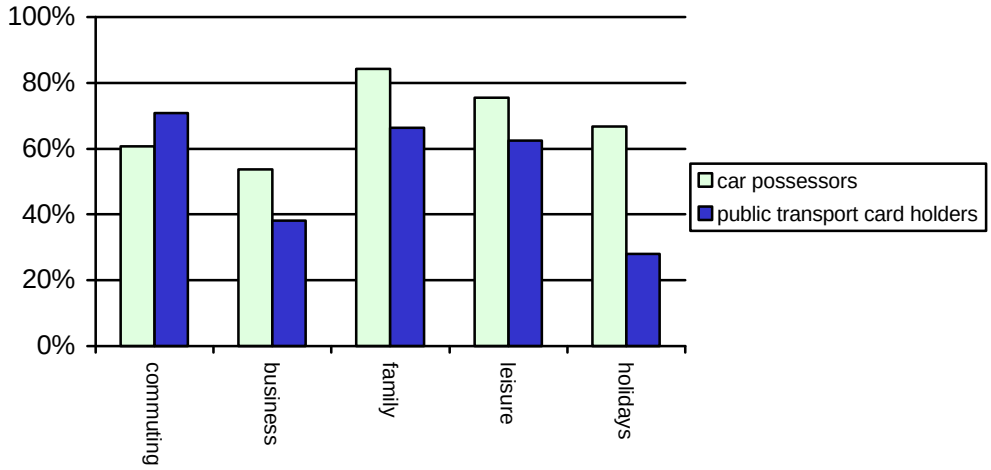


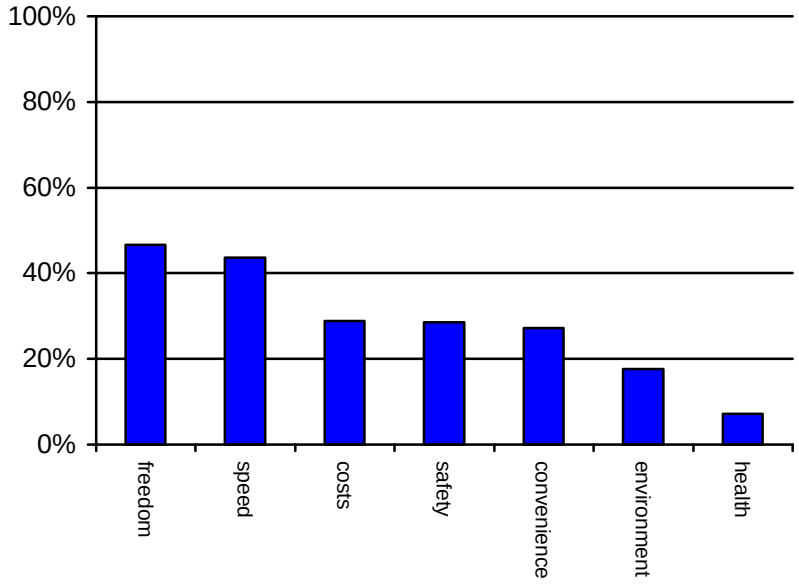
Figure 2. Modal choices of car owners and public transport card holders



4. ‘Slow Motion’ as a ‘Double-Edged Sword’

The heterogeneity of the transport market and of the users of transport prompts the question whether ‘slow motion’ may be an acceptable option for the travel behaviour of designated groups of travellers. It is evident that the business market does not offer any perspective for slow modes of transport, but there may be segments of home-to-work journeys, social trips, recreational trips and holiday trips for which slower modes of transport may be an appealing alternative. Such modes would have a ‘double dividend’, if they would have lower environmental externalities (seen from a common interest) and a higher satisfaction for the traveller (seen from the individual’s interest). The basic question then is whether such a ‘double-edged sword’ does exist and is perceived as a meaningful choice alternative by travellers. This is an empirical question which can only be answered on the basis of applied field work.

Figure 3. Criteria scores for choice of transport mode



The empirical research in our study has been undertaken in the form of a survey questionnaire which aimed to map out the motives and bottlenecks for the travel behaviour of individual trip-makers in the Netherlands. The questionnaire forms were handed out to travellers at public transport terminals and gasoline stations. The total response was 316 (with a response rate of 23.9%, with a slightly higher response rate for users of public transport). The questionnaire contained various items related to personal characteristics, travel motives and travel behaviour, in particular: personal attributes (profession, income, age, gender), modes of transport (to be) used, choice criteria in selecting a mode, trip purposes, origin-destination etc. Some interesting outcomes from the questionnaire results are depicted in Figure 1 to 4.

Figure 4:. Importance of convenience criteria

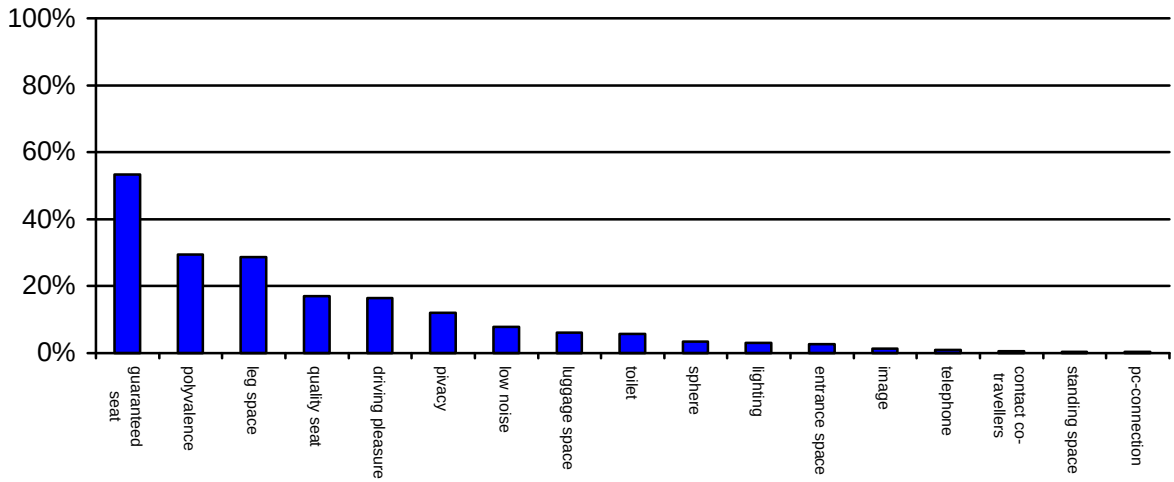


Figure 1 shows the distribution of the respondents over four groups: 21% of the respondents has a car as well as a public transport card; 38% has only a car and 36% has only a public transport card, while 5% has none of them. Figure 2 shows for what travel motives the respondents use their cars or their public transport cards. The various criteria for making the modal choices in the light of travel motives are mapped out in Figure 3. The convenience attribute is rather general and deserves a closer investigation. Since it seems plausible that relatively slow modes of transport may have certain convenience benefits, the convenience criterion has been further subdivided into various constituent subcriteria (see Figure 4). The dominant factor here seems to be the need to have a guaranteed seat.

Further insight into the motives of travellers was obtained by presenting to them interesting cover stories on 'virtual' travel choice situations, with the request to describe the choice mechanism and the criteria in selecting a certain transport mode. This stated preference method generated quite some fascinating insights into the trade-offs of travellers. In general, there appears to be a relatively high preference for the faster transport modes, even for situations where speed might be expected to matter less, such as recreation or vacation. Thus, it seems plausible that a modal shift to slower modes of transport can only be achieved, if the level of convenience and the quality-cost ratio of slow transport modes are drastically higher than those of fast modes. Are there still perspectives for 'slow motion'?

In order to answer the latter question, in Section 5 an attempt will be made to identify a group of potential 'time pioneers' from our sample, and to assess their preferences and attitudes regarding 'slow motion'.

5. Time Pioneers in an Empirical Context

A time pioneer is willing to 'buy' extra time without knowing in advance how to spend it. A part of our empirical analysis aimed at identifying respondents as time pioneers. In order to properly formulate the question in the survey, it was necessary to operationalize the notion of time pioneer. We have chosen for the following operational definition: a time pioneer is somebody who is willing to give in a substantial proportion of his income in exchange for more discretionary time, without having a designated purpose for the time gained beforehand. This definition corresponds to the notion of 'time pioneer' given by Hörning et

al. (1990). They describe time pioneers as people who want to manage their time consumption patterns themselves. Time pioneers do not want to submit themselves to the conventional 40 hours' working week and demand completely individual working times. They also refuse to meet the norm imposed by the economic order of the market economy that all time has to be used as efficiently as possible.

The question on time pioneers in the survey was split into two parts. The first part asked the respondents whether they were willing to exchange income for more leisure time. Those who affirm this, are called 'income shifters' . Next the group of income shifters was asked how they would spend the time they would gain. They were allowed to choose from one or more of the following activities: housekeeping and care for the children, visiting friends and family, diversion, hobbies and sports, travelling. They could also indicate that they would reduce their working hours to enable their partners to have a (better) job, or that they would decide on this when they had the time. People stating the latter are called time pioneers: they want to reduce their working times, but do not have a specific purpose for this time. If they declare that they also want to use the time for some other purpose, they are called semi-time pioneers. Table 2 shows the results of this characterization for the sample population.

The group of time pioneers appears to be small. Only 2.5% of the respondents can be interpreted as pure time pioneers, while 4.7% is semi-time pioneer. It is striking that 12 respondents state that, although they do not have a paid job, they are willing to give up income. It seems thus reasonable to restrict the analysis to the respondents with paid jobs. The small number of time pioneers complicates the application of statistical methods to pinpoint their typical characteristics. Therefore, an alternative, non-statistical but quantitative, method will be used here.

Table 2. Time behaviour of the sample population

Category/ paid job	paid job	no paid job	total
income shifters:			
- time pioneers	7	1	8 (2.5%)
- semi-time pioneers	13	2	15 (4.7%)
- other income shifters	61	9	70 (22.2%)
other respondents	162	61	223 (70.6%)
total	243	73	316 (100%)

Table 3. Stratification scheme

Category	Frequency
income shifters	
- pure time pioneers	7
- semi-time pioneers	13
- other income shifters	20
other respondents	20
total	60

This method, called rough set analysis, is suitable in particular for small data sets. This method will concisely described in Section 6. Although our data set is not very large, it is too large to apply the rough set method in a manageable way. Therefore, a stratified sample will be drawn from the original data set. Table 3 shows the stratification scheme. The number of pure time pioneers and the number of semi-time pioneers serve as the reference frame for the stratification scheme. As these numbers are small, all of them are included in the sample. Besides two control groups are added. The sizes of the two control groups are chosen to equal the total number of time pioneers, i.e. 20. The size of the stratified sample adds up to 60 observations. This data set will now be used in the rough set analysis.

6. The Rough Set Method: Introduction and Use

An important research question in the empirical study is by which behavioural characteristics time pioneers can be distinguished from other respondents. A conventional method to answer such questions is the use of a linear regression model or one of its variants, such as the probit and the logit model. Such models deliver statistical measures of the correlation between a dependent variable and a number of independent or explanatory variables. However, in case of a small number of observations, the validity of these results is low.

Instead of this statistical technique we will use a method which is based on new advances in set theory. This method, rough set analysis, has been described comprehensively by Pawlak (1991). In Slowinski (1992) several applications of the method can be found (see also Van den Bergh et al. 1997). The rough set method is very suitable to analyze qualitative information. This information is considered as a finite set of objects which can be described on the basis of a set of attributes. These attributes constitute the available information on the objects.

On the basis of a set attributes we are able to divide the objects into groups. Objects belonging to the same group are indiscernible for an observer. Given his information, an observer cannot make a distinction between objects of the same group. The groups of objects that result from the classification on the basis of all attributes are called elementary sets. If the information on the objects increases, the number of elementary sets will never decrease. A set which is not a union of one or more elementary sets, is called a rough set.

A set is rough, if, given the information (i.e. the attributes) on the objects, an observer is not able to indicate all elements of the set concerned with certainty. He is however, able to identify all objects that are certainly elements of the set. He is also able to mark the objects that possibly belong to the set. The set of objects that belong with certainty to the rough set, is called the lower approximation of the rough set, while the set of objects that are possibly or certainly elements of the rough set, is called the upper approximation. The ratio of the number of elements belonging to the lower approximation to the number of elements belonging to the upper approximation, is a measure of the accuracy of the approximation.

Consider now a partition of the total set of objects. In our example the classification of the respondents into pure time pioneers, semi-time pioneers, other income shifters and other respondents is a partition. The set of objects that can be assigned to one of the subsets of the partition with certainty, is called the lower approximation of the partition. The ratio of the number of objects belonging to this lower approximation to the total number of objects is called the quality of classification. This measure will play an important role in our analysis.

A rough set analysis can take place in three successive steps (Baaijens and Nijkamp 1997). In the first place it is decided which information will be included in the analysis. In the second step the information

chosen is transformed into a coded information table. For each attribute the data are divided into classes. The third step is the eventual application of the rough set method. Then the so-called reducts of attributes are determined. Each of these reducts is a basis for a minimal decision algorithm on the assignment of objects to sets. In a recent study by Baaijens and Nijkamp (1997), rough set analysis was applied to a case-study in which the number of attributes was large in proportion to the number of objects. As a result several reducts were found that could serve as a basis for decision algorithms. These decision algorithms were comprehensible because they did not comprise many (i.e., more than seven) decision rules.

In our study the situation is different. The number of objects as well as the number of attributes considered is much larger: we consider 60 objects and 23 attributes. This ratio of attributes to objects leads to a very large number of reducts. Furthermore, the minimal decision algorithms become incomprehensible because they comprise dozens of decision rules. Therefore, we have chosen to tackle the analysis in a different way here.

The approach chosen here aims to order the attributes considered according to their importance. To rank the attributes by means of rough set analysis we have designed a search strategy. This strategy may be seen as a recipe for a rough set analysis. It consists of four steps. The first step is the basic step which is carried out after the relevant information is chosen and coded.

1. Try to find the reducts and the core of the set of all attributes.

If this first step results into a large, incomprehensible number of reducts, it is meaningful to analyze the information groupwise in distinct classes.

2. Divide the set of attributes considered into groups or subsets.

3. Try to find the reducts and the core of each subset of attributes.

Now it is possible to make a distinction between relatively important and relatively unimportant information for each subset of attributes. Attributes belonging to the core are regarded as important, while the other attributes are regarded as unimportant. With the help of the criterion of core membership, it is not possible to order the attributes more accurately. Therefore, an alternative criterion, viz. that of the marginal contribution to the quality of the classification, will be employed. The marginal contribution to the quality of the classification is the increase of this quality when, given a set of attributes, an extra attribute is added. We will formulate two alternatives for the application of this rule.

4.
Alternative 1 (sequential addition): Start with an empty set of attributes. Add the attribute with the largest marginal contribution to the quality of the classification. Repeat this until the quality of classification equals 1.

Alternative 2 (sequential elimination): Start with the set of all attributes considered. Remove the attribute with the smallest marginal contribution to the quality of the classification. Repeat this until the quality of classification equals 0.

7. Empirical Results

7.1 Introduction

In Section 6 a stepwise approach to the application of rough set analysis was proposed and devised in order to analyze the stratified sample of 60 respondents from the original data set of 316 respondents, discussed in Section 5. The respondents , were classified into four disjoint sets: pure time pioneers, semi-time pioneers, other income shifters and other respondents. In Table 13 in Appendix 1 the attributes considered and the codifications chosen are shown. The nature of all information except the year of birth is qualitative in nature.

When we applied the first step of the strategy to this sample, we found hundreds of reducts of attributes and an empty core. This means that all attributes are dispensable, so that much information is redundant for distinguishing the elements of the four groups.

In the second step of the strategy the set of attributes was subdivided into subsets. We have chosen the following subsets of attributes: socio-economic characteristics, time behaviour characteristics, and characteristics of vehicle convenience. For each of this subsets we will now try to compute the reducts and the core. Furthermore, according to the fourth step of the strategy we will try to rank the attributes.

7.2 Socio-economic characteristics

The first subset of attributes dealt with, is the set of socio-economic characteristics. This subset consists of nine attributes, each of them being able to assume different values. In Table 13 in Appendix 1 the different values of the attributes are listed. There are 61,440 possible combinations of values of these attributes.

Although we can distinguish so many different combinations of attribute values, we are not able to classify all the respondents with certainty on the basis of the socio-economic characteristics. Table 4 shows that the categories of semi-time pioneers, other income shifters and other respondents are rough sets, as the lower approximations do not equal to the upper approximations. Two respondents may belong to the class of semi-time pioneers or the class of other income shifters, while two other respondents may be classified as either other respondent or semi-time pioneer. The set of time pioneers is however not rough. On the whole, it appears that on the basis of the socio-economic attributes 56 from the 60 respondents can be classified with certainty, so that the quality of classification equals 0.933 (=56/60).

The core of attributes consists of the set age, gender, education, residential location, working status, income and double income. The core equals the unique reduct. Only two attributes, family and working outdoor, do not belong to the core. According to the core criterion these two attributes are not important to distinguish between the above mentioned four categories of respondents.

Table 4. Quality of classification and accuracies of approximation for socio-economic characteristics

quality of classification	0.933
category	accuracy of approximation
pure time pioneers	1 (=7/7)
semi-time pioneers	0.733 (=11/15)
other income shifters	0.905 (=19/21)
other respondents	0.905 (=19/21)

With the help of the criterion of marginal contribution to the quality of classification it is possible to rank the attributes more precisely. In Section 6 two rules for the use of this criterion were discussed. The first rule starts with the situation that there is no information on the respondents available. Next, it is examined which of the attributes considered produces the highest quality of classification by itself. In this respect, the attributes working status and income appear to perform best. On the basis of working status as well as income we can categorize 3 of the 60 respondents with certainty.

Table 5. Ranking of socio-economic attributes according to Alternative 1

attribute added	resulting quality of classification
(1) income	0.050
(2) residential location	0.167
(3) age	0.450
(4) education	0.733
(5) gender	0.850
(6) double income	0.917
(7) working status	0.933
(8) household/working outdoor	0.933

The attributes working status and income are both the starting points for the application of the first ranking strategy. Thus, this strategy leads to at least two different rankings. Furthermore, it is possible that, in due course, the situation that the criterion can be satisfied in more than one way, occurs more than once. As a consequence, the number of possible rankings would increase more and more. We would, however, clearly prefer one ranking to more rankings, as the latter case is more difficult to interpret. This problem can be circumvented by calculating the qualities of classification of all pairs of attributes including one of the attributes income or working status. Afterwards we can then choose the pair of attributes that performs best.

The pair income and residential location appears to produce the highest quality of classification, so that income is assigned the first place and residential location the second place. Given this pair of attributes, the application of Rule 1 is straightforward. There is always one single attribute that gives the best performance (see Table 5).

The second ranking strategy begins with all available information (i.e. all socio-economic attributes). In this initial situation the effect of the omission of each attribute is investigated. The attribute that causes the smallest decrease of the quality of the classification, is removed. When the attributes working outdoor and family are eliminated, the quality of classification does not change. As these attributes do not make part of the unique reduct (and the core), this is not surprising. The application of the second strategy is straightforward (see Table 6).

When we compare the two resulting rankings as well as their distribution on the basis of the criterion of core membership, we see quite some correspondence in the results. According to each of these criteria, the characteristics household and working outdoor appear to be the least important attributes to discriminate between the four categories of respondents. In particular for the attribute household, this is a remarkable conclusion.

Table 6. Ranking of socio-economic attributes according to Alternative 2

attribute removed	resulting quality of classification
(7) household/working outdoor	0.933
(6) working status	0.917
(5) double income	0.850
(4) gender	0.733
(3) age	0.400
(2) education	0.167
(1) income/residential location	0

It does not seem important to know whether a respondent lives alone or together with a partner or with children to categorize him/her in one of the four classes.

Sequential addition and sequential elimination appear to have resulted into almost the same ranking of attributes. Only age and education have switched positions, but in both rankings they are successors. Income turns out to be the most discriminating attribute. We also found that residential location is important.

Double income and working status are apparently not very important. This implies that total household income is more important than the way it is earned; either by one or two incomes, or by a full-time or a part-time job.

7.3 **Time behaviour characteristics**

Time pioneers and income shifters are willing to give in a proportion of their income in exchange for more leisure time. This formulation suggests that time pioneers make the classical economic trade-off between time and money (Becker 1965). Time pioneers, however, object against this time paradigm. They want to experience and spend time in a different way.

The respondents were asked whether they were satisfied with their current time allocation. They were shown a list of six activities and next they were asked to indicate at most two activities which they

desired to spend more time on. Moreover, they were asked how much importance they attached to managing their own time. Altogether, seven attributes were considered. The first six attributes refer to the six activities and can assume two values: a respondent mentioned the activity or he did not. The seventh attribute, the importance of own time management, is measured on a five-point scale. This results into 320 possible combinations of attribute values.

The quality of classification appears to be now substantially lower than the same quality indicator for the socio-economic attributes. In total 31.7% of the respondents can be classified with certainty to one of the four categories. This low value can partially be explained by the relatively small number of 320 possible combinations of attribute values. This number was much larger for the socio-economic attributes: 61,440 possible combinations. Table 7 reveals that on the basis of the time behaviour characteristics we cannot pinpoint any pure time pioneer, since the accuracy of approximation of the set of pure time pioneers is 0. The performances of the other categories are also low. The category of other income shifters can best be approximated. The upper approximation consists of 36 respondents, while the lower approximations comprises 8 respondents.

The core consists of all attributes except the attribute commuting. Only one reduct is found, which is equal to the core. Given the other attributes, the attribute commuting does not help us to distinguish between time pioneers, income shifters and other respondents.

Table 7. Quality of classification and accuracies of approximation for time behaviour characteristics

quality of classification	0.317
category	accuracy of approximation
pure time pioneers	0 (=0/26)
semi-time pioneers	0.161 (=5/31)
other income shifters	0.222 (=8/36)
other respondents	0.146 (=6/41)

Next, we will try to rank the time behaviour characteristics more precisely with the help of the criterion of the marginal contribution to the quality of the classification. First, the sequential addition rule will be used. Given the empty set, only an addition of the attribute work leads to a positive quality of classification. All pairs of attributes including the attribute of work are not able to increase the quality of classification more than the attribute work separately. Therefore, the qualities of classification for all combinations of three attributes including the attribute work are calculated. The trio consisting of work, time management and relatives and friends performs the best. The sequence in Table 8 is now uniquely completed. The relatively high position of commuting is noticeable, because this attribute does not make up part of the reduct.

Table 8. Ranking of time behaviour attributes according to Alternative 1

attribute added	resulting quality of classification
(1) work	0.033
(2) time management/relatives and friends	0.117
(3) housekeeping/care for children	0.200
(4) commuting	0.250
(5) diversion	0.283
(6) hobbies/sports	0.317

The second strategy, sequential elimination, pays attention to the effect of omission of information (see Table 9). As the attribute commuting is not an element of the core and a unique reduct, elimination of this attribute does not diminish the quality of classification. As a consequence, this attribute is assigned the last ranking position. By the application of sequential elimination a unique ranking does emerge. There is always one single attribute that satisfies the criterion.

There is clearly some difference between the ranking based on sequential addition and the ranking based on sequential elimination. The ranking according to the second strategy is most consistent with our expectations derived from the description of time pioneers in Section 4. Time pioneers and income shifters are willing to give in income in exchange for more leisure time. It is plausible then that the attribute time

Table 9. Ranking of time behaviour attributes according to Alternative 2

attribute removed	resulting quality of classification
(6) commuting	0.317
(5) work	0.300
(4) housekeeping/care for children	0.267
(3) friend and relatives	0.133
(2) diversion	0.033
(1) hobbies/sports/time management	0

management is an important discriminating factor. Furthermore, it is plausible that the activities related to leisure time, viz. hobbies and sports, diversion, friends and relatives, score high, while the more necessary activities like housekeeping and care for children, work and commuting have low scores.

7.4 **Characteristics of vehicle convenience**

The third group of characteristics consists of seven aspects of vehicle comfort. Respondents were asked to mention the two aspects which are most important for them. Because time pioneers are supposed to have a deviant way of life, it is expected that time pioneers, income shifters and other respondents attach much importance to different aspects.

Each attribute can assume two values: the respondent mentioned the relevant aspect as one of two most important aspects or he did not. Knowledge on these preferences appears to provide an

observer with less information than knowledge on socio-economic or time behaviour characteristics of the respondents (see for results Table 10). On the basis of the information provided, an observer can indicate only one pure time pioneer. The other categories are also rough sets. Nevertheless, an observer would be able to categorize 25% of the respondents to one the four groups with certainty. In this respect, it is noteworthy that there are only 128 possible combinations of attribute values, while the number of possible combinations were far higher for the socio-economic attributes and, to a lesser extent, for the time behaviour characteristics.

All attributes appear to belong to the core, so that the core is equal to the unique reduct. As a consequence, the criterion of core membership is not suitable to make a distinction between important and unimportant attributes.

Therefore, we have tried, just as before, to rank the attributes on the basis of the criterion of the marginal contribution to the quality of the classification. The first strategy, sequential addition, starts with the empty set (see Table 11). None of the attributes appears to be able to increase the quality of the classification separately. Some pairs of attributes however, can make the value of the quality positive. In this respect, the pair freedom of movement and health achieves the best result. Three attributes are eligible for the second position: comfort, cost and environment. After doing some more trials we observe that the sequences of four attributes including the attribute cost perform best, so that we assign cost the second position. Analogous to these arguments, the attributes environment and comfort are given the third position, while safety and speed are assigned the fourth and the fifth place, respectively.

Table 10. Quality of classification and accuracies of approximation for convenience characteristics

quality of classification	0.250
category	resulting accuracy of approximation
pure time pioneers	0.044 (=1/23)
semi-time pioneers	0.044 (=4/35)
other income shifters	0.154 (=6/39)
other respondents	0.098 (=4/41)

Table 11. Ranking of convenience attributes according to Alternative 1

attribute added	resulting quality of classification
(1) freedom of movement/health	0.050
(2) cost	0.067
(3) comfort/environment	0.117
(4) safety	0.150
(5) speed	0.250

The second strategy, sequential elimination, starts with the complete set of vehicle convenience attributes (see for results Table 12). The smallest decay in quality of classification arises when either the attribute speed or the attribute cost is eliminated. Next, the effect of eliminating each of the pairs of attributes including one or both of the attributes speed and cost is calculated. Omission of the pair speed

and feeling of freedom causes the smallest decrease in the quality of classification. As a result, we choose the attribute speed as least important attribute. Given this attribute, there is one unique ranking of attributes.

When we compare the two rankings, we observe again some differences. Speed however, has the lowest position in both rankings. Speed is apparently not very important to discriminate between time pioneers, income shifters and other respondents.

Table 12. Ranking of convenience attributes according to Alternative 2

attribute removed	resulting quality of classification
(5) speed	0.200
(4) freedom of movement	0.167
(3) safety	0.133
(2) environment	0.083
(1) comfort/health/cost	0

In this section we have used rough set analysis to identify factors which may help us to recognize time pioneers and income shifters. The conclusions are rather straightforward. Total household income and residential location appear to be important features, while working status and composition of the household appear to be far less critical. The ranking of time behaviour attributes on the basis of the sequential elimination criterion indicates that time pioneers, income shifters and other respondents can be distinguished most pronouncedly with the help of the attribute time management and the attributes related to leisure time activities. The importance attached by respondents to the criteria cost, health and comfort is apparently the most discriminating vehicle convenience attribute. It is noteworthy that speed has not proven to be a discriminating factor between time pioneers, income shifters and other respondents.

8. **Concluding Remarks**

The need for high travel speed is deeply rooted in our modern society. The paradox is however, that people do not use the extra time saved for alternative purposes (e.g., reading, walking, sports), but spend it immediately on other trips. Thus, there seems to be a drive for 'hypermobility'.

Slow modes tend to be more environmentally benign. If they would also serve personal needs, we might have an interesting case of a 'double-edged sword'. In general however, the slower modes do not have a level of convenience or a price-quality ratio that makes them competitive compared to high speed modes. Nevertheless, for certain travel motives and for certain groups of travellers 'slow motion' may increase personal satisfaction. This prompts the notion of a 'time pioneer'; this study has tried to investigate the feasibility of a transport system that would be oriented towards the needs of such pioneers.

Our empirical research has clearly demonstrated that 'slow motion' behaviour is rather rare, and does not have a sufficiently critical mass to warrant entirely new transport systems serving the needs of 'slow motion' travellers. Nevertheless, there may be a case where a sufficiently high frequency level of transport linked with an extremely high comfort level and a very favourable quality-price ratio may create a competitive (sub-)market of a reasonable size. The long run generative impact of such behavioural changes might also be that commuting distances might be reduced, given the law of constant travel time. Such more compact spatial patterns of living and working might create significant environmental benefits.

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Appendix 1. Data on Time Pioneering Survey

Table 13. Considered attributes and codification

Socio-economic characteristics
(1) Age, Year of birth
1 = ☯ 1933
2 = 1934 - 1943
3 = 1944 - 1953
4 = 1954 - 1963
5 = 1964 - 1973
6 = > 1973
(2) Gender
1 = male
2 = female
(3) Education
1 = no/ primary
2 = LBO/MAVO
3 = HAVO/MBO/VWO
4 = HBO/University
(4) Household
1 = single/other
2 = with partner
3 = with partner and children
4 = single with children
(5) Residential location
1 = suburb
2 = centre of big city
3 = medium sized municipality
4 = smaller municipality
5 = small municipality
(6) Working status
1 = self-employed
2 = full-time job (more than 30 hours a week)
3 = part-time job (less than 30 hours week)
4 = temporary job/ exployment job
(7) Net month income
1 = ☯ 1900 guilders
2 = 1900 - 3200
3 = 3200 - 4300
4 = > 4300
(8) Double income
1 = no
2 = yes
(9) Working outdoor
1 = no
2 = yes

Time behaviour characteristics
(10) Work
1 = don't want to spend more time
2 = want to spend more time
(11) Household=care for children
1 = don't want to spend more time
2 = want to spend more time
(12) Diversion
1 = don't want to spend more time
2 = want to spend more time
(13) Commuting
1 = don't want to spend more time
2 = want to spend more time
(14) Relatives and friends
1 = don't want to spend more time
2 = want to spend more time
(15) Hobbies=sports
1 = don't want to spend more time
2 = want to spend more time
(16) Own time management
1 = very important
2 = important
3 = indifferent
4 = not important
5 = very unimportant

Characteristics of vehicle convenience
(17) Speed
1 = relatively unimportant
2 = important
(18) Freedom of movement
1 = relatively unimportant
2 = important
(19) Comfort
1 = relatively unimportant
2 = important
(20) Health
1 = relatively unimportant
2 = important
(21) Cost
1 = relatively unimportant
2 = important
(22) Environment
1 = relatively unimportant
2 = important
(23) Safety
1 = relatively unimportant
2 = important