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Determinism and backcasting in futures studies

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Determinism and backcasting in future studies

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Abstract

In this paper, four often-cited phenomena from the field of transport futures studies are criticised. The first is the tendency to try to find cyclic behaviour of socio-technical changes. The second is the view that transport and communication are positively correlated. The third is the so-called hypothesis of constant travel time, stating that the average daily travel time over a population is approximately stable. The fourth is the alleged causal relationship between urban density and gasoline use.

The use of these approaches is criticised in a number of ways, among others for oversimplifying the underlying mechanisms and being too deterministic. In cases when a greater change is needed, the trends must be broken and perhaps with other measures than those indicated by these approaches. Thus, interesting opportunities may be hidden and necessary actions may be overlooked.

Backcasting is put forward as a more promising approach, in situations when great changes are needed. However, it is found that backcasting and different forecasting approaches are complementary. The argument is that backcasting is mainly interesting when current trends are leading towards an unfavourable state. Therefore, forecasting methods are needed in order for the backcaster to know that backcasting is wanted in the situation in question. The use of models

in planning is also discussed, primarily in the context of their role in the path-analyses of backcasting-scenarios.

1. Introduction

There are a number of different approaches for analysing what will, could, or hopefully should happen in the future (e.g. scenario techniques, forecasting, backcasting, Delphi-studies, causal analysis, and modelling). One approach does not necessarily have to be opposed to another, but there are differences among them. They have different roles and cannot do the same job.

In principle two different aims of a future study can be identified. The first is a desire to know what the future will be like, so that adjustments can be made when there still is time. This can be the motive for a planning authority just as well as for a business firm. The second reason for studying the future is a belief that planning can change development. With this thought, the interest in future development may be driven by a willingness to change development paths, rather than to adjust to a path that is more or less given. This can be the driving force for planning authorities and for big corporations, but hardly for smaller firms.

The aim of this paper is to point at some risks with certain applications of future studies and also to give a brief presentation of the backcasting approach that in some situations may be more fruitful. We will also try to clarify the relationship between some of the different approaches, especially between forecasting, backcasting and mathematical modelling.

In section two, we look at three approaches that take historical time-series data as a starting point, and one cross-sectional approach, where the aim is to find a causal relationship based on how certain phenomena co-vary among cities. In section three, some risks and problems with these approaches are discussed. In the succeeding section, we argue that backcasting can be a relevant alternative or complementary approach when development seems to take an unwanted path, and when no solutions to the identified problems can be found with the help of other approaches. Backcasting, and its relation to other approaches in future studies, are presented in some detail, in the section preceding the concluding discussion.

2. Time series and cross-sectional approaches in future studies

In this section we present four different approaches that have been used in analyses of future transport. The first one is the use of cycles to represent a historical development. The second one is concerned with the parallel development between communication and transport and the third one is the law of constant travel time. The fourth one is of a different kind: the use of a cross-sectional data to identify the effect of urban density on gasoline use.

2.1 Cycles

The title of Alvin and Heidi Tofflers' book "Creating a new civilization: The politics of the Third Wave" **Error! Bookmark not defined.**, alludes to an idea about the society as becoming more and more dominated by mankind's third long wave. The first wave was the agricultural development. The second one was industrialism, and now comes the information wave. The Tofflers argue that in times when one wave is dominating, as in Europe during the 19th century, it is relatively easy to get a picture of the future. However, in transition periods between two waves (as currently is the case) it becomes difficult to imagine what the future will be like.

The Tofflers write:

> "The First Wave of change – the agricultural revolution – took thousands of years to play itself out. The Second Wave – the rise of industrial civilization – took a mere three hundred years. Today history is even more accelerative, and it is likely that the Third Wave will sweep across history and complete itself in a few decades." **Error! Bookmark not defined.**

Arnulf Grübler is another researcher who has worked a lot with cycles, or waves **Error! Bookmark not defined.**. He has among other things shown how different transport technologies have succeeded each other during the last two hundred years. Using a figure with S-shaped curves, where he has plotted the relative length for canals, railroads and surfaced roads, as a percentage of respective saturation level, he argues that they have developed along the same pattern (see figure 1).

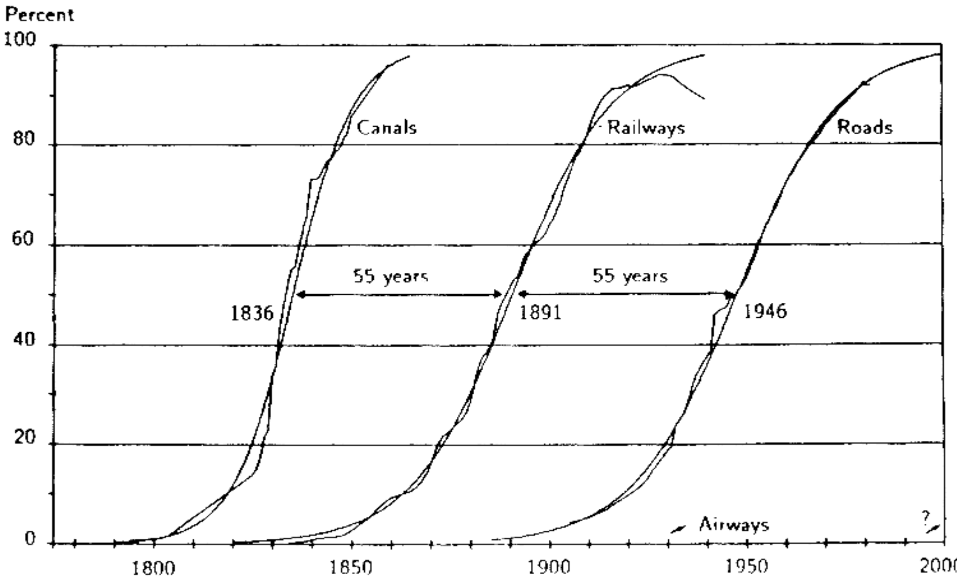

Figure 1. Growth to limits of canals, railroads, and surfaced roads in the US. Note that absolute saturation levels are different between the three infrastructure systems ***Error! Bookmark not defined.****.*

2.2 The parallel development of transport and communication

Grübler has also collected data on the development of transport and communication in France 1825-1985 (see figure 2). He argues that this data indicates that transport and communication have developed in unison during the period.

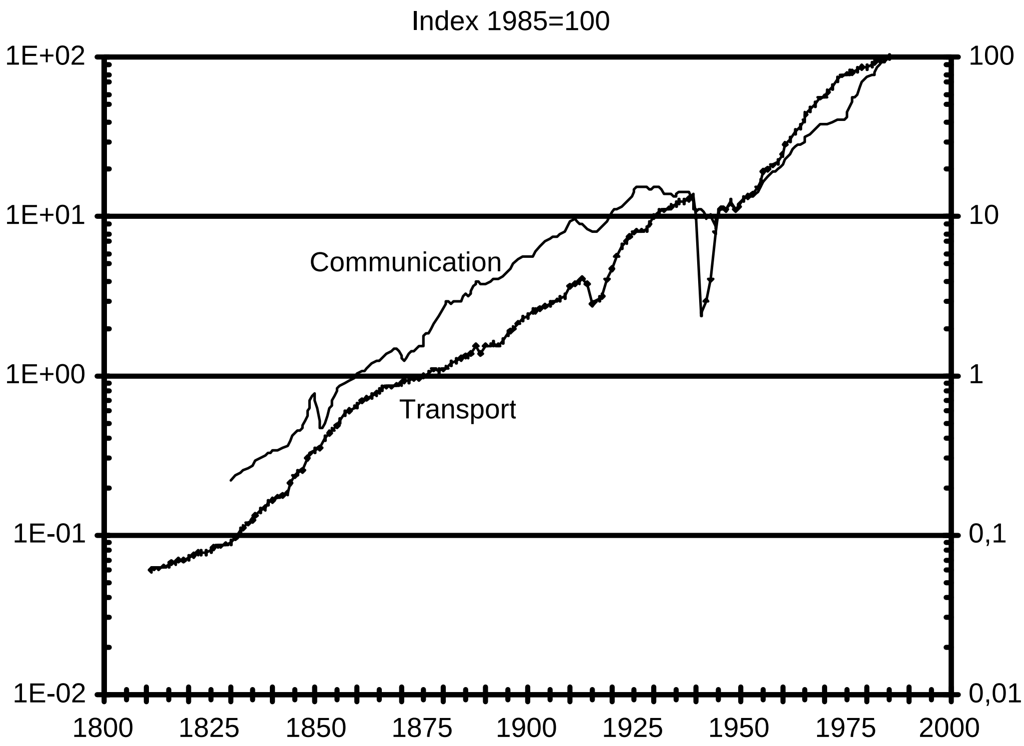

Figure 2. Growth of passenger transport and communication in France, measured in passenger-km and total number of messages transmitted in form of an index 1985=100 ***Error! Bookmark not defined.***[a]*.*

[a] According to Grübler, the figure is based on data from a number of sources **Error! Bookmark not defined.**. However, even with a close look into these sources, it has been impossible to trace all the data. Therefore, this figure is based on Grübler's figure, rather than on actual data.

Figure 2 has been used in a number of different contexts to demonstrate a causal relationship between increasing transport and increasing communication **Error! Bookmark not defined.**.

The use of telecommunications for planning of personal meetings is the presumed foundation of the connection **Error! Bookmark not defined.**. The idea is that the improved opportunities to get new contacts will increase the number of trips that are actually made.

2.3 The law of constant travel time

The law of constant travel time says that the average time used for transport per day is in principle constant over time and among different population groups. It is also independent of travel mode.

Yacov Zahavi **Error! Bookmark not defined.** was one of the first researchers to look deeper into this phenomenon. He collected data from several different places and years, and argued that the data for travel time showed a stable pattern. Zahavi was careful in drawing conclusions from this. Being a transport modeller, it seems like his prime reason for studying the phenomenon was to reach a better understanding of travel behaviour. He did not intend to bring the constant travel time into the model as a given fact.

According to a Swedish survey, Swedes between the ages of 15 and 84 years travelled 79 minutes per day on the average in 1985 **Error! Bookmark not defined.**. People living in the Stockholm region spent a little more time on travelling than the others did. People in the ages 64+ travelled considerably less than the average, but with these exceptions the average was independent of age, travel mode and region. However, there were huge individual differences. 14 % of the population in the survey did not travel at all the day of measurement[1].

In a paper of a later date, Vilhelmson **Error! Bookmark not defined.** refers to a number of surveys that state that travel time (including travel on foot, though with seasonal variations) has been relatively constant over a long period of time, possibly over hundreds of years. However, it looks like travel time actually has increased slightly after all. Therefore, the law of constant travel time is sometimes reformulated so that it states that the time for travel amounts to a constant share of the day *excluding* hours of work.

Vilhelmson **Error! Bookmark not defined.** presents three different theoretical explanations to why travel time should be constant. The first one is biologistic. It presupposes that man seeks to keep stability in habit and behaviour. According to this explanation, man has spent about the same average time for

[1] The person who was recorded for the longest trip had a travel time of impressing 2305 minutes (38 hours) for the day of measurement **Error! Bookmark not defined.**. If nothing else, this illustrates the difficulties in handling large amounts of data.

movement every day since the early days of history. Therefore, she is now by evolution biologically programmed to continue to do so[2].

The second explanation is economic. It is based on the idea of man as a maximiser of utility. The net utility of a trip consists of two parts: the derived utility from what can be reached by travelling and the intrinsic utility of the actual movement. To begin with, the derived utility increases, since travelling further away implies access to a much larger supply of activities. After a while, it decreases because using the time for travelling will become more and more in conflict with using it for other activities. The intrinsic utility also increases to begin with, but it starts to decrease quite soon. And after a while it will be more and more negative when the travel becomes a pain (see figure 3).

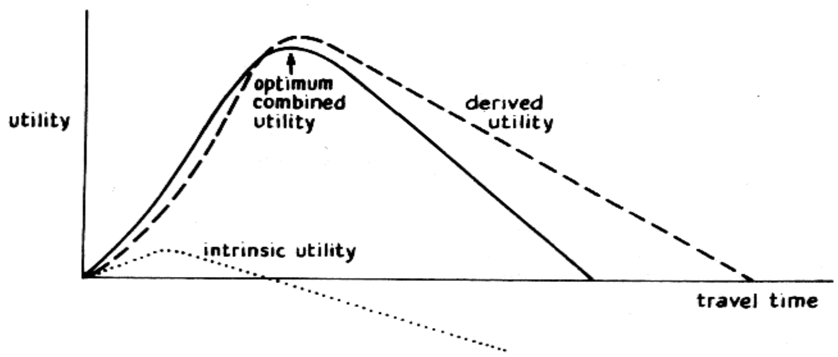

Figure 3. Utility versus travel time ***Error! Bookmark not defined.***.

Geurt Hupkes **Error! Bookmark not defined.** launched the economic explanation. He uses it as an instrument to analyse possible changes in people's daily travel time. He does not look upon the daily travel time as a natural constant. On the contrary, he speculates in which factors could change travel time. For example, he mentions a breakthrough of IT as one possible factor. A certain utility that demands transport today may be possible to reach without

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[2] This explanation is further developed by Marchetti **Error! Bookmark not defined.**. He argues that the stability of travel time may be an instinct acquired during mankind's cave period. When man lived in caves she was forced to balance the risk of being outcaves to the opportunity to get hold of a quarry when leaving the cave.

transport in the future. The derived utility will then be higher for a shorter travel time, while the intrinsic utility remains the same. Optimum would then occur for a shorter travel time than before.

Finally, Vilhelmson mentions a social explanation to the constant travel time. Everyday life is full of routines, and habits are often quite settled. Therefore, travel settles as well. Hägerstrand **Error! Bookmark not defined.** has suggested that a worker's full-time day can be divided into 9 hours of sleep and personal care, 1 hour of eating (excluding cooking), 8 hours of working and 1.5-2 hours of shopping and other service activities. The remaining 4 hours are left for travel and leisure. This sets restrictive bounds for the time that can be spent on travelling. It is then not surprising if the average time devoted to travelling will be about one and a half hour and that this value is changing relatively slowly[3]. This is thus the only explanation that reflects on why the travel time would be stabilised at 80 minutes. Vilhelmson's discussion of the law of constant travel time is concluded with:

> "The main point … is that there is reason to believe that the travel time in a population is rather stable over time" **Error! Bookmark not defined.**.

This seemingly strong statement is however relieved by Vilhelmson's own strong opposition to any claims on simple societal laws, in the discussion that follows the above citation.

2.4 The density and gasoline relationship

The urban density and gasoline relationship, compiled and made well-known by Newman and Kenworthy **Error! Bookmark not defined.**, returns frequently in discussions on the possibilities of influencing say CO_2 emissions by land use measures (see figure 4). This relationship is based on data from 32 cities on different continents for the year 1980.

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[3] This argument is due to Åkerman **Error! Bookmark not defined.**.

By those using this relationship, it is often interpreted as a causal relationship between residential density in an urban area and the use of motorised vehicles leading to a causal relationship between density and per-capita gasoline use. It has sometimes led to a clear policy recommendation:

> “The first fundament of sustainable mobility is a policy of concentrated development of residential and industrial areas and public facilities. In a concentrated spatial structure the distances to be travelled are shortest; the fastest transport mode is the bicycle, and good public transport can be provided.” Fourth Note (Extra) on Spatial Development in the Netherlands (quoted from Wegener **Error! Bookmark not defined.**)

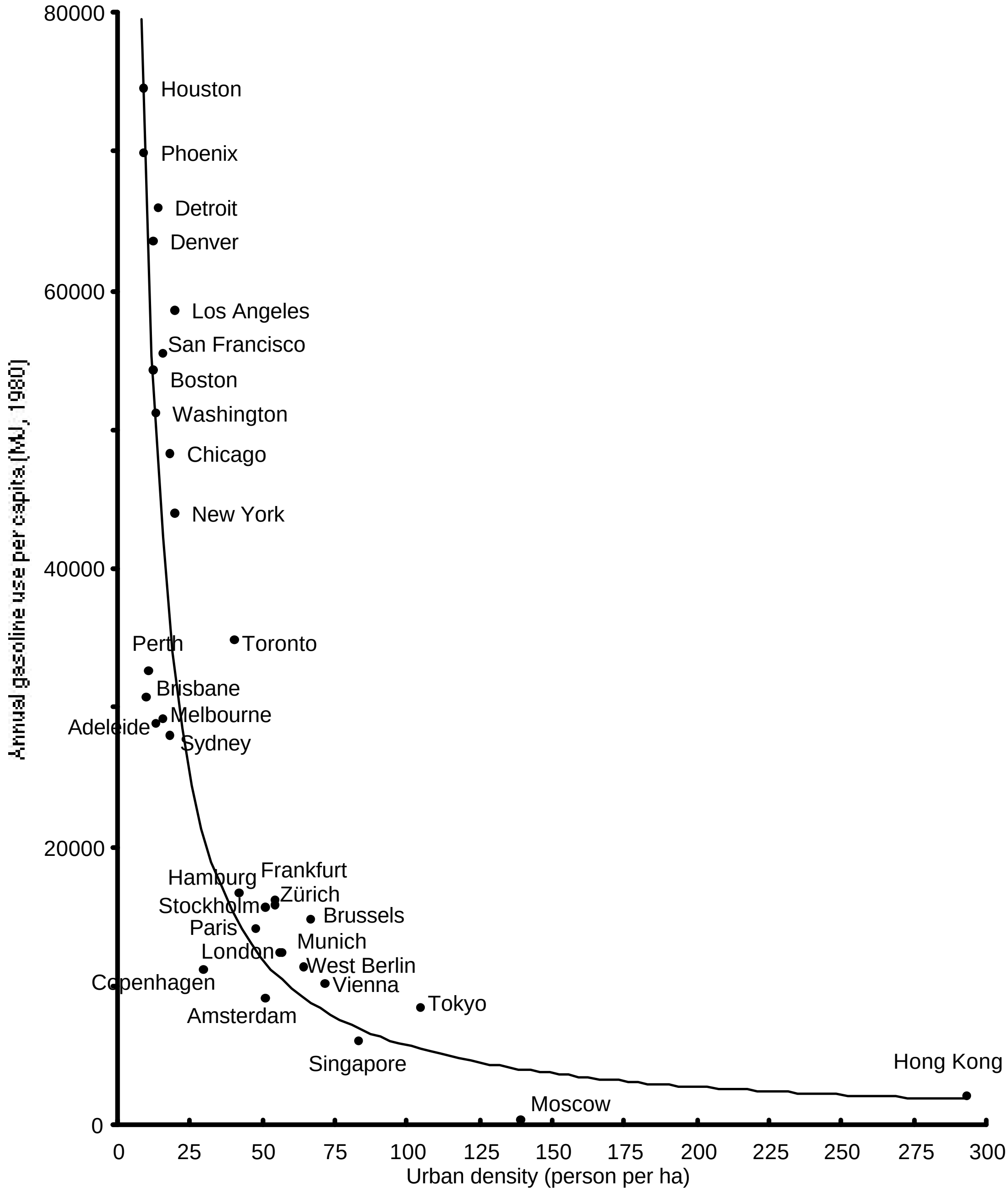

Figure 4. Gasoline use per capita versus urban density ***Error! Bookmark not defined.****.*

3. Discussion of time series and cross-sectional approaches in future studies

In the previous section, we have presented three different ways of describing historical patterns (cycles, time series correlation, invariance) and one way of describing spatial patterns (covariance). All four approaches have deterministic features that may lead to proposals for solutions that will not work or may hide the sight for solutions that do not fit into the pattern. Therefore they may have a conserving or oversimplifying influence on research and policy-making.

3.1 Cycles

Among Tofflers' three waves, the first wave lasted for thousands of years, the second one lasted for hundreds of years and the third one washes over history in a couple of decades. This means that a development that has been going on for millennia is compared to something that is expected to be over within a lifetime. If this line of argument is taken one step further, the absurdity of it becomes clear: A hypothetical fourth wave would last for a couple of years, a fifth one for only fractions of a year etc. This becomes an apocalyptic way of writing history, which ends somewhere around 2010-2030. It resembles other asymptotic stories, like the one with the hare never reaching the turtle and the arrow never hitting the target. This sweeping historical perspective obviously represents a simplistic analysis glancing ahead without nuances.

Grübler's cycles of transport technologies suffer from partly the same weaknesses as Tofflers' waves. The problem is that by setting up the curves the way Grübler does, he implicitly states that this type of technological substitution will continue (see especially the question mark at the lower right corner of figure 1). And that is to stretch the data too far. In fact, the actual quality of the data can also be questioned, since the statistics in question cover such a long time period and relate to factors that are not easily measured.

3.2 Time series correlation

Both the connection between transport and communication development and the law of constant travel time are based on historical data. Below we will review them in similar ways. First we discuss the actual data and how it is presented. Then we look at reliability and validity of the data. Finally, we look at the theoretical foundations for, and the usefulness of, the different approaches.

There are some serious problems with Grübler's presentation of the connection between transport and communication. A closer look at the two curves for transport and communication reveals that they actually have not followed the same path during the whole period 1830-1985. In 1950 both transport and communication were about 10 % of the 1985 level, according to Grübler's data. In 1975, however, transport had already reached 80 %, whereas communication was only at 45 %. During the last ten years of the period communication developed much faster than transport. This illustrates the suburbanisation and the accompanying development of the car-society from the 1950s and onwards. It also indicates the very quick development of communication technologies and the use of such technologies from the mid 70s.

It is important to realise that a relationship between two factors that may look strong in a 150-year-perspective, does not necessarily imply that the two factors are dependent. We argue that the relationship, as presented in figure 2, is exaggerated by the choice of 1985 as the year of reference for the index and by the non-linear scale of the y-axis. Figure 5 illustrates how the same data can be presented with linear y-axis and other years of reference. The relationship between transport and communication is considerably less evident when the data is presented in this way.

Grübler argues that even if the curves have not followed exactly the same path during the last century, they still have developed in unison.

> ”In the long-term, however, the two seem to re-establish parity. This long-term parity rate appears to be in the vicinity of around six passenger-km travelled per message transmitted. As shown in Figure 4.5.3 (figure 6 here, our remark), this is not only true for France but also for Germany and UK. Thus, one might conclude that whatever growth potential due to new communication technologies realized, it may just be sufficient to bring the ratio of face-to-face to information channel communication back to long-term parity.” **Error! Bookmark not defined.**.

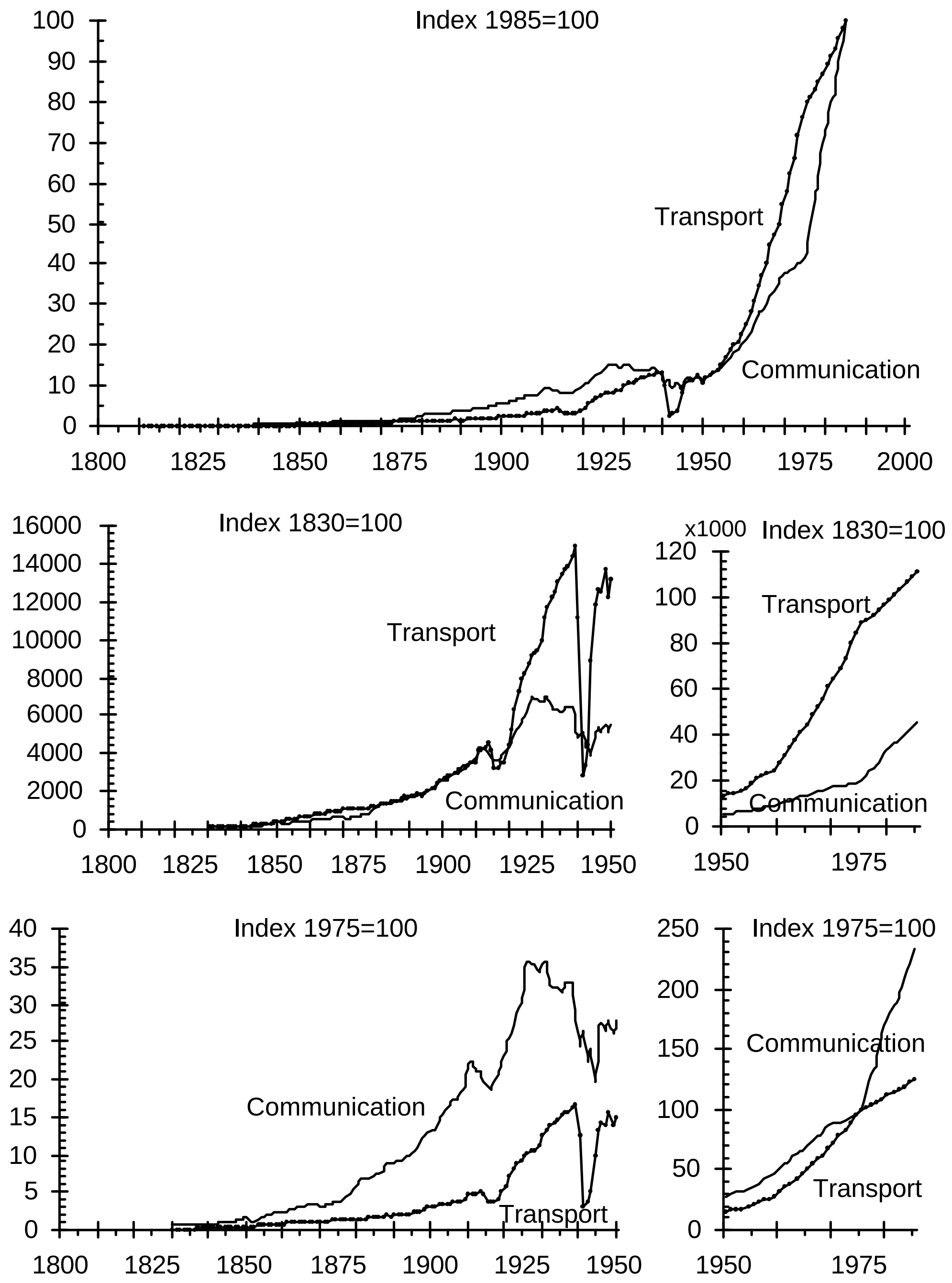

Figure 5. Grübler's data ***Error! Bookmark not defined.*** *with linear y-axis and index 1985=100 (top), index 1830=100 (middle) and index 1975=100 (bottom).*[b] *Note that the scales differ between the diagrams.*

[b] Since it has not been possible to reproduce the data from Grübler's sources, the data in this figure is taken from ocular examination of figure 2.

To us, it is far from evident that the line in figure 6 should be interpreted as a horizontal line with the value 6.

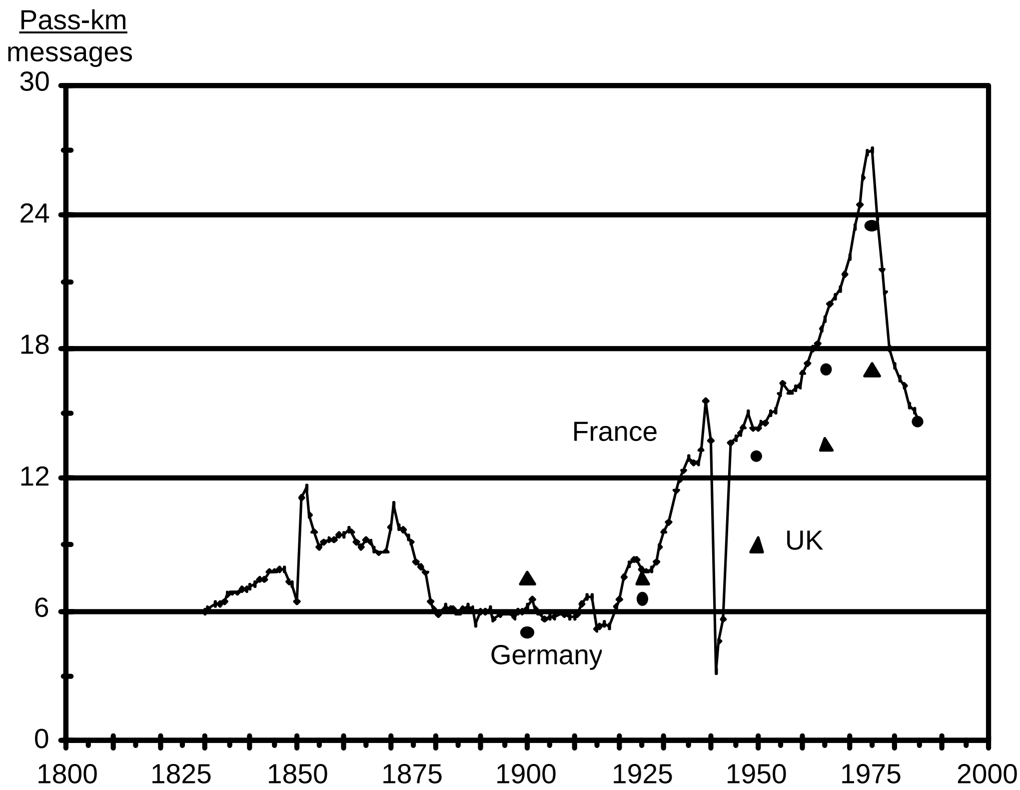

Figure 6. Ratio of passenger travel to messages sent in France, Germany (FRG after 1945), and the UK. Figure based on Grübler ***Error! Bookmark not defined.****.*

[c] According to Grübler, the data is collected from a number of sources, but since it has not been possible to trace all the data, this figure is based on ocular examination of the original figure (see also figure 2).

The reliability of Grübler's data could have been better. The definition of communication (total number of messages sent, by letter, telegram, telex, telefax and telephone) has been changed several times during the period. For example, magazines and post cards have been included sometimes but not always **Error! Bookmark not defined.**. The whole analysis is built on French statistics only. Can the conclusions really be generalised to other countries as well? In Grübler's own book some data for Great Britain and Germany is presented, but the data does not actually support the statement that transport and communication are developing in unison. According to that statistics, transport has developed quicker than communication from the beginning of this century and until 1975 (see figure 6). However, Grübler interprets this data in another way as can be seen from the previous citation.

Finally, it is quite questionable if the measures of communication and transport are relevant. What is 'communication'? Does a one-line telex message, a one-hour phone-call and a five-page letter have equal value? Should one-way communication, such as television and radio, be included somehow? And what about ordinary face-to-face communication? And how will e-mail, interactive games and netsurfing be measured in this context? These questions indicate that it is unclear what is measured in Grübler's communication data set. A similar problem arises for transport. What is transport? A farmer walking to the field? A farmer working on the field? A steward in the air? A nurse walking in a hospital? A child taking a walk with the dog? There are many questions here as well.

Grübler's conclusion from the data presented is that:

> ”New communication technologies may consequently be seen as 'catch-up' instruments in the long-term complementary and synergistic relationship between transport and communication, a hypothesis at least consistent with 200 years of history.” **Error! Bookmark not defined.**.

According to the arguments we have presented above, it is difficult to see that the hypothesis is supported by history[4]. Obviously, a relationship between transport and communication may still exist, but the empirical evidence presented by Grübler is not satisfying. The theoretical arguments supporting such a hypothesis are also weak.

3.3 Historical invariance

The law of constant travel time also includes some peculiarities. To begin with, the empirical data can be questioned. Above, we pointed at the difficulties in finding reliable and relevant data on the volume of passenger transport, measured in kilometres. Data on the travel time is even harder to find. It must

[4] It can also be noted that Grübler's data only covers 155 years of history.

be calculated from available data on the lengths of passenger travel combined with approximations of travel speeds, travel modes and available travel time. There are many possible errors in such calculations.

The differences among individuals may be huge even if the average travel time in a group is 80 minutes. When the differences among individuals are huge, the law of constant travel time is difficult to explain theoretically.

Moreover, there exists data that contradicts the law of constant travel time even at an aggregate level. Three different Swedish travel surveys have been used by different researchers to study the development of passenger transport in Sweden. The first one is from 1978, the second one is from 1984/85 and the third one has been going on continuously since 1994. There are some differences in definitions between the three surveys, so comparisons between them should be made with caution.

Krantz **Error! Bookmark not defined.** has compared the mobility of men and women in Sweden 1978 and 1995. The comparison shows that men's daily travel time has decreased from 76 to 66 minutes whereas women's travel time has increased slightly from 54 to 55.[5] Another Swedish study **Error! Bookmark not defined.**, based only on the latest of the three surveys, concludes that the average daily travel time for employed people with high income is about 90 minutes. Employed with low income have a travel time of 70 minutes and retired people travel only 46 minutes a day. One of the studies previously referred to **Error! Bookmark not defined.** suggests that the average daily travel time for Swedes in 1984/85 was 79 minutes. Still another study **Error! Bookmark not defined.** indicates that the travel time has changed considerably during the period 1978 to 1994 (see table 1). Another result from the same report is that the changes have been even bigger for some population groups. For example, travel time for men in the age between 25 and 34 decreased with 22 % between 1984 and 1994.

	1978	1984	1994
Women	65	70	64
Men	85	88	78

Table 1. Daily travel time for women and men, minutes ***Error! Bookmark not defined.***.

The data presented above indicates both that the average travel time can change quickly, and that there are big differences in travel time between different population groups (or that there are definitional problems). Neither the law of historically constant travel time, nor the law of constant travel time among population groups is supported.

The law of constant travel time is a law about the average value for individuals, for whom the travel times vary a lot. However, the three theoretical explanations in previous section are all explanations at an individual level.

The biologic explanation says that man is biologically programmed to travel a certain share of the day. But how does this programme know that walking, biking, travelling by car and flying are to be summarised? And that other movements, such as walking at home or at work, are not to be included? Why does our biological programme accept such big variations among different days and different seasons and different periods of life? And why are individuals' programmes so different, while the average is constant? And finally, what has happened to the truck drivers' and the stewardess' programmes?

The economic explanation only states that the utility from travelling is increasing until a certain travel time is reached. After that time, the net utility decreases, since the generalised travel cost increases quicker than the increased utility from travelling further. The optimum can be quite different for different individuals. A 30-minute-trip gives access to completely different options depending on where you live and how you travel, which, in the context of

[5] The values refer to a version of table 4.1 that has been corrected by Krantz.

access to workplaces, is illustrated by e.g. Mattsson and Weibull **Error! Bookmark not defined.**. Moreover, the options are valued differently depending on whom you are. If all this is to result in a common and stable travel time, it would require a biological explanation of the kind that was criticised above.

The social explanation suffers from the same sort of difficulties as the economic explanation. Why would the fact that many people's lives are routinised result in a stable average travel time? A problem with the explanation based on Hägerstrand's **Error! Bookmark not defined.** observation on people's time restrictions is that his individual is a modern man, hardly an 19^{th} century farming woman. For this man's wife, some of the 8 hours of work is substituted for cooking and other housework. It is possible that the remaining time is quite equal. However, it is easy to imagine that there are great variations, an imagination that is supported by the data on Swedish men's and women's travel time presented above.

Finally, the actual usefulness of the law of constant travel time can be questioned. The possible travel time is restricted. In practice many people must adjust their lives to activities such as work and sleep, which normally cannot be co-ordinated with travel. In spite of this, there is a wide spread in travel time among people. The line of argument supporting the law of constant travel time, tends to slide from first being valid only for an average, to later on being valid also for smaller groups. A danger is then that it is generalised to claim validity even for people in general. When sliding from an average to people in general, the average becomes the 'normal'. And this may be taken as an indication that planning should be adjusted to this 'normal' behaviour. However, the law does not state that the average would be normal in the sense that this is the travel time of most people in the group. So if planning is directed according to an idea of 80 minutes travel a day, it will not be in accordance with most people's actual travel behaviour, *even if 80 minutes actually is the average.*

The weaknesses of the law imply that it is hardly reasonable to presuppose that travel time is constant when planning for future transport systems and urban structures. If the law nevertheless would be regarded as true, measures to reduce travel time would be inefficient, and it would be meaningless to try to implement them from an environmental point of view. Only measures that reduce the detrimental environmental effects per unit of travel time would be efficient. Reduced commuting times would only result in increased travel for other purposes. In sum, fortunately the law of constant travel time is hardly valid and should not be taken a prerequisite in discussions of future transport systems. It may, however, be relevant to reflect on the issue of people's preferred commuting times. Would people use all the saved time for other trips, for making longer trips or would some of it be spent on other activities? We argue that the answer will depend on the social, economic, technological and spatial context.

3.4 Spatial covariance

Although Newman and Kenworthy's relationship (figure 4) indicates a striking covariance between urban density and gasoline use, it does not necessarily imply that higher density causes lower gasoline use, at least not in a direct way and in the short run. First the curve is based on a limited, and non-random, sample of cities selected partly on the basis that there was data available. There are also a number of definitional problems involved in combining data from different cities with varying social, political and cultural situations. In addition one has to make a very strong assumption when interpreting a statistical correlation between density and gasoline use found by comparing different cities as a casual relationship that would hold for any particular city when intentionally changing its density (cross-sectional determinism).

Obviously, the alleged relationship between density and gasoline cannot hold in the short run. If higher density actually will cause lower gasoline use, it presupposes that people adjust their location and activity choices so that they need not travel so far, or can to a larger extent rely on non-motorised or public transport, and perhaps even abstain from owning a car. Location and ownership decisions are long-term decisions that are taken after a substantial time of consideration. In order to take advantage of higher density to reduce car use, a number of follow-up actions must also be taken in the city planning, such as improving the public transport system, building dedicated roads for bikes etc. If the density would be raised in a particular city, it is plausible that these other conditions would also have to be changed to a level typical for cities with this higher density, should the gasoline use be reduced to the level indicated by Newman and Kenworthy's curve.

The most fundamental objection against a simple casual interpretation of this relationship is, however, that high density and low gasoline use can both be stimulated by the same reason – a high gasoline price. Wegener **Error! Bookmark not defined.**, on elaborating on Newman and Kenworthy's data, shows that this should not be excluded, see figure 7. Rather his analysis suggests that the price is at least part of the explanation of the gasoline use in a city[6]. In cities with a high price, the demand for public transport may be higher, as may be the demand for living in the city centre. Such living is known to lead to more biking and walking and to a lower level of car ownership. In cities with a high gasoline price the market mechanisms could thus be expected to stimulate high density.

[6] Newman and Kenworthy **Error! Bookmark not defined.** are of course aware of the fact that many factors including the price influence the gasoline use (see e.g. p. 76).

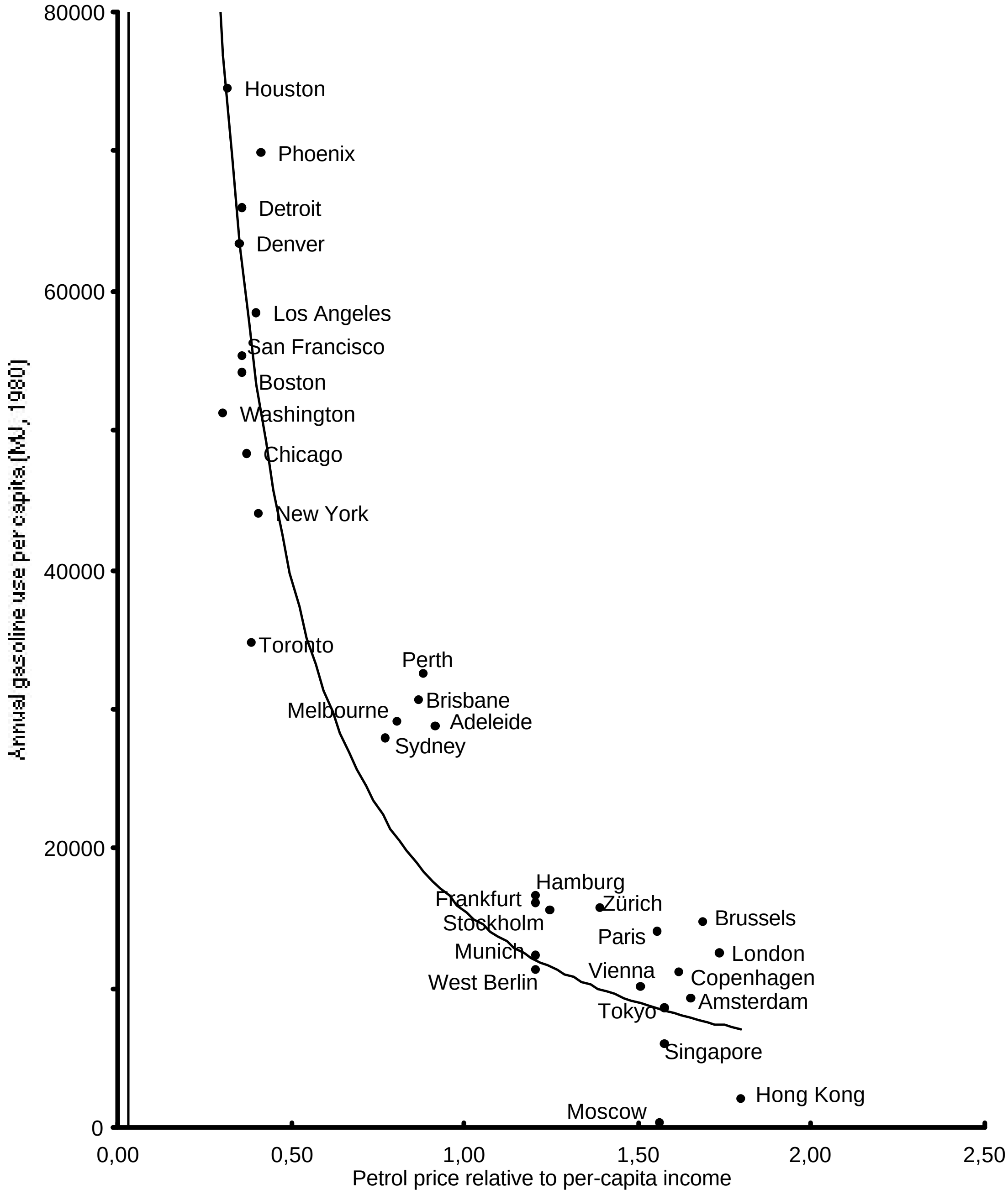

*Figure 7. Gasoline use per capita versus gasoline price (Wegener **Error! Bookmark not defined.** with data from Newman and Kenworthy **Error! Bookmark not defined.**).*

Similarly, an urban policy supporting a compact spatial structure would in this case be advantageous to the citizens and probably striven for by the city administration. So rather than the high density *per se* it may be the high gasoline price that is the main cause for low gasoline use. High density may be a natural market and planning answer to a high gasoline price that will further stimulate a reduction of the gasoline use.

4. Backcasting and mathematical modelling – some reflections

When exploring the future, and in particular when investigating how the demanding environmental issues we foresee might be tackled, a broad systems view is necessary. Simple forecasting, based more or less on prolonging existing trends, is of little value beyond the role of an alarm-clock. What we usually need is a much deeper analysis that uncover the fundamental mechanisms in society that are important for the issues at stake. This is especially true, if we, as is typically the case for many environmental problems, want to analyse how certain trends could be broken and what measures could help to bring about this.

In investigating possible solutions to societal problems, such as what a sustainable transport system could be, we often want to focus on how desirable futures (in terms of fulfilling certain environmental restrictions) might look like and how we could reach such a state. The latter requires an analysis of what changes must occur, what decisions would be necessary, what restrictions would be implied etc. Such an analysis has been termed backcasting[7]. Backcasting has an obvious normative side: what future is desired? It has also an analytical or descriptive side: how can we attain this desirable state?

In figure 8 the applicability of backcasting is illustrated. Backcasting is typically relevant when short-term directional studies and longer-term forecasts indicate that targets will not be met within stipulated time. In such a situation an approach in the spirit of backcasting may be useful. It implies a concentration on understanding what a future situation, in which the targets are met, could look like and how it could be attained. The point is to encourage searching for new development paths, when the conventional paths do not seem to solve the problem. If used in a clever way, backcasting can be helpful in opening the eyes

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[7] According to Robinson **Error! Bookmark not defined.** the term is attributable to Amory Lovins.

for overlooked options. This way, it is rather an attitude to the research task than a method.

One characteristic feature of backcasting is the emphasis on the need for alternative solutions when forecasts indicate that the targets that have been set up will not be attained **Error! Bookmark not defined.**. When one or more scenarios have been identified that meet the targets, it is time to analyse the consequences of the scenarios in various respects and the drives that may influence their realisation. This is also the first step of an implementation study, i.e. the analyses of how the desired scenario could be fulfilled. Different kinds of mathematical modelling can be important tools in this phase.

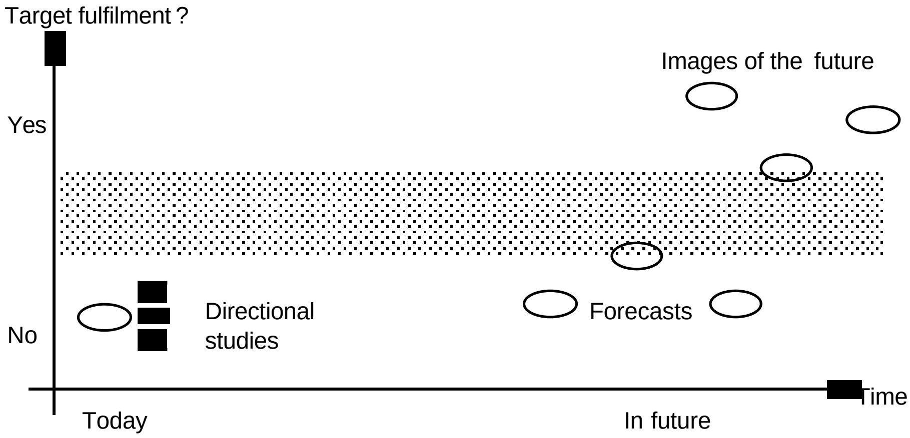

Figure 8. Applicability of backcasting. Backcasting is motivated when forecasts and directional studies indicate that targets will not be met. A in the figure represents directional studies, B forecasting studies and C backcasting. The shaded area in the figure represents states where the targets may be reached. Both the scale and the unit of the y-axis, 'target fulfilment', are explicitly normative. The figure is adapted from Steen and Åkerman ***Error! Bookmark not defined.***.

The backcasting approach is only relevant if the reason for studying the future is a willingness to, and belief in, change, as discussed in the introduction. Imagine for example that current traffic volumes are regarded as a problem. Imagine then that empirical studies on telework indicate that telework makes little difference for the total traffic volumes. In such a situation two quite different, but complementary, conclusions can be drawn with regard to future work in the field. The first conclusion is that telework is of no interest when looking for solutions to the problem. With continued empirical studies it will be possible to see if this situation changes. The second conclusion could be that since it seems as if telework-related options, as defined in the empirical studies and under current socio-economic-technological conditions, will not help to solve the problem, something else must be done. With a backcasting perspective, the task could then be to try to find out what changes in the design of telework, or changes in the current conditions, could make telework-related options more relevant.

Backcasting is dependent on forecasts. It can be said that backcasting studies begin with a vision of a desirable future and one or more forecasts. In the following step, the forecasts are compared to the desired vision. If the vision will not be reached according to the most reliable forecasts, model calculations and other judgements, the task is to generate images of the future, scenarios, that fulfil the targets expressed in the vision. The images will be scrutinised to see what the potential effects of them may be.

Wegener has pointed at a number of advantages with scenario descriptions:

> ”Scenarios have the potential of being [such] a less rigorous and more open method of exploring the future. Perhaps they are the only method to identify ‘corridors’ of relevant and feasible futures within a universe of possible ones... Used in public planning discussions, scenarios have the potential to translate expert opinion into a format comprehensible also to non-experts and so to stimulate the debate between the expert community and the public.” **Error! Bookmark not defined.**.

Slaughter **Error! Bookmark not defined.** argues along the same line, when he claims that “speculative imagination” can be useful when exploring the future. Slaughter is discussing how a world based on quite different values than today’s society could look like. One way of approaching such a completely different society, could be to create images of the future, since these can “take the human mind out beyond the boundaries of currently constituted reality – beyond trends, forecasts and the like – and feed our capacities for speculation, imagination and social innovation”.

Wegener **Error! Bookmark not defined.** argues that the traditional way of using models in traffic studies – forecasts of urban growth – is not particularly useful for analysis of environmental problems. The reason is that the changes that are required to take care of the environmental problems are much bigger than those usually handled with the models. According to Wegener, the usefulness of models in environmental research is primarily that they can indicate paths for the necessary spatial reorganisation of urban areas towards sustainable development.

Lakshmanan **Error! Bookmark not defined.** has discussed how new demands on transport models have appeared at the same pace as new laws and regulations have been enforced in the US, especially the Clean Air Act as of 1990 and the Intermodal Surface Transportation Efficiency Act as of 1991. Lakshmanan argues that changing conditions for transport modelling must force the models to develop. It does not mean that they loose in importance.

We want to stress not only the normative or scenario-forming side of backcasting, but also the analytic and critical side: how can we possibly attain a state that has been identified as a desirable one? In other words, if we are standing at a desirable end-point, we need to work back to check the physical and social feasibility (in fact this is the origin of the term backcasting). This is an issue that Robinson **Error! Bookmark not defined.** emphasises, while Dreborg **Error! Bookmark not defined.** pays little attention to it. This is a necessary part, since it is not possible to intentionally strive towards a certain option, unless the option can be experienced. However, the actual backcast is also important, when the ideas from the scenario are to be given a concrete form.

Desirable scenarios often require that current trends are broken. If backcasting should be not only wishful thinking, it is important that the feasibility of the scenarios is analysed and that necessary measures and actions for the realisation of the scenarios are identified. During that process models, or other tools that try to quantify the consequences of different measures, are important instruments.

5. Concluding discussion

In sections 2 and 3, we pointed out some problems with using historical and cross-sectional data in future studies. Our criticism is aimed at historical determinism and the use of oversimplified relationships. We do not argue that trying to understand connections is useless, or that we cannot learn anything from history. On the contrary, it should be underlined that there is nothing wrong with looking at historical trends, searching for waves, trying to find invariances or looking for casual relationships as in the examples we have criticised. But as these approaches have been used, they are not well suited for *forecasting* and *policy-making*, even if it may look nice when curves are prolonged into the future **Error! Bookmark not defined.**. What is wrong is that the analyses in these particular examples are so simplistic that they give very few insights into which mechanisms are at work and hence provide little help in finding out what measures and policies could be useful, if we want to avoid an undesirable future.

Moreover, a too narrow look at forecasts based on trends will show no opportunities other than those in line with the trends. In practise all forecasts are conditional, conditional on the presumptions that have been set up, explicitly or implicitly. The presumptions are often based on historical data, and therefore, they often confirm current trends. If the presumptions are not fulfilled, the forecast cannot be expected to come true either. In order to emphasise the forecasts' dependence on presumptions, it may be wise to use the concept analysis instead of forecast.

In addition, it is also possible that the presumptions of how the factors are connected are incorrect, or that the connection is changing. As one example, a forecast saying that traffic will increase with a certain percent in the following 20 years, presuming a certain economic growth, can fail because of several different reasons. The economic growth can become another than the presumed, the connection between economic growth and traffic growth can be wrong, or the connection may change[8]. As another example, by interpreting the density-gasoline relationship as a simple casual relationship, policy-makers can drastically overestimate the extent to which gasoline use is possible to reduce by land-use measures alone.

The reason why forecasting has been treated with such a scepticism in backcasting is that, in spite of these well-known difficulties in making forecasts, a forecast may in the public debate very well be misapprehended as true and thereby become self-fulfilling. In this way, there is a risk that forecasts get a conserving effect. They can easily strengthen a trend, and thus prevent alternative development paths. However, different analytical tools can be used in different ways. It is not the tool *per se*, but rather how it is used that determines how useful it will be in a particular analysis.

Also mathematical modelling in general has been looked upon with great scepticism in backcasting **Error! Bookmark not defined.**. One reason may be that it has been falsely identified with forecasting. Although forecasting is a kind of mathematical modelling, all mathematical modelling is indeed not forecasting. Modern transport and location analysis systems are far beyond simple unconditional forecasting and can contribute a lot to reveal important relationships in society and be helpful in evaluating the effects of proposed measures and actions to realise desirable scenarios. In fact, should it ever be possible to investigate the internal consistency of a desirable scenario as well as how it might be attained, advanced analytical tools, including sophisticated mathematical models, will very much be needed. Still it must be admitted that the issues in focus usually are of such a long-term character, and are so complicated and broad, that the comprehensive model that really is needed simply does not exist. However, insufficiencies and limitations of existing

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[8] Vilhelmson **Error! Bookmark not defined.** is using data from Andersson et al. **Error! Bookmark not defined.** and own estimates to show that the elasticity of travel to GDP has been changing a lot during the latter part of this century.

models should not hide their possibilities and prevent their use. Rather it should stimulate their further development (cf. Lakshmanan **Error! Bookmark not defined.**).

By repeating and developing figure 8, we may be able to synthesise our view on the relationship between forecasting, backcasting and modelling.

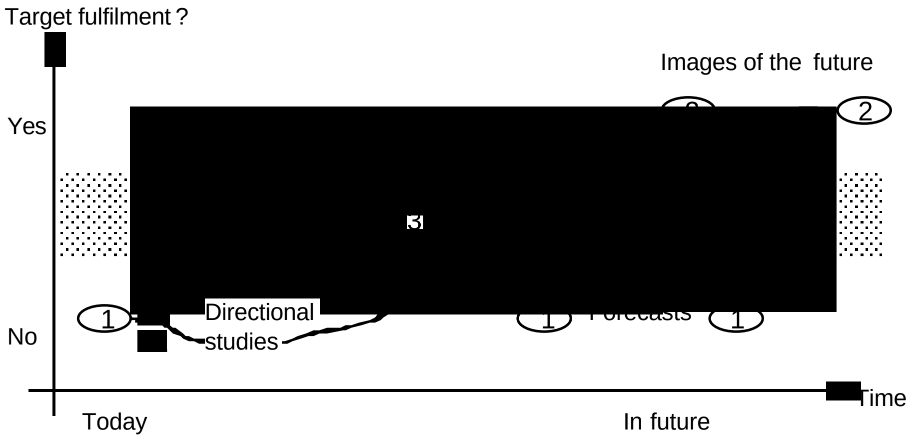

Figure 9. The backcasting framework. The forecast indicates that the target will not be met (1). Therefore scenarios that do fulfil the target are generated with the help of a suitable scenario method (2). Finally, the path between current situation and the scenarios are analysed with the help from e.g. different kinds of mathematical models. See also figure 8.

Figure 9 introduces a temporal aspect to figure 8. In the figure ‘1’ represents the forecasts. They work as alarm clocks “The target is not met – it’s time to do something”. ‘2’ in the figure is the generation of scenarios. “This is what a solution could look like”. And ‘3’ in the figure is the analysis of how a desirable scenario could be reached. This is where the modelling may have its most important use.

In conclusion, the approaches that were discussed in the first sections of this paper are not very appropriate as tools for future studies. The reason is partly that they are so suggestive, and therefore may give a false sense of security as to the predictability of the future. Indeed, if not critically apprehended, they could even be harmful by not prompting a real understanding of the mechanisms at study. Conceivable desirable futures that deviate from prevailing trends may be overlooked. Nevertheless, without forecasts it could be difficult to perceive when an ongoing development is undesirable.

However, a forecast should not be seen as a prediction, but rather as a reference scenario. The main point with backcasting is that it provides alternatives to this reference scenario, thus emphasising that the forecast is just one possible development.

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