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The Valuation of Logistics Improvements in CBA of Transport Investments; A Survey.

EXECUTIVE SUMMARY

This Survey has been commissioned by the SAMGODS-group represented by the Swedish Institute for Transport and Communications Analysis (SIKA). The other organisations in the SAMGODS-group are the National Road Administration, the National Rail Administration, the Civil Aviation Authority, the Maritime Authority and the Swedish Agency for Innovation Systems.

The purpose of the Survey is to review research on the valuation of freight time and other quality factors affecting goods, as well as how logistics improvements are being accounted for in the cost-benefit method used in Sweden, as well as by other countries and organisations. A further purpose is identify relevant issues as well as possible actions to be taken by SAMGODS to improve the valuation of logistics improvement in cost-benefit analyses (CBA) of transport interventions.

The Survey is based on the assumption that the framework typically made use of when undertaking a CBA is reasonable, and can be taken as given. It is therefore argued that for the purposes of a CBA of a transport intervention, the valuation of logistics improvements may be decomposed into a transport element and a goods element, as is normally also done, and therefore to examine separately the costs associated with the goods, including the time required for their shipment and other quality factors. The Survey, hence, focuses on the goods element of the logistics cost.

Unit prices related to goods are made use of in the CBA methodology applied by the National Road Administration (VV) and the National Rail Administration (BV). In addition, such unit prices feature in the SAMGODS model system, which is a model for forecasting goods transport by different modes in Sweden, including import, export and transit traffic. The methodology used by VV only reflects the cost of freight time, whilst BV and SAMGODS also use values with respect to (improved) reliability.

The impact on goods of a transport intervention is normally not taken into account in the CBA methodology applied by the road (and, where relevant, rail) authorities in other countries in the world. Research into the cost of goods in transport has been carried out in a number of countries and recommendations have been made but so far, no action has been taken by the authorities concerned. Several authorities are at present reviewing the matter further. International financing institutions such as the World Bank, EBRD and EIB, which apply CBA when appraising road schemes, do normally not account for logistics improvements except costs related to vehicles and their drivers.

Empirical studies concerning the goods dimension of logistics costs focus on three aspects, viz. the time duration of transport, reliability, and damage and loss. Given that the costs related to the mode used to transport the goods are handled separately, the remainder of the benefits associated with improvements in logistics should adequately be reflected through these three variables and the prices or (unit) values associated with them.

Two approaches may be used to estimate the values associated with these three variables, viz. market prices and using values derived from models of choice between transport alternatives in which these variables are explanatory factors. The CBA methodology used in Sweden today is, in effect, based on a mixture of the two methods.

The two approaches give very different results. The approach based on market prices (also referred to as the capital value approach) can be expected to result in low prices, indeed much lower values than the ones currently in use in Sweden. Even taking into account reliability, which is currently not recognised in the CBA-methodology used in the road sector in Sweden, would not likely change that assessment. It appears that the value of reliability using the market price approach would yield values per time unit saved which are of the same order as the 'pure' value of freight time based on the market price approach. No estimates have been prepared for damage and loss using this approach on account of lack of data on the probability of damage and loss per km or time unit. This is a void that should not be all that difficult to fill.

The SP-approach to the estimation of values of relevance to freight, in particular, has attracted a lot of interest during the last decade, and there is an abundance of results. They indicate substantial variability and appear to be very sensitive to the specification of the model used and the method of estimation. The value of these estimates must be viewed as doubtful, at least for the time being, for the following reasons:

- CBA is normally based on market prices. There must therefore be a reason - related to the issue of validity - for not using the capital value approach. The literature does not appear to offer any such reasons.

- SP- and RP-models make use of variables which are not relevant from the point of view of performing cost-benefit analyses of transport schemes. For example, reliability is in these models often measured in terms of the portion of shipments that arrive late. When appraising transport interventions by way of CBA it would normally not be feasible to measure their impact on the portion of shipments arriving late.

- The SP- and RP-approaches are based on methods which raise a number of issues as concerns what is being measured, and therefore if estimated values are valid from an economic point of view. There is a need to address these issues through research before the estimates of these models are accepted for use in officially sanctioned CBA methodology.

The gist of the findings of this report is that values used currently in Sweden are too high and that values related to freight are of limited importance for the outcome of CBA of infrastructure interventions.

1. INTRODUCTION

Investments in transport infrastructure impact on the transport of goods, and in most cases both the time required for undertaking the transport operation is reduced and the quality is improved. Reduced time and improved quality in turn impact on the total cost of moving goods from where they are produced to where they are being consumed or stored to bridge the lead-time between production and consumption. The total cost of moving goods from a point A where they are produced to a point B where they are being used (or consumed) is in this Survey referred to as the logistic cost. Reduction in transport time and quality improvements resulting in reduced logistic costs for moving goods from A to B may also lead to an increase in demand for the shipment of goods between these two places.

Seen in an economic perspective, the logistics cost includes storage services, transport services (which include loading and unloading), the cost of the working capital tied down in goods being stored and transported, and the damage to and loss of goods whilst in transit between production and consumption. The services required to put together the logistics chain, including forwarding and insurance, also form part of the logistics cost.

Cost-benefit analysis (CBA) has been used to appraise infrastructure investments in the road sector in Sweden since the late 1960s and in the railway sector since the late 1980s. Important components of logistics cost have been taken into account, but never in a comprehensive way. Originally only the cost of transport was recognised, later on the cost of capital tied down in goods being transported have been taken into account, and more recently attempts have been made to also account for improved quality, including expected delays or risk of delays.

This Survey has been commissioned by the SAMGODS-group represented by the Swedish Institute for Transport and Communications Analysis (SIKA). The other organisations in the SAMGODS-group are the National Road Administration, the National Rail Administration, the Civil Aviation Authority, the Maritime Authority and the Swedish Agency for Innovation Systems. The purpose of the Survey is to review research on the valuation of freight time and other quality factors affecting goods, as well as how logistics improvements are being accounted for in the cost-benefit methods used in Sweden, well as by other countries and organisations. A further purpose is identify relevant issues as well as possible actions to be taken by SAMGODS to improve the valuation of logistics improvement in cost-benefit analyses (CBA) of transport interventions carried out in Sweden.

Whilst this report has been reviewed by SIKA as well as a committee representing the National Road Administration, the National Rail Administration, the Civil Aviation Authority, the Maritime Authority and the Swedish Agency for Innovation Systems, the author is alone responsible for its findings, conclusions and recommendations.

2. THEORETICAL FRAMEWORK AND MEASUREMENT METHODS

2.1 Estimating the benefits of logistics improvements

The motive for considering logistics improvements in CBA is straightforward. Ultimately, CBA aims at showing whether an investment will result in an improvement in welfare. The traditional criterion applied to asses this is the so-called Hicks-Kaldor criterion, in terms of which an investment is justified if those persons who gain from it can compensate those who lose from it. The approach used to determine whether or not the criterion is met is to assess what is referred to as the willingness to pay or more formally the compensating variation (CV).

The resources tied down in transport and storage are not ends in themselves. They are inputs into final consumption. Therefore, if an investment results in logistics improvements, resources are freed up which can be used elsewhere in the economy and to produce more goods and services desired by consumers. The ambition of CBA is to measure the willingness to pay for being able to obtain these additional goods and services made possible by way of the improvement in infrastructure. The question is: How is willingness to pay to be measured?

The textbook approach is based on the assumption that the demand for the good subject to transport and storage can be explained by way of a demand function. This function indicates how demand is determined by a set of factors (variables), including the time required to transport the good from A to B and the quality of this transport. It is furthermore assumed that the quality dimension may be represented by measurable variables reflecting the uncertainty in transport time, the risk of accidents, and loss and damage en route and whilst loading and unloading. Given that (i) such a function exists, (ii) the actual levels of the explanatory variables before the investment is incurred may be determined, and (iii) their levels after the investment has taken place may be determined as well, then this function can directly be used to determine the willingness to pay (the CV) for the investment. Such a demand function would, in other words, enable the analyst to directly determine the economic value of the logistics improvement. A number of assumptions have to be fulfilled for the approach to be valid, including perfect competition.

Textbook demand functions only exist in textbooks. In real life much simpler demand functions have to be made use of. The basic idea of the approach used in practice is that the total logistics cost of a particular shipment can be decomposed into in principle three basic components

- the cost of transport (e.g. the cost of using a goods vehicle)
- the cost of 'freight' (reflecting that goods in transit cannot be consumed)
- other costs such as damage and uncertainty on account of transport times not being fixed (the quality factors)

It is further assumed that the last two of these components in turn can be expressed in a format which is referred to as a generalised cost. A generalised cost is based on the idea that the cost can be formulated as the sum of the product between a variable (assumed to influence demand) and a unit value, a price. Generally the cost of transport is assumed to be a part of the generalised cost of the shipment, although it is not a necessary to make such an assumption. When the transport cost is part of the generalised cost it is assumed that a transport improvement resulting in reduced logistics costs and increased demand for shipments, will not affect the size of the shipment.

The approach used in practice, in Sweden is based on the following further assumptions:

- unit values are constant with respect to the level of each variable entering into the generalised cost function (and explaining demand)
- unit values reflect willingness to pay (measured in the form of a CV).

In this Survey this approach will be assumed to be reasonable, and taken as given. It is therefore argued here that for the purposes of a CBA of a transport intervention, the valuation of logistics improvements may be decomposed into a transport element and a goods element, and to examine separately the costs associated with the goods, including the time required for their shipment and other quality factors.

The goods component of the logistics cost comprises the following cost elements (as also borne out by the available studies into the goods component as will be reviewed below):

- the cost of goods being in transit whilst being transported from the location of production to the location of its use (consumption)
- the cost of the uncertainty (or unreliability) of the duration of the time for transport, i.e. that it normally cannot be assumed that the transport time is fixed
- the degradation, loss and damage of the goods in transit from production to consumption.

The unit values to be applied to calculate these costs may be referred to as:

- the (unit) value of freight time (typically applied on the expected time or the expected time saving
- the (unit) value of (improved) reliability (rarely applied in practice and estimated in different ways; see below)
- the (unit) value of (reduced) damage (rarely if ever applied in practice; see below)

In the sequel, this Survey will focus on only the goods component - being part of the total logistics cost - and its associated unit values.

2.2 Market-based prices and unit prices based on revealed and stated preference methods

As will be discussed further below, there are two basic approaches for determining unit values. One, which is based on market prices, is the same as used when determining e.g. vehicle operating cost (VOC) savings in a CBA.

The other approach is based on inferring values from choices made between available alternatives for undertaking a shipment, e.g. choice between different routes or modes. Such alternatives may each be associated with different transport times and quality levels, i.e. levels of the explanatory variables. The econometric models used are typically logit models, which express the probability of the choice of an alternative in terms of the generalised cost of that alternative as well as of the other available alternative(s). To estimate the parameters of the econometric model, there is a need for a set of observations on (i) the actual choice made; and (ii) the level of the explanatory variables which enter into the generalised cost functions.

There are two methods for obtaining data sets of this nature allowing for the deduction of unit values by way of econometric models, viz. data on observed choices (revealed preference (RP) data), and data on hypothetical choices obtained through interviews (stated preference (SP) data). In a few studies a mixture of revealed and stated preference data have been used to estimate unit values.

Stated preference data are typically obtained through interviews involving games. The respondent is presented sets of data on explanatory variables, and is asked to identify the alternative which he/she prefers. The levels of the explanatory variables are related to a real situation, but the choices made in the interview are based on hypothetical levels. These hypothetical data may be obtained through identification of alternatives that the respondent could face in real life. Often, however, they cannot be related to a real life situation and they are then said to involve abstract choices.

Most of the research in the field of the cost of the goods component of transport has focused on determining unit values based on SP- and RP-data (see Tables 1 and 2 and Appendix 2), but unit values used in practice in Sweden today have partly been derived by using the market price approach, partly the approach based on SP-data.

3. THE UNIT PRICE APPROACH IN PRACTICE

3.1 Sweden

Unit prices related to goods are made use of in the CBA methodology applied by the National Roads Authority (VV) and the National Rail Authority (BV). In addition, such unit prices feature in the SAMGODS model system, which is a model for forecasting goods transport by different modes in Sweden, including import, export and transit traffic.

3.1.1 Road planning

CBA was introduced into Swedish road planning towards the end of the 1960s, and it then also became established as the basic instrument for preparing long term investment plans. In the early 1980s, VV started to make use of a computerised model for calculating VOCs (FOKO), which also allowed for the calculation of the cost of freight time. The concept applied was based on the assumption that time savings for goods on account of road investments should be determined as the saving in the capital tied down in the goods. To this end, different types of trucks were assigned a value of the goods they carry, and the hourly value of the capital then determined by multiplying with an hourly interest rate, obtained by dividing the annual interest rate with 8760, the number of hours in a year. This approach has subsequently been referred to in Sweden as the capital value approach for determining values of freight time.

A review of this methodology was undertaken by VV in the mid-1980s (Bruzelius (1986)), against the background of criticism that had been directed against it for not taking into account certain other aspects of relevance to the transport of goods, in particular the value of improved reliability. The review concluded that it would be possible to account for improved reliability by scaling up the value of freight time by a factor of 2 to 2.5. It was furthermore concluded that this would at most have a marginal effect on the feasibility and ranking of projects. It is unclear if VV ever did incorporate the proposed modification to account for improved reliability into its CBA-methodology.

In the early 1990s, VV commissioned an SP study of the values of freight time, reliability and damage (Transek (1992)); see Appendix 2 for a summary. The study concluded that the value of freight time for a shipment by road in Sweden was equal to SEK 30 per hour, on average. This value subsequently served as a basis for revising the values of freight time used by VV. Values determined in the SP study related to reliability and damage were not taken on board.

In a review of the CBA methodology undertaken in the late 1990s (SIKA (1999)), it was recommended that it would be preferable to base the value of freight time on the capital value approach. A further modification was made in order to introduce six different generic types of goods (bulk goods with low and high density, and general cargo with low and high density, as well as low and high value per weight unit; see Appendix 1)[1]. The value per ton of each one of these six groups of goods was determined, and a freight value of per hour and ton derived by assuming (i) an annual rate of interest of 20%; (ii) that the hourly rate of interest would be obtained by dividing by 3600 hours; and (iii) that the value obtained in this way should be multiplied by the factor 2.

No justification was offered for the choice of the rate of interest, whilst the choice of 3600 hours, in lieu of 8760 hours was motivated by that all hours of the year are not available for transport and handling of goods. The motive for multiplying with the factor 2 was to include 'not valued time costs as indicated in empirical studies', i.e. to somehow bridge the large gap between estimates of values of time obtained through the capital value method and the SP/RP methods, as will be discussed further below. As a consequence of this change in approach, the values of freight time used by VV in its CBA-methodology were revised again. The values used at present are at Appendix 1. VV does not make use of values with respect to reliability and damage at present.

It should be mentioned that VV, as well as BV, make use of separate prices to calculate accident costs, and that these costs also include cost components to reflect damage to property. However, at the present time the property component only reflects damage to vehicles and rolling stock and not damage to what these vehicles carry. The CBA-methodology used by VV, hence, does not account for that interventions in the road sector may impact on the damage, loss and degradation of goods in transport.

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1. Goods in terms of standard classification systems were also identified as belonging to one of these types of goods.

3.1.2 Railway infrastructure

BV was established in 1988, and subsequently developed a CBA-methodology similar to the one used by VV. To provide a basis for valuing freight a SP-study was commissioned (Transek (1990)). Values of freight time were derived for different types of railway wagons and these findings were incorporated into the CBA-methodology. The average value of freight time derived for a goods wagon was estimated at SEK 6/hour.

In 1999, it was decided to change the methodology for determining values of freight in rail transport in the same way as done for road transport. Two changes were thus implemented, viz. the capital value approach was introduced, and freight values of time for six different types of goods (differentiated as for the road sector) were estimated. From these new values of freight time per ton and hour, average values per goods wagon were also determined; for details on the values of freight time currently used in the BV CBA-methodology, see Appendix 1. Unlike for road transport, the new approach used to determine values of freight time in rail transport implied an increase in real terms in comparison with the previous approach which was based on the SP-study from 1990.

In addition to time, the CBA-methodology used by BV accounts for improvements in reliability. Reliability is estimated in terms of expected delay time. The approach used is the following. In the *ex ante* situation, the proportion of trains during a given time period (say a year) which are delayed are determined and divided into three classes, viz. trains delayed less than 1.5 hours, trains delayed between 1.5 and 3.5 hours and trains which are delayed by more than 3.5 hours. This division into classes of delay is only done for trains carrying goods which cannot arrive the day after the agreed date, which made up about 45% of the shipments in the survey used in Transek's 1990 study. In other words, and in practice, only 45% of delayed trains are divided into the three classes. For each one of these classes the expected reduction in delay time on account of the planned intervention is then determined and a value of reduced expected delay time applied. Separate values of improved reliability are applied on the estimated reduction in the expected delay in each one of the three classes. The unit values are expressed per wagon and differentiate between different types of wagons.

It is understood that the original (unit) values on expected delay time were derived from Transek's study. It is to be noted, however, that Transek's study used a different variable to measure reliability, viz. the risk of a delay or the frequency of shipments delayed, and then estimated unit values of relevance to this variable. It is not known to this author how the values obtained in Transek's 1990 study have been converted into unit values with respect to the variable 'expected delay time'. The original values made use of by BV have later been updated to account for inflation, but the original differentiation between different types of wagons as well as classes of expected delay times in the *ex ante* situation has been retained. The methodology of the reliability values were, in other words, not revised in 1999. The values currently used in the BV CBA-methodology are at Appendix 1.

When compared to other (unit) values of time, these unit values applied by BV on reduced expected delay time must be judged as being exceptionally high. The ordinary freight value of time is at present SEK 19 per hour and wagon (1999 prices and including indirect taxes). A reduction of an expected delay by one hour for an average wagon is valued at between SEK 1058 and 2166 (1999 prices including indirect taxation) depending on the size of the *ex ante* expected delay. This is implausible.

3.1.3 SAMGODS

One of the components of the SAMGODS model is the network model referred to as STAN. STAN assigns generalised costs to different modes for shipments from one region to another, also taking into account costs when transfers take place at a node from one mode to another. SAMGODS is, hence, able to handle entire transport chains involving a number of different modes, including combined transport.

In STAN, differentiation is made between different types of goods. For 1999, a distinction is made between 11 types, 6 of which are also the ones used to determine the values of freight time applied in the CBA-methodology used by VV and BV. It is understood, that the types of goods will be redefined for future years in the forecasting model.

The values of freight time made use of in STAN have been determined in the same way as the values used by VV and BV; the only difference is hence that STAN differentiates between 11 different types of goods instead of the 6 ones taken into account by BV and VV. The freight values to be used on the types of goods identified for future forecasting years in the SAMGODS model are determined in the same way, i.e. by way of the capital value approach.

Reliability is also accounted for in the STAN generalised cost functions. The principle used is to measure reliability in terms of a risk of delay and assign values to a decrease in the risk of a delay, e.g. per mille unit change. To this end STAN differentiates between the 11 types of goods referred to above, and identifies values per mille reduction in risk level for each one of these commodities. The risk of delay for a shipment is determined as the risk per ton-km for different types of transport means (all in all 12 different modes of transport) multiplied by the distance and weight of the shipment. Additional risk elements are identified in connection with transfers at nodes.

The values assigned to a per mille reduction in the risk of delay have (apparently) been derived from a study commissioned by the SAMGODS group in 1999 (INREGIA (1999); see Appendix 2. How this has been accomplished is, however, unclear to this author. The INREGIA study does not differentiate between the types of goods used by STAN, and produced values from functions which in general can not be seen as being linear generalised cost-functions. The study also examined given shipments with fixed origin and destination, which vary with each respondent. The INREGIA study is thus (implicitly) based on the assumption that the valuation with regard to a per mille risk change would be independent of the actual distance involved in or the time required for undertaking a transport.

3.2 Other countries and models

Two previous surveys (Aaltonen (1993) and Waters et al. (1995)) have concluded that the impact on goods is not being taken into account in the CBA methodology applied by the road (and where relevant, rail) authorities in different countries. As a whole that still applies, although as noted, Sweden has been an exception already since at least the early 1980s.

Research into the cost of goods in transport has been carried out in a number of countries and recommendations have been made but so far, no action has been taken by the authorities concerned. This applies in particular to Holland and the UK, countries in which large studies were carried out in the mid-1990s on behalf of the Ministry of Transport and the Department of Transport (DOT), respectively[2].

However, the Department of Environment, Transport and Region (the successor to DOT) is currently reviewing the matter, and expert advice is being sought. Mention should be made of that TransFund, which funds, *inter alia*, road infrastructure in New Zealand is currently carrying our surveys with a view to account for the impact on goods of transport interventions. Recommendations coming out of that work will be implemented as from about mid-2002. Austroads, the association of the road authorities in the states of Australia as well as New Zealand, publishes estimates of freight travel time values for a range of freight vehicle stereo types (Austroads (2000)). Austroads has commissioned further research and additional recommendations are expected to be forthcoming in the near future.

In the context of the European Union, it is noted that values of freight time have been proposed by EUNET (1998), a project funded by the European Commission under the Transport RTD Programme of the Fourth Framework Programme. The purpose of EUNET is to develop a methodology to evaluate socio-economic effects of transport infrastructure investments. Deliverable D9 provides 'freight user values of time' (i.e. unit values of freight time). The report notes that Sweden is the only country to make use of such values, and hence recommends that the values used by Sweden be used also by other EU countries, suitably modified to the cost level in these other countries. The values recommended for use in EU are thus the old Swedish values used by VV in the mid-1990s, which have subsequently been abandoned. In a report from the Western European Road Directorates (2000) recommendations are made for use of the EUNET freight values of time.

International financing institutions such as the World Bank, EBRD and EIB, which apply CBA when appraising road schemes, do normally not account for logistics improvements except costs related to vehicles and their drivers. The Highway Development and Management Model (HDM-4), a comprehensive tool for analysing road schemes which is frequently used by these institutions and their clients, provides for the calculation of 'cargo holding costs' by multiplying with an hourly value of freight time. The analyst has to provide the freight value of time per road transport vehicle. This function is rarely, if ever, employed by HDM users.

2. The results have been used on an *ad hoc* basis in some CBA.

4. EVALUATION OF ESTIMATES OF UNIT PRICES

4.1 Using market based prices

4.1.1 Value of Freight Time

As will be elaborated upon below, SP-studies yield values of time and reliability which are higher or much higher than values obtained through using the approach based on market prices. As noted, BV and VV at present make use of values of freight time which are based on the latter approach. It is, however, argued here that the current Swedish values (hereinafter the ASEK approach) must be seen as being overestimates of the values of freight time.

There are three assumptions going into the ASEK approach that need to be reviewed:

- The rate of interest is now set at 20%, in real terms, an assumption which must be viewed as high. The return on capital invested in Sweden in the private sector is normally lower (probably half as high in real terms). Also there is a need to ensure that the assumptions made with respect to this rate of interest harmonise with the assumptions made about other parameter values in a CBA which reflect the fact that public investments may push out investments in the private sector, and that returns are different and measured differently in the two sectors.

- The current values are multiplied by the factor 2. The reason for this is unclear. One possible motive could be to take into account reliability, but this factor is at present taken account of separately in the BV methodology. Another explanation could be that this factor should reflect uncertainty in demand and damage; see further below.

- To obtain an hourly value, the yearly value is divided by 3600 hours and not (365x24=) 8760 hours. This is based on an error of thinking, because the time savings in the CBA methodology used by VV and BV are determined in terms of hours saved so a price per hour is required. The rate of interest (20%) is a yearly price so to convert to an hourly price the yearly price must be divided by 8760.

It may thus be argued that the values of freight recommended by ASEK, which are based on the capital value approach, are far too high and by the following factor

$(0.20/0.10)*(2/1)*(8760/3600) = 9.73$

i.e. by almost 10 times.

It is to be emphasised that a value of freight time based on the capital value approach only reflects the savings made from goods being able to reach their destination quicker, thereby reducing the working capital invested in the goods. Another way of looking at this saving, and from the point of view of the entire time period of a CBA, is to recognise that goods being transported in effect are goods that are being stored. The discounted time savings in the CBA hence reflects the goods that will be released from this stock and made available to consumption.

It is to be emphasised that this interpretation of what is actually reflected in the value of a freight time saving, estimated in terms of the capital value approach, does not in any way depend on whether demand and/or supply is uneven in time or production or transport only take place during a given number of hours of the year (e.g. during 3600 hours as assumed by ASEK). The value of freight in terms of the capital value method always reflects the condition that the time required for transport implies that goods are being stored on a vehicle. A time saving during a transport (repeated continuously during the period of the analysis) therefore gives rise to a saving in the stock required to bridge the location of where the good is produced and the location where it will be used.

It is sometimes argued that unit values determined on the basis of the capital value approach do not reflect the full willingness to pay for goods to arrive more quickly at their destination. The argument is related to the condition that demand for the goods in question is stochastic; this should not be confused with the condition that the transport time may be uncertain, a matter to be considered in the next section.

One can think of several explanations of why stochastic demand may give rise to a high willingness to pay for quick delivery. One example is when an accident occurs, requiring urgent transport of e.g. spare parts to enable a production process to continue, which otherwise would have to stop in the absence of stocks. Another example is the nature of modern production and logistics methods, which often makes it cheaper not to meet a demand immediately through an available stock, but by receiving an order and then producing the good that is demanded. Of course, once an order has been placed the customer often wants to have it and the seller wants to deliver it immediately, and there may therefore be an additional willingness to pay for this.

It is recognised that in both these cases, there is a possibility that the customers' willingness to pay would be higher than the value reflected through a straightforward application of the capital value approach. As concerns the first example, it may be argued that it could not be a very common feature in relation to total transport flows, but also that the additional value is limited. The reason for saying this is that the person responsible for the production process after all made the decision not to stock the required spare parts, instead relying on delivery in case of a break-down. Apparently this latter alternative was viewed as being less expensive.

As concerns the second example, it may be argued that if there is a high demand for immediate delivery, then the market will meet this demand. Indeed many products may today be bought either through an order against later delivery or directly off the shelf, reflecting that some consumers are prepared to pay a premium for immediate delivery. But this, of course, also means that those who are prepared to wait are those who for various reasons can wait. It is difficult to find an explanation of why those who are prepared to wait would be willing to pay more for reduced time in transit on account of an intervention in the transport system than what is reflected through the capital value approach.

4.1.2 The Value of Improved Reliability

The capital value approach can be taken further by also accounting for reliability and damage. A theoretical analysis of the issue of reliability has been presented by Minken (1997), and a simplified version is to be found in Bruzelius (1986). However, as far as is known to this author, no extensive empirical analysis has so far been made based on this approach. It would require studies of the variation in the transport time, which is seen as the source of unreliability. The approaches used by Minken and Bruzelius both presume that the variability in transport time can be described in terms of a probability density function and that logistics planners build up stocks to ensure that stockout will not occur, or will occur rarely on account of the variability in transport time. The value of improved reliability is determined from the reduction in the buffer stock made possible by a reduction in the variability in transport time. The method may be used to obtain values of reliability through simulation. The attractiveness of the approach is that it allows for expressing improvements in reliability in terms of variables that may be measured in the context of a CBA of a transport intervention, e.g. by way of changes in the standard deviation in the transport time. A further property of the approach is that it may be used to provide estimates which may be seen as an upper limit on the value of improved reliability, in view of the fact that logistics planners have a choice between using a buffer stock and not using such a stock at all. When the latter alternative is chosen it is cheaper to allow for a stockout.

In the Bruzelius study a simple model is used in order to obtain an estimate of the value of reliability. It is based on the assumption that arrival times are normally distributed and that the relationship between speed and the variation in transport time is linear. It is shown that when applying the rule that stocks should be adequate 99% of the time, the value of improved reliability may be assumed to be somewhat higher that the value of freight time, i.e. the size of the reduced stock on account of improved reliability is somewhat higher than the stock reduction on account of reduced transport time. Bruzelius argued that his model would provide a reasonable estimate of the value of reliability in CBA of many normal road investments for the following reasons. The model would likely yield an overestimate because:

- the specific assumptions made with respect the relationship between speed and the variation in transport time
- stocks are not only maintained on account of the variability in transport time but also because variability in demand
- only part of the transported goods is subjected to stringent arrival times requiring the build-up of stocks

The model might on the other hand result in an underestimate on account of

- the actual cost of maintaining stocks (i.e. the cost of the warehouse and warehousing)
- the variation in arrival times might be better described by a skewed distribution (e.g. the log-normal, see below), which could result in the need to hold a larger stock at a given target level for a stockout, say stocks available at 99% of the time.

The conclusion of Bruzelius (1986) was that it would be reasonable in CBA of normal road investments to account for reliability resulting in reduced variability in transport time by doubling the value of freight time (based on the capital value approach). Bruzelius also argued that the detailed measurement of the value of reliability should not be seen as important in view of the fact that the cost of freight time normally plays an insignificant role in comparison with other components in a CBA.

As concerns rail transport it should only be noted here that the approach used by BV entails a mixture between different approaches. The value of freight is based on the capital value approach, whilst the origin of the values applied on reductions in expected delay times is apparently to be found in SP-studies.

4.1.3 The value of reduced damage

No attempts appear to have been made to determine the value of reduced damage using the capital value approach. This approach would require information about

- the value of goods (data are available)
- the risk of damage (and loss) per km or per hour for different modes
- the nature of the damage, i.e. the proportion of the goods that would not be accepted and would have to be disposed of on account of damage.

The value of damage determined in this way cannot be expected to be substantial, although this is a matter that should be investigated further. The INREGIA (1999) study suggests that 11 per mille of goods transported by road and 22 per mille of goods transported by rail are subjected to damage. These values refer to the entire transport operation from start to end, and presumably reflect the loading and unloading operations as well. They can therefore not (given the information available through the report) be converted into values per hour or km. In addition, it is unclear what is meant by damage in the INREGIA study in that it cannot be determined what proportion of a shipment, which has been described as having being damaged, that has actually been fully lost.

4.2 Stated and revealed preference analyses

The second approach to determining values for freight time, reliability and damage is by way of revealed and stated preference analysis. As evidenced by Tables 1 and 2, as well as Appendix 2, there is a large number of analyses of this nature. However, it is unclear to this author why it is preferable to use the SP/RP approach to the capital value approach to determine values for freight. Vehicle operating costs (VOCs) e.g. are determined on the basis of market prices, and as far as is known no attempts have been made to replace the traditional estimates of VOCs with values obtained by way of the SP-method. The basic principle underlying the estimation of costs and benefits in CBA is to as far as possible use market prices, i.e. prices that may be observed. The underlying assumption is that the economy of the country in which the analysis is carried out is characterised by a reasonable level of competition so that market prices can be seen as reflecting willingness to pay. Unit values deduced from various types of trade-off analyses are therefore normally only used when market prices are believed to be invalid or such prices do not exist.

Indeed it may be argued that if SP and RP studies would yield estimates clearly indicating that the willingness to pay to reduce freight time is larger than the estimates obtained by way of market prices, then these results should not be applied. The values to be used in a CBA are, in principle, the values of the additional goods that may be consumed through e.g. the time savings, and not the values of shippers and receivers.

It may also be argued that the SP/RP approach raises a number of issues with respect to the validity of estimates obtained with it, several of which cannot be addressed through the research now available. For both SP- and RP-data, these issues concern the models and estimation techniques used. For SP-models there are, in addition, questions as concerns the interview method made use of.

The following issues may be identified:

- SP- and RP-models involve choice between alternatives for how to transport shipments. These shipments are of course very diverse in nature (value, size, weight, distance), whilst the models normally used to explain choice presume a value which is independent of these characteristics. Attempts are often made to lessen the effect of this restriction by estimating separate values for different types of goods, etc. Even under these circumstances a fixed value of time must be viewed as a very strong assumption. There are examples of studies in which distributions have been introduced for the values of time (e.g. Wynter (1995) and Kawasaki (2000)), but these are exceptions (and the mentioned studies also suffer from other shortcomings).

- The CBA methodology is based, as mentioned, on the concept of linear generalised costs. However, a number of studies have estimated values from non-linear functions, including the two Swedish studies from the early 1990s (Transek (1990) and (1992)). The validity of estimates obtained from non-linear functions is unclear. The type of function used matters. The data from the Transek (1992) study have subsequently been used by Bergkvist and Westin (2000), who estimated values of freight time by applying a linear function as well as using a different estimator. The value of freight time obtained by Bergkvist and Westin (SEK 14 per shipment and hour) was less than half that obtained through the original approach (SEK 30).

- The most popular model used to estimate values from SP-data is the logit model. The logit model is based on the assumption that the error term of the generalised cost function is independently distributed (with an extreme value distribution). However, SP-data are obtained through repeated interviews, which means that the independence assumption is not fulfilled. This results in biased estimates (overestimates) of the t-values and in the significance of parameter estimates being overstated (see Cirillo et al. (1996)).

- The position held by the person interviewed to obtain SP-data vary from study to study. In general, a person in managerial position, having the authority to make decisions is interviewed This person normally represents the shipper (consignor), less often the operator and even less often the receiver (the consignee). The importance of who is actually interviewed is analysed from a theoretical point of view by Winston (1981). An aspect to consider is, of course, the terms of the contract for the purchase of the goods, in particular how these are being paid for. If paid CIF, the shipper is probably the key person to interview, but if the goods are sold FOB, the receiver is likely to be more important. This issue will, of course, not matter when the shipper and receiver come from the same firm (i.e. transports are internal). It would not seem appropriate to use data on choice made by transport operators (i.e. firms which undertake transport for hire and reward) as they will likely be more concerned with the cost of their own operations than the cost of the goods they carry (although contractual arrangements may impact on this). It is noted that with the exception of the study by Winston, the issue as to whether the shipper or the receiver should be interviewed is not addressed. It is also noted that estimates of values of time obtained from managers of hauliers tend to be higher than those obtained from respondents representing shippers. See e.g. the study by Fowkes et al. (2001), and the study reported on by de Jong (2000) which contains data from the UK value of time study in the mid-1990s. The values of freight time for operators in these studies are much higher than the values obtained from shippers.

- This last point brings up a related issue, viz. to what extent the choices made by SP-respondents are clouded by other concerns which do not enter into the alternatives - in the form of variables - that they can choose between in the SP games, or by the condition that variables are incorrectly specified. Similarly, it may be queried to what extent the respondents in the interviews can consider the longer term consequences of the alternatives. It should be emphasised that from the point of view of a CBA, it is not short-term effects that are of interest but the longer term impacts, reflecting a situation where the economy has found a new equilibrium after a change.

- More fundamental as concerns the quality of the data is the question to what extent a respondent is in fact able to rank alternatives in terms of a utility function (fulfilling the assumptions typically made such as completeness, transitivity and reflexivity). During interviews the respondents normally have limited time before they have to make a choice, and he/she never incurs any rewards or penalties for making a decision. The INREGIA study suggests that respondents often make a decision on the basis of the level of one variable only instead of weighing together all the variables of each alternative before making the choice. Is it possible that the data obtained through SP-interviews are better explained in terms of a lexicographic ordering than the ordering assumed by the economist? The question has not been analysed. It should also be emphasised that the cost of transport is small in relation to the value of the goods (some 2 to 3 % in most instances), which may have an additional effect on choice not only in SP-interviews but in real life. To this should be added that the abstract alternatives in SP interviews often are structured in such a way that the respondents can chose between alternatives which imply better quality at a higher cost. Everybody wants better quality, and the decision maker who serves as the SP-respondent is probably often rewarded for improving quality. If the cost to be paid for improved quality in the game is no real cost, then will the data not tend to overstate the willingness to pay for better quality? The available evidence suggests that the way in which the alternatives are structured have an impact on the answers obtained. In the 1994/95 value of freight study in the UK (reported on in de Jong

(2000)) transport operators (for hire and own account operators) were subjected to two sets of games, one involving abstract alternatives and one involving a toll road and a toll free alternative. The latter experiment yielded values in the range GBP 21-34, whilst the former resulted in values in the range GBP 36-48. It is understood that the same persons were interviewed in the two games.

- Many of the above issues relate to SP studies alone. But also the few available RP studies are characterised by data problems. RP data have thus often been obtained *ex post* through reconstruction by the researcher and may therefore not represent the actual prices, times and quality factors faced by the decision maker when he made his decision.

4.2.1 Values of Freight Time

Table 1 presents the values of freight time obtained through SP- and RP-studies. Note that the included values reflect different currencies, years and units. The last column also indicates if the estimates have been obtained from data on decisions made by road transport companies (operators) or models which have not been formulated in terms of linear generalised costs (non-linear). To provide a reference point: the current values of freight in Sweden, derived from the capital value approach, are on average SEK 35 for a road transport vehicle and SEK 23 for a rail wagon. Whilst clearly being overestimated (in terms of the capital value approach), they appear to be low in comparison with the values obtained through the SP- and RP-approaches.

Table 1: Results of SP and RP studies: Values of Freight Time

Study	Year of data	Mode/ Country	Value	Unit Value per	Comment
Transek (1990)	89/90	Rail/S	SEK 6	hour & wagon	Non-linear
Transek (1990)	89/90	Road/S	SEK 20	hour & shipment	Non-linear
Transek (1992)	1991	Road/S	SEK 30	hour & shipment	Non-linear
Kurri et al. (2000)	1997	Road/SF	$ 1.53	hour & ton	
Kurri et al. (2000)	1998	Rail/SF	$ 0.1	hour & ton	
Fridstrøm et al. (1995)	1992	Road/N	NOK 0-70	hour & shipment	Non-linear
Hodkins et al. (1978)	1970s(?)	Road/Sea/AUS	AUS$ 10	day & ton	RP
Kawamura (2000)	98/99	Road/US	$ 23.4-26.8	hour & shipment	Operators
Wigan et al. (2000)	1998	Road/AUS	AUS$0.66-0.40	hour & pallet	
Wynter (1995)	90-94?	Road/F	FF 7	min.& shipment	Operators
de Jong et al. (2001)	2000	Road/F	FF 29-60	hour & shipment	SP+RP
"	2000	Rail/F	FF 17-73	"	"
"	2000	Combined/F	FF 34-53	"	"
Fosgerau (1996)	88/89	Road/DK	DKK 2.7-6.0	min. & shipment	Operators
Winston (1981)	75-77	Road/US	$125-1187	day & shipment	RP
Winston (1981	75-77	Rail/US	$490	day & shipment	RP
de Jong et al. (1992)	91/92	Road/NL/ (99 prices)	$ 32-42	hour & shipment	Non-linear
"	"	Rail/NL/ "	$ 32	hour & wagon	"
"	"	IWT/NL/ "	$ 222	hour & shipment	"
Fowkes et al. (2001)	00/01	Road/UK	£ 37.2-169.3	hour & shipment	Partly operators
de Jong et al. (2000)	94/95	Road/UK/ (99 prices)	$ 21-48	hour & shipment	Partly operators
Fowkes et al. (1991)	88/89	Road/UK / 99 prices	$ 0.09-1.29	hour & ton	
Viera (1992)	1990?	Rail/US/99 prices	$ 0.59	hour & ton	SP+RP
Roberts (1981)	1980?	IWT/US/99 prices)	>$ 0.05	hour & ton	RP
Blauwens et al. (1988)	1985?	IWT/B/99 prices)	$ 0.1	hour & ton	RP
Fehmarn Belt (1999)	1997?	Road/DK+D/ 99 prices	$ 21	hour & shipment	Operators?
de Jong et al. (1995)	1995	Road/D/99 prices	$ 33	hour & shipment	Non-linear
"	1995	Road/NL/ 99 prices	$ 40-43	hour & shipment	Non-linear
"	1995	Road/F/ 99 prices	$ 34	hour & shipment	Non-linear
Bergkvist et al. (2000)	1991	Road/S	SEK 14	hour & shipment	
Bergkvist (2001)	1991	Road/S	SEK 34-509	hour & shipment	
INREGIA (2001)	1999	Road/S	SEK 0-227	hour & shipment	
"	1999	Rail/S	SEK 0	hour & shipment	
"	1999	Air/S	SEK 117	hour & shipment	
Small et al. (1999)	1995?	Road/US	$ 144-193	hour & shipment	Operators

IWT = Inland waterways transport

4.2.2 Values of Improved Reliability

The most common approach to estimating the value of reliability in SP-studies is by way of the variable percentage (or per mille) delay. During an SP-interview, the first stage involves identifying the number of delayed consignments for a typical transport operation of the firm of the respondent. In the second stage the respondent is then asked to chose between alternatives which involve other values on the delay variable (as well as other influencing variables). In some studies a distinction is made between goods which are considered delayed if they arrive late during the agreed arrival date, and goods which are considered delayed only if they arrive the day after the agreed arrival date. The theoretical basis for using this specification is unclear.

The recent study by Fowkes et al. (2001) suggests an alternative way of measuring reliability, and by way of what is called the spread. The spread is the time between the earliest arrival time of a given shipment and the time when 98% of all shipments have arrived. The spread variable is thus based on the notion of a probability distribution of arrival times, but tries to describe it in a very simple way. However, its usefulness is limited. It will normally not be possible to determine how the spread time is changed through a proposed investment to be appraised with CBA .

In some US studies attempts have been made to take into account variability through the standard error of the estimated travel time or the coefficient of variation, i.e. the ratio between the standard deviation and the mean travel time. The study carried out by Small et al. (1999) assumes that the travel time follows the log-normal distribution, and then attempts to estimate values of reliability reflecting this distribution, and through three different approaches, i.e. (i) the standard deviation; (ii) coefficient of variation, and (iii) a function reflecting that arriving early is associated with a cost per time unit, whilst arriving late gives rise to both a fixed penalty and a penalty per time unit delayed. The number of observations used in this SP-study was, however, limited, and the respondents apparently also expressed difficulties in understanding the questions posed including the variables reflecting early and late arrivals, which were formulated so as to reflect the assumption of a log-normal distribution. The usefulness of the results of this study is also limited by the condition that the interviews were carried out with transport operators.

The appropriateness of all the above approaches to measuring reliability may also be questioned as they are based on the assumption that delay or reliability is not related to the length of the trip or its duration in time. It would seem more reasonable to assume that reliability is a function of the time duration. If, in addition, this relationship could be assumed to be linear (as assumed in STAN), a value on reliability could readily be incorporated into the standard CBA-framework. Indeed, if reliability is a function of transport time, one possible explanation for the high values of freight time obtained through SP- and RP-studies could be that they also reflect the value of reliability

Some of the results obtained from SP and RP-studies are presented in Table 2

Table 2: Results of SP studies: Values of Reliability

Study	Year of data	Mode/ Country	Value	Unit Value per	Comment
Transek (1990)	89/90	Rail/S	SEK 60 same day	1 % unit & shipm	Non-linear
Transel (1990)	89/90	Rail/S	SEK 40 next day	1 % unit & shipm	Non-linear
Transek (1990)	89/90	Road/S	SEK 150 same d.	1% unit & shipm	Non-linear
Transek (1990)	89/90	Road/S	SEK 30 next day	1% unit & shipm	Non-linear
Transek (1992)	1991	Road/S	SEK 280 same d.	1% unit & shipm	Non-linear
Transek (1992)	1991	Road /S	SEK 110 next day	1% unit & shipm	Non-linear
Kurri et al. (2000)	1997	Road/SF	$ 47.47	hour & ton	Expected delay
Kurri et al. (2000)	1998	Rail/SF	$ 0.50	hour & ton	Expected delay
Wigan et al. (2000)	1998?	Road/AUS	AUS$1.25-2.56	1% unit & pallet	
de Jong et al. (2001)	2000	Road/F	Not reported	1% unit & shipm	SP+RP
"	2000	Rail/F	"	"	"
"	2000	Combined/F	"	"	"
Winston (1981)	75-77	Road/US	$ 404	day, standard dev.	RP
Winston (1981	75-77	Rail/US	$299-4110	day, standard dev.	RP
de Jong et al. (1992)	91/92	Road/NL/	Not reported	1% unit & shipm	Non-linear
"	"	Rail/NL	Not reported	1% unit & shipm	"
"	"	IWT/NL	Not reported	1% unit & shipm	"
Fowkes et al. (2001)	00/01	Road/UK	£ 61.5-167.6	hour & spread	Partly operators
de Jong et al. (2000)	94/95	Road/UK	Not reported	1% unit & shipm	Partly operators
de Jong et al. (1995)	1995	Road/D	Not reported	1% unit & shipm	Non-linear
"	1995	Road/NL	Not reported	1% unit & shipm	Non-linear
"	1995	Road/F	Not reported	1% unit & shipm	Non-linear
Bergkvist et al. (2000)	1991	Road/S	SEK 165 same d.	1% unit & shipm	
"	1991	Road/S	SEK 84 next day	1% unit & shipm	
Bergkvist (2001)	1991	Road/S	Not reported	1% unit & shipm	
INREGIA (2001)	1999	Road/S	SEK 63	1 per mille & shipment	From linear model
"	1999	Rail/S	SEK 1142	1 per mille & shipment	From linear model
"	1999	Air/SWE	SEK 264	1 per mille & shipment	From linear model
Small et al. (1999)	1995?	Road/US	$ 371.33	hour & shipment	Expected delay, operators

4.2.3 Values of reduced damage

A limited number of the studies include variables related to damage and loss, e.g. Transek (1992), de Jong et al. (1992) (the Dutch VOT study), de Jong et al. (1995) (studies of road transport in Holland, France and Germany), Fridstrøm and Madslien (1995), Wigan (2000) and Bergkvist and Westin (2000). With the exception of the study by Wigan (2000), in which damage is defined in terms of pallets not being accepted by the receiver, it is not fully clear what is meant by damage, i.e. whether the whole shipment is lost or only part of it.

Estimates vary significantly. The Transek (1992) study resulted in an estimate of SEK 270 for one per mille unit reduction in the frequency of damage. Bergkvist and Westin (2000) using the same data but a linear specification and anther estimator obtained a value of damage of SEK 20 for a per mille unit reduction in frequency of damage to a shipment.

As in the case of reliability, the SP- and RP-values for damage are of limited usefulness from the point of view of CBA, as they are not expressed in relation to the distance or the time duration of shipments.

5. CONCLUSION

5.1 Findings

Empirical studies concerning the goods dimension of logistics costs focus on three aspects, viz. the time duration of transport, reliability, and damage and loss. Given that the costs related to the mode used to transport the goods are handled separately, as is the case in the CBA methodology used in Sweden, the remainder of the benefits associated with improvements in logistics should adequately be reflected through these three variables and the prices or (unit) values associated with them.

Two approaches may be used to estimate the values associated with these three variables, viz. market prices and using values derived from models of choice between transport alternatives in which the three variables are explanatory factors. The CBA methodology used in Sweden today is, in effect, based on a mixture of these two methods.

The two approaches give very different results. The approach based on market prices (also referred to as the capital value approach) results in low prices, indeed much lower values than the ones currently in use in Sweden. Even taking into account reliability, which is currently not recognised in the CBA-methodology used in the road sector, is not likely to change that assessment. It appears that the value of reliability using the market price approach would yield values per time unit saved which are of the same order as the 'pure' value of freight time based on the market price approach. No estimates have been prepared for damage and loss using this approach on account of lack of data on the probability of damage and loss per km or time unit. This is a void that should not be all that difficult to fill.

The SP-approach to the estimation of values of relevance to freight, in particular, has attracted a lot of interest during the last decade, and there is an abundance of results. They indicate substantial variability and appear to be very sensitive to the specification of the model used and the method of estimation. The value of these estimates must be viewed as doubtful, at least for the time being, for the following reasons:

- CBA is normally based on market prices. There must therefore be a reason - related to the issue of validity - for not using the capital value approach. The literature does not appear to offer any such reasons.

- SP- and RP-models make use of variables which are not relevant from the point of view of performing cost-benefit analyses of transport schemes. For example, reliability is in these models often measured in terms of the portion of shipments that arrive late. When appraising transport interventions by way of CBA it would normally not be feasible to measure their impact on the portion of shipments arriving late.

- The SP- and RP-approaches are based on methods which raise a number of issues as concerns what is being measured, and therefore if estimated values are valid from an economic point of view. There is a need to address these issues through research before the estimates of these models are accepted for use in officially sanctioned CBA methodology.

5.2 Recommendations

Whilst awaiting the results of further research into relevance of the SP-approach and results of SP studies, it is suggested that ASEK continue to make use of the capital value approach, as already done with effect from 1999. The following further suggestions are made :

1. The value of freight time should be recalculated in terms of the principles set out in section 4.1.1.
2. There is a need to review through further analysis, by making use of simple illustrative examples, whether stochastic demand (see section 4.1.1) may warrant an adjustment of the value of freight time calculated as recommended under 1.
3. In Section 4.1.2, it has been suggested that the value of improved reliability may be accounted for by doubling the value of freight time determined as recommended under 1. There is a need to undertake further desk analyses of this nature to verify, modify or alter this approach.
4. To determine values reflecting damage, loss and degradation it should be possible to make use of data to be obtained from e.g. insurance companies on frequency of damage, and how damage, loss and degradation may be explained by loading, unloading, transfers, and transport distance and/or transport time. There is also a need to consider if such values should be integrated into the accident values already used in the VV and BV CBA-methodology.

5.3 Concluding words

The gist of the findings of this report, viz. that the values used currently in Sweden are too high and that values related to freight are of limited importance for the outcome of CBA of infrastructure interventions, will likely raise a few eyebrows. Indeed these findings may not be well received. There appears thus to be a concern that current values are low, and also that the logistics effects are not adequately reflected in the current CBA methodology; see e.g. Östlund et al. (2000).

Two considerations may shed some light on this situation. The first is that the benefits related to logistics improvements and goods are reflected in the accounts of firms. In addition, time savings for goods materialise in the form of reduced stocks from the point of view of a company and its accounts. The logistics effects, taking into account the whole period of the investment, are therefore immediately reflected in the accounts, making these benefits much more transparent than other benefits of a transport scheme. In addition, firms tend to be better at articulating their needs than ordinary persons.

Secondly, it appears to this author somewhat strange that so much interest is being vested in the reliability of the transport of goods, whilst the current Swedish CBA methodology does not take into account the impact of uncertainty in travel time on VOCs and the cost of travel during working as well as non-working time. Irrespective of which values that are assigned to freight, the impact of improved reliability on travel costs and VOCs on the outcome of a CBA of a transport scheme should be substantially much higher than that of freight. Is it possible that those who express concerns about inadequate attention being paid to logistics costs are targeting the wrong half of the ground, and should turn their attention to the means of transport instead of on what they carry?

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APPENDIX 1:

VALUES USED BY VÄGVERKET (VV, THE SWEDISH NATIONAL ROAD ADMINISTRATION) AND BANVERKET (BV, THE SWEDISH NATIONAL RAIL ADMINISTRATION) TO VALUE IMPACT ON GOODS IN CBA

Table 1: Values of freight time; 1999 prices

Type	Bulk		General				Average
Value (SEK/kg)	n/a	n/a	>25	<25	>25	<25	
Density (kg/m^3)	>1.0	<1.0	>0.6	>0.6	<0.6	<0.6	
Value of goods (SEK/ton)	2 100	1 800	128 500	6 400	167 300	4 500	
Value of freight time (SEK/ton & hour)#	0.23	0.20	14.3	0.7	18.9	0.5	
Value of freight time (SEK per loaded rail wagon & hour)	5.4	4.6	328	16	430	12	19
Value of time (SEK per average truck & hour)	3.3	2.8	203	10	264	7.1	28*
Value of time for light goods vehicle (SEK/hour)							7.9*
Value of time for heavy foods vehicle (SEK/hour)							41.2*

* These values are used in practice by VV after multiplication by the factor 1.23 (to bring up to consumer price level) yielding:

Average:	35 SEK/hour
Light goods vehicles	10 SEK/hour
Heavy goods vehicles	50 SEK/hour

BV uses these values of time per ton and hour for each one of the six groups of goods (after multiplication by the factor 1.23)

Table 2: Expected delay values of time applied by BV on 45% of traffic for delayed traffic in three categories of delays in the ex ante situation. SEK per hour and loaded wagon

Category	**< 1.5 hours**	**1.5-3.5 hours**	**>3.5 hours**
Single wagon load	1 406	2 108	2 812
Wagon in unit train	529	793	1 058
Combined	1 058	1 588	2 166
Foreign wagons	1 406	2 108	2 812
Domestic wagons	881	1 321	1 763
Private wagons	881	1 321	1 763
SJ wagons	1 058	1 588	2 116
Average	1 058	1 588	2 166

APPENDIX 2.

SUMMARY INFORMATION ON STUDIES OF VALUES OF FREIGHT TIME AND FREIGHT TIME RELIABILITY

Title: Transek (1990): *Godskunders värderingar*, Banverket Rapport 9 1990:2

Approach: Discrete choice experiment; conjoint analysis, choice between abstract road transport alternatives and choice between abstract railway alternatives

Type of data and year collected: SP data collected through face to face interviews, 1989-90, Sweden.

Who makes the decisions: Shipper (manager)

Type of model: Logit models for choice between alternatives

Type of goods: The goods are expected to be representative for all railway transports in Sweden. However, the values for truck alternatives apply only to shippers who make use of rail transport

Variables used:
- (i) door-to-door transport time (expected time)
- (ii) cost of transport
- (iii) frequency of shipments arriving late either the same day or the following day
- (iv) headway (this variable was insignificant for rail transport and not used for road transport)

Variables measured not in absolute values, i.e. as differences in time and price, but in terms of percentage changes.

Estimation method: Max. likelihood

Main estimation results:

A number of values of freight time applicable to a goods wagon by rail were estimated. Differentiation with respect to type of train and type of carriage, but not type of good. The average value per wagon was 6 SEK.

Two values with respect to delay times were estimated, one pertaining to those who incur some form of penalty for a late arrival during day of planned arrival, and those who incur a penalty if the arrival is one day after the day of planned arrival. 45% belonged to the first group and 55% to the second. The value of 1 percentage unit improvement in frequency of delays in the fist group was 60 SEK/wagon, on average. The corresponding value for the second group was 40 SEK/wagon, on average.

The value of freight time for a truck was estimated at 20 SEK/hour and shipment. As for rail, two values of delay times were also estimated for truck transport, defined in the same way as for rail. 1 percentage unit improvement in delay frequency is valued at 150 SEK for those who incur penalty already the same day. For those who incur penalty if arrival is the day after the agreed day, the value of 1 percentage unit improvement is 30 SEK.

Specific issues:

The estimated models are not formulated in terms of differences between the generalised costs for shipments, but in terms of percentage changes for each one of the explanatory variables. The interpretation of the calculated unit prices are unclear; the prices are also not constant with respect to the level of the explanatory variables.

Also, all values apply to a wagon in the case of rail and a truck in the case of road transport.

Title: Transek (1992): *Godskunders transportmedelsval,* VV 1992:25, oktober.

Approach: Discrete choice experiment; conjoint analysis, choice between abstract road transport alternatives

Type of data and year collected: SP data collected through face to face interviews, 1991, Sweden.

Who makes the decisions: Shipper (manager), but also own-account vehicles used

Type of model: Logit models for choice between alternatives

Type of goods: The goods are expected to be representative for all road transports in Sweden by lorry.

Variables used:
(i) door-to-door transport time (expected time)
(ii) cost of transport
(iii) frequency of shipments arriving late either the same day or the following day
(iv) risk of damage, (frequency of damage to shipments)

Estimation method: Maximum likelihood

Main estimation results:

Value of freight time estimated at, on average, 30 SEK/hour per shipment (lorry).

About 25% indicated that penalty would be incurred if arrival on the agreed day was delayed, the rest that penalty would be incurred if arrival was one day after the agreed day. The former category was prepared to pay 280 SEK for one percentage unit reduction in late arrival. The latter 110 SEK for one percentage unit reduction in late arrival.

The value of one per mille unit reduction in risk of damage during transport was valued at 270 SEK per shipment

Specific issues:

The estimated models are not formulated in terms of differences between the generalised costs for shipments, but in terms of percentage changes for each one of the explanatory variables. The interpretation of the calculated unit prices are unclear; the prices are also not constant with respect to the level of the explanatory variables.

Also, all values apply to a shipment (a lorry load). Note that values are higher than in the previous study, which includes data for shippers using rail and road. The present study refers to representative road transport shippers who may therefore not use rail at all.

Title: Kurri, Jari, Ari Sirkiä, and Juha Mikola (2000). Value of Time in Freight Transport, *Transportation Research Record* 1725:26-30

Approach: Discrete choice experiment; conjoint analysis, choice between abstract road transport alternatives and choice between abstract railway alternatives

Type of data and year collected: SP data collected through face to face interviews, 1997 for choice between road transport alternatives and 1998 for choice between rail alternatives, Finland.

Who makes the decisions: shipper (manager)

Type of model: Logit models for choice between alternatives

Type of goods: Selected commodities, not necessarily representative with respect to traffic on Finnish roads and railways

Variables used: Absolute values:
total transport time door-to-door
total cost
average unexpected delay, i.e. the average delay, when a delay would occur

Estimation method: Maximum likelihood

Main estimation results:

The average value of freight time for road transport: $ 1.53 per ton and hour
The average value of freight time for rail transport: $ 0.1 per ton and hour
The average value of delay for road transport: $47.47 per ton and hour
The average value of delay for rail transport: $0.50 per ton and hour

Note that *delay* has been determined by multiplying unexpected delay with the probability of a delay.

Specific issues:

The interpretation of the delay variable is not clear.

Title: Fridstrøm, Lasse och Anne Madslien (1995): *Engrosbedrifters valg av transportøsning*, TØI rapport 299/1995, Oslo.

Approach: Discrete choice experiment; conjoint analysis, choice between truck alternatives. Three sets of choices. Choice between abstract own-account alternatives, choice between abstract for hire alternatives and a choice between abstract own-account and for hire alternatives.

Type of data and year collected: SP data collected through face to face interviews, 1992, Norway.

Who makes the decisions: Shippers in wholesale companies (outbound shipments)

Type of model: Logit models, two alternatives

Type of goods: Models for different types of goods handled by wholesale firms

Variables used:
- cost
- transport time
- frequency of shipments arriving late
- frequency of shipments being damaged

Estimation method: Maximum likelihood

Main estimation results:

Cannot be translated into 'unit values' since non-linear function used. Values of freight time derived vary between about 0 to 75 NOK per shipment and hour.

Specific issues:

Non-linear models. Cannot be used to derive 'unit values'.

Title: Hodkins, K.E. and D.N.M. Starkie (1978): Values of Time in Long-distance Freight Transport, *The Logistics and Transportation Review,* 14(2):117-26

Approach: Estimation of mode choice model based on observed data. Discrete choice between road transport and transport by sea.

Type of data and year collected: RP data from 1970s (?), Australia.

Who makes the decisions: Unclear (either shipper or consignee)

Type of model: Logit model?

Type of goods: Long-distance transport for many types of commodities. Types not indicated and separated between.

Variables used: price
transport time

Estimation method: Max. likelihood?

Main estimation results:

The value of freight time is AUS$ 10 per ton and day

Specific issues: ?

Title: Kawamura, Kazuya (2000): Perceived Value of Time for Truck Operators, *Transportation Research Record,* 1725:31-36.

Approach: Discrete choice experiment; contingent analysis? Choice between toll road (different toll levels and time savings) and a toll-free road

Type of data and year collected: Stated preference data, obtained through face-to-face interviews, California, 1998-99.

Who makes the decisions: Managers in trucking companies

Type of model: Two models

1. Estimation with least square method of the parameters of log-normally distributed function using observation on switching points, i.e. observations of when the decision maker is indifferent between the two alternatives

2. Logit models, but assuming that the 'parameters' are log-normally distributed.

Type of goods: Focus on different types of transport operators, not on the goods carried.

Variables used: transport time
tolls (unclear if other costs)

Estimation method:

1. Least squares
2. maximum likelihood

Main estimation results:

1. US$ 26.8 per hour, average
2. US $ 23.4 per hour, average

Specific issues:

These values of time probably reflect not the value of goods but the operating costs of the transport operators (wages, VOCs)

Title: Wigan, Marcus, Nigel Rockliffe, Thorolf Thoresen and Dimitris Tsolakis (2000): Valuing Long-Haul and Metropolitan Travel Time and Reliability, *Journal of Transportation and Statistics,* December:83-89.

Approach: Discrete choice experiment; conjoint analysis, choice between abstract road transport alternatives.

Type of data and year collected: Stated preference data obtained through face-to-face interview, 1998. Three types of truck operations are analysed

Who makes the decisions: The shipper (manager)

Type of model: Logit model

Type of goods: Not in focus. The aim is to analyse three different segments of the road transport market

Variables used:
- door-to-door transport time
- cost
- reliability (per cent shipments arriving late)
- damage (per cent shipments being damaged and not accepted)

Estimation method: Maximum likelihood of linear cost functions

Main estimation results: (1998 AUS$)

Segment	Freight time pallet/hour	Reliability per 1% reduction	Damage per 1% reduction
Intercapital (FTL)	0.66	2.56	49.70
Urban (FTL)	1.30	1.25	18.29
Metropolitan multidrop	1.40	1.97	27.06

FTL: Full truck load

Specific issues:

It is unclear how to interpret reliability and damage, and if these refer to the unit of shipment studied, viz. a 'pallet'. Also '1% reduction' in table above should probably be read to say 'one percentage unit reduction'.

Title: Wynter, Laura (1995): Stated Preference Survey for Calculating Values of Time of Road Freight Transport in France, *Transportation Research Record,* 1477:1-6.

Approach: Discrete choice experiment; contingent analysis? Choice between toll road (different toll levels and time savings) and a toll-free road

Type of data and year collected: Stated preference data, obtained through telephone interviews, France, date not given but likely during first half of the 1990s.

Who makes the decisions: Managers in trucking companies

Type of model: Estimation of the parameters of log-normally distributed function using observation on switching points, i.e. observations of when the decision maker is indifferent between the two alternatives

Type of goods: Goods transported over longer distances in France

Variables used: vehicle operating costs (excluding wage costs?)
transport times
tolls on motorways

Estimation method: Unclear, presumably max. likelihood estimation of the parameters of the long-normal function.

Main estimation results:

Average freight VOT was estimated at about FF 7 per minute.

Specific issues:

The above VOT estimate probably reflects the cost of the driver per time unit, and not the value of the goods.

Title: de Jong, Gerard, Carine Vellay, and Michel Houée (2001): *A Joint SP/RP Model of Freight Shipments from the Region Nord-Pas de Calais,* Paper presented at the European Transport Conference.

Approach: Two sets of data: one based on discrete choice experiment; conjoint analysis, choice between abstract road transport alternatives and choice between various other abstract mode alternatives. The other combines the first set of data with revealed preference data.

Type of data and year collected: Stated preference data collected through face-to-face interviews in 2000. Revealed preference data through a shippers' survey in 1999, combined with synthesised data for the non-chosen alternative and for missing data for the chosen alternative.

Who makes the decisions: Shippers (managers)

Type of model: Logit models

Type of goods: Not in focus; the mode of transport and certain attributes of different modes are considered.

Variables used:
- transport cost
- transport time
- probability of delay (for shipments with agreed arrival time)
- frequency of shipments to the same client
- dummy variables to reflect specific goods or access to rail, etc.

Estimation method: Maximum likelihood

Main estimation results:

A number of values of freight time are estimated which are summarised as:

Mode	Per shipment FF/hour	Per ton FF/hour
Road; hire and reward	29.0-60.0	5.0-10.9
Rail	17.0-73.0	1.7-7.3
Combined transport	34.0-53.0	1.8-2.8

Other values not reported.

Specific issues:

The only freight values of time presented above are from linear models. Some values are from SP data some are from combined SP and RP data. Values for other attributes are not presented in the source document.

Title: Fosgerau, M.(1996): *Freight traffic on Storebælt fixed link,* Paper presented at the 24th European Transport Forum.

Approach: Discrete choice experiment; conjoint analysis, choice between road transport alternatives involving two alternative ferry crossings across Storebælt as well as the choice between ferry and a fixed connection across Storebælt.

Type of data and year collected: Stated preference data with regard to shipments actually transported across Storebælt, collected in 1988/89. Probably face-to-face interviews, but this is not stated.

Who makes the decisions: Managers in transport companies.

Type of model: Logit model

Type of goods: No distinction made. Distinction made between type of truck used.

Variables used:
- transport time
- transport distance (km)
- headway (ferries)
- official fare of ferry or fixed connection
- dummy variables for discounts and fixed connection

Estimation method: Maximum likelihood

Main estimation results: Values of freight time per truck: DDK/min

Solo truck 6.0
Road train 3.2
Articulated vehicles 2.7

Specific issues:

It is possible that the estimated values of time reflect the cost of the driver; they may also reflect VOCs. Note there is no separate variable for the cost of transport, but the distance variable may be seen as a proxy of in the first instance the VOC.

Title: Winston, C. (1981): A disaggregate model of the demand for intercity freight, *Econometrica,* 49: 981-1006, 1981

Approach: Mode-choice model based on disaggregate revealed preference data

Type of data and year collected: Data are from various sources for the period 1975-77. Data on costs and transport times, etc. have been obtained from external sources and not from the respondent.

Who makes the decisions: 13 different commodities are considered. For some the shipper makes the decision, for some the receiver. This is explicitly accounted for in the models.

Type of model: Multinomial probit

Type of goods: 13 groups of commodities.

Variables used: Shipment size (lbs.)

commodity value ($/lbs)
freight charges
mean transport time
standard deviation transit time
reliability (coefficient of variation)
miles from rail siding

Estimation method: Weighted exogenous sample maximum likelihood

Main estimation results:

Yields values of freight time; values vary between $ 125-1187 per day and shipment by road. One significant value for rail: $490 per shipment and day.

Also yields values w.r.t. reliability measured in two ways, viz. by way of the standard deviation of transit time and its coefficient of variation (standard deviation divided by the mean).

Values for the standard deviation vary between $ 299 and $ 4110 per day and shipment for rail. The only significant value obtained for road transport is $ 404 per day and shipment

Specific issues:

It is unclear how the estimated values should be interpreted against the background of that the model also includes parameter estimates w.r.t. shipment size and commodity value

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Title: de Jong, G. C., M.A. Gommers, and J.P.G.N. Klooster (1992): *Time valuation in freight transport: Methods and results,* Paper presented at the XXth Summer Annual Meeting, PTRC, Manchester.

Approach: Discrete choice experiment; conjoint analysis, choice between abstract road transport, rail and inland waterways transport alternatives.

Type of data and year collected: SP data collected through face to face interviews, 1991-92, Holland.

Who makes the decisions: Shippers (managers) and transport operators

Type of model: Logit models

Type of goods: For road transport, four different categories, for rail and inland waterways no differentiation. The goods should be representative with respect to transports in Holland.

Variables used: transport costs (rates)
transport time door-to-door

transport time reliability (measured as percent not on time)
probability of damage
frequency of shipment

Estimation method: Maximum likelihood

Main estimation results: Value of freight time in US$ per shipment and per hour in 1997 prices

Road: varies between 32 and 42
Rail: 32 (for a wagonload) (GBP 0.5/tonne and hour; 1995 prices)
Inland waterways: 222 (GBP 0.12/tonne and hour; 1995 prices)

Values related to other variables are not reported in the source document.

Specific issues:

The estimated models are not formulated in terms of differences between the generalised costs for shipments, but in terms of percentage changes for each variable. The interpretation of the calculated unit prices are unclear; the prices are also not constant with respect to the level of the explanatory variables.

Separate models were estimated for transport operators resulting in higher freight values of time, suggesting that VOC and wages are mixed into the freight values of time.

Title: Fowkes, A.S., P.E. Firmin, A.E. Whiteling and G. Tweedle (2001): *Freight Road User Valuations of Three Different Aspects of Delay,* paper presented and the European Transport Forum.

Approach: Choice experiment; conjoint analysis, choice between abstract road transport alternatives

Type of data and year collected: Stated preference data collected with the LASP (Leeds Adaptive Stated Preference) survey methodology. Data collected in November 2000 and March 2001, through face-to-face interviews.

Who makes the decisions: Transport managers in firms with own-account vehicles
Transport managers in transport firms
Transport managers representing shippers

Type of model: Logit model

Type of goods: Many different types of goods carried by truck over longer distances in the UK

Variables used: cost
transport time (minimum amount of time for door to door)

spread (additional time over minimum time required for 98% of deliveries
schedule delay (delayed departure in relation to planned or optimal departure time)

Estimation method: Maximum likelihood (?). Separate model for each interviewee.

Main estimation results: (pence per minute and shipment; end 2000 prices)

	time	spread	schedule delay
Own account	169.3	89.5	126.0
Transport operator	155.1	167.6	86.8
Shipper	37.2	61.5	31.3

Specific issues:

Note the much lower values for shippers, suggesting that the other respondents mix in operating costs in their time valuation

It appears that a non-linear generalised cost functions have been utilised. This is unclear.

Title: Fowkes, A.S., C.A. Nash and G. Tweedle (1991): Investigating the market for inter-modal freight technologies, *Transportation Research, A,* 25(4):161-172.

Approach: Choice experiment; conjoint analysis, choice between abstract road transport alternatives and also combined transport

Type of data and year collected: Stated preference data collected with the LASP (Leeds Adaptive Stated Preference) survey methodology. Data collected in 1988/89, through fact-to-face interviews.

Who makes the decisions: Shipper

Type of model: Logit model

Type of goods: Goods transported over longer distances in the UK

Variables used:
Cost per tonne
transport time
% on time
inter-modal dummy

Estimation method: Least-squares

Main estimation results:

Value of freight time US$ 0.09-1.29 per ton and hour (1999 prices) quoted from de Jong (2000)

Specific issues:

It is unclear how de Jong has obtained his estimates from the original study, which does present any freight VOT results.

Title:

1. de Jong, Gerard (2000): Value of Freight Travel-Time Savings, in Hensher, D.A. and K.J. Button (eds.): *Handbook of Transport Modelling,* Elsevier.

2. de Jong, G.C., Y. van de Vyvere and H. Inwood (1995): *The value of freight transport: A cross-country comparison of outcomes.* World Conference on Transport Research, Sydney.

Approach: Discrete choice experiment; conjoint analysis, choice between abstract road transport alternatives and choice between tolled and untolled road

Type of data and year collected: Stated preference data obtained through face-to-face interviews in 1994/95 in the UK

Who makes the decisions: Own-account operators
Transport operators

Type of model: Logit model

Type of goods: All kinds of goods carried by road. Distinction made between heavy and light goods vehicles as well as hire and reward and own-account operators

Variables used:
- transport time
- total transport cost
- information about delays
- chance of unexpected delay of 30 minutes or more

Estimation method: Maximum likelihood

Main estimation results: Freight values of time in 1999 US$ per hour and shipment

Segment	Abstract alternatives	Route choice
LGV; hire and reward	45	21
LGV; own account	36	21
HGV; hire and reward	48	21
HGV; own account	36	34

Values related to other variables are not reported on in the source document.

Specific issues:

Note absolute values on variables. This study may suggest that the abstract models normally used tend to inflate values of time. Also note that choices are not made by shippers or receivers but by transport operators

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Title: Viera, L.F.M. (1992): *The value of service in freight transportation,* Ph.D. dissertation, MIT, Cambridge, MA.

Approach: Choice experiment; conjoint analysis

Type of data and year collected: Combination of SP and RP data, USA, date unknown

Who makes the decisions: Unclear but probably shipper

Type of model: Logit model in terms of logistic costs

Type of goods: Unclear

Variables used: Unclear

Estimation method: Unclear

Main estimation results:

US$ 0.59 per tonne and hour for rail in 1999 prices (reported in de Jong (2000)). (Implied discount rate 240% per year)

Specific issues:

Title: Roberts, P.P. (1981): *The translog shipper cost model.* Cambridge, MA: Center for Transportation Studies, MIT.

Approach: Disaggregate model

Type of data and year collected: USA, revealed preference, year unclear.

Who makes the decisions: Shipper, logistics manager

Type of model: Logit model? with logistics costs

Type of goods: Unclear

Variables used: Unclear

Estimation method: Unclear

Main estimation results:

Value of time in inland waterways in 1999 US$ per ton and hour is > 0.05 (data reported in de Jong (2000))

Specific issues:

Title: Blauwens, G. and E. van de Voorde (1988): The valuation of time savings in commodity transport, *International Journal of Transport Economics,* 15:77-87

Approach: Mode choice model based on revealed preference

Type of data and year collected: Aggregate data on choice between road and inland waterways in Belgium

Who makes the decisions: Unclear but either shipper or receiver

Type of model: Logit

Type of goods: Unclear

Variables used: Unclear

Estimation method:

Main estimation results: Value of freight time in inland waterways in 1999 US$ per ton and hour is 0.10 (data reported in de Jong (2000))

Specific issues:

Title: Fehmarn Belt Traffic Consortium (1999): *Fehmarn Belt traffic demand study,* Danish and German Ministries of Transport, FTC, Copenhagen, Final Report, 1999.

Approach: Discrete choice, conjoint analysis, choice between ferry alternatives for road transport

Type of data and year collected: Stated preference data obtained through interviews (face-to-face?) relevant to traffic between Denmark and Germany. Date unclear, but from late 1990s.

Who makes the decisions: Unclear, but probably road transport operators

Type of model: Logit

Type of goods: All goods by truck.

Variables used: Unclear

Estimation method: Unclear

Main estimation results:

Value of freight time per hour and shipment in 1999 US$ 21.

Specific issues:

Title: de Jong, G.C., Y. van de Vyvere and H. Inwood (1995): *The value of freight transport: A cross-country comparison of outcomes.* World Conference on Transport Research, Sydney.

Approach: Discrete choice experiment; conjoint analysis, choice between abstract road transport alternatives

Type of data and year collected: Stated preference data obtained through face-to-face interviews in 1995 in the Netherlands, Germany and UK

Who makes the decisions: Shippers

Type of model: Logit model

Type of goods: All kinds of goods carried by road.

Variables used:
- transport time
- total transport cost
- reliability (% not delivered on time)
- probability of damage
- flexibility

Estimation method: Maximum likelihood

Main estimation results: Freight values of time in 1999 US$ per hour and shipment

Germany: 33 The Netherlands: 40-43 France: 34

Specific issues:

Variables measured in percentage terms and not in absolute terms.

Title: Bergkvist, E and L. Westin (2000): *Regional Valuation of Infrastructure and Transport Attributes in Swedish Road Freight,* Umeå Economic Studies No. 546, Umeå.

and

Bergkvist, E. (2000): *Estimating values of time and forecasting transport choices in road freight with a non-linear profit specification. The logit versus neural networks.* Umeå Economic Studies, No. 540, Umeå.

Approach: Discrete choice experiment; conjoint analysis, choice between abstract road transport alternatives

Type of data and year collected: SP data collected through face to face interviews, 1991, Sweden. The same data as used in Transek (1992)

Who makes the decisions: Shipper (manager), but also own-account vehicles are used.

Type of model: Logit (and other) models for choice between alternatives

Type of goods: The goods are expected to be representative for all road transports in Sweden by lorry.

Variables used:

(i) door-to-door transport time (expected time)
(ii) cost of transport
(iii) frequency of shipments arriving late either the same day or the following day
(iv) risk of damage, (frequency of damage to shipments)

Estimation method: Weighted exogenous maximum likelihood

Main estimation results:

Value of freight time estimated at, on average, 14 SEK/hour per shipment (lorry) (to be compared with 30 SEK/hour in original model). The main reason for this may be that absolute variables were used (and not percentage), but possibly also that a WESML estimator was used. Additional values of time estimated for short and long distance transports in the Northern part and the Southern parts of Sweden

About 25% of interviewees indicated that penalty would be incurred if delayed arrival on agreed day, the rest that penalty if arrival one day after agreed day. The former category was prepared to pay 178 SEK for one percentage unit reduction in late arrival. The latter 90 SEK for one percentage unit reduction in late arrival.

The value of one per mille unit reduction in risk of damage during transport valued at 20 SEK per shipment

Specific issues: It is unclear if the data set used in this study is different from the original one.

Additional results obtained with non-linear specifications as well as by using neural networks are not considered here.

Title: Bergkvist, Erik (2001): *Freight Transportation; Valuation of Time and Forecasting of Flows,* Umeå Economic Studies, No. 549, Umeå

Approach: Discrete choice experiment; conjoint analysis, choice between abstract road transport alternatives

Type of data and year collected: SP data collected through face to face interviews, 1991, Sweden. The same data as used in Transek (1992). However, a number of observations have been eliminated to yield the data set used in this particular study, which makes a distinction between on the one hand for hire and own-account operations, and on the other between short and long distance operations

Who makes the decisions: Shipper (manager), but also own-account vehicles are used.

Type of model: Logit models for choice between alternatives

Type of goods: The goods are expected to be representative for all road transports in Sweden by lorry.

Variables used:
(i) door-to-door transport time (expected time)
(ii) cost of transport
(iii) frequency of shipments arriving late either the same day or the following day
(iv) risk of damage, (frequency of damage to shipments)

Estimation method: Weighted exogenous maximum likelihood

Main estimation results: Value of freight time estimated at, on average, 37 SEK/hour per shipment in 1996 prices. When divided into own-account and for hire operations, the estimates obtained for the value of freight time become respectively 241 SEK/hour and 34 SEK/hour.

Specific issues: Whilst there may be other explanations (e.g. the value of the goods), the results of this study may suggest that costs of transport cloud the estimates. An own-account operator may thus associate time increases with increases also in the cost of operations of the own-account fleet.

Title: INREGIA (2001): *Tidsvärden och transportkvalitet - INREGIA:s studie av tidsvärden och transportkvalitet för godstransporter 1999,* Underlagsrapport till SAMPLAN 2001:1, februari.

Approach: Discrete choice experiment; conjoint analysis, choice between abstract (i) road transport alternatives; (ii) railway alternatives; (iii) shipping alternatives; (iv) air transport alternatives; and (v) road and rail transport alternatives.

Type of data and year collected: SP data collected by phone interviews, 1999, Sweden.

Who makes the decisions: Transport manager in manufacturing companies with and without their own road haulage vehicles

Type of model: Logit

Type of goods: Six different goods defines in terms of bulk/general, density and value per kg.

Variables used:
- transport time
- transport cost
- per mille delayed
- per mille damaged
- dummy variable to differentiate values of time in terms of type of good and delivery time requirements

Estimation method: Maximum likelihood

Main estimation results: Two different models estimated; only results from model 1 are reported on here as model two is not in terms of linear generalised cost functions.

All freight values of time in SEK per hour and shipment, 1999 price level

Road Transport: 0-337
Rail Transport: 0
Ship: -
Air Transport: 117

Risk of delay in SEK per mille unit change, 1999 price level

Road transport: 63
Rail transport: 1142
Air transport: 264

Risk of damage in SEK per mille change; 1999 price level

Road transport: -
Rail transport: 2294
Ship: -
Air transport: 1175-4225

Specific issues:

Title: Small, Kenneth, Robert Noland, Xuehao Chu and David Lewis (1999): *Valuation of Travel-Time Savings and Predictability in Congested Conditions for Highway User-Cost Estimation,* Report 431, National Cooperative Highway Research Program, Washington, D.C.

Approach: Discrete choice experiment; conjoint analysis, choice between abstract road transport alternatives

Type of data and year collected: Stated preference data collected through telephone interviews, California, around 1995

Who makes the decisions: Transport operators

Type of model: Logit model

Type of goods: Four different types of goods, reflecting four different classes with respect to time sensitivity

Variables used:

transport time
cost
and four different measurements of reliability, based on transport time having a log-normal distribution, viz.
(i) coefficient of variation
(ii) standard deviation
(iii) probability of being late
(iv) probability of being late, schedule delay early and schedule delay late

Estimation method: Maximum likelihood

Main estimation results:

Values of freight time vary between US$ 144 - 193 per hour and shipment. Reducing one hour of schedule delay is valued at US$ 373

Specific issues: Most ambitious study yet to try to model reliability. However, most parameter estimates related to reliability were either insignificant or had the wrong sign. Two explanations: a small sample and respondents had problems in understanding the alternatives and questions related to reliability.