

An empirical on-the-job search model with preferences for relative earnings: How high is the value of commuting time?

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Abstract

The purpose of this paper is to estimate the average value of commuting time (VoCT) in an empirical on-the-job search model. A large Swedish sample of employee-establishment linked data obtained from administrative registers is used to this end. The sample contains detailed information on the individuals' place of residence and place of work and it is combined with information on travel times and travel distances in the road network. We use two empirical models of the individuals' utility function: a basic model and an augmented model. The latter introduces a set of variables intended to capture the effect of interpersonal comparisons of earnings and commuting times in the individual's utility function and on the estimated VoCT. The basic model suggests the average VoCT to be as high as 232 Swedish kronor (SEK) per hour, which is about two and half times higher than the net hourly wage rate in the sample. If we discard the effect of interpersonal comparisons of earnings and commuting time on job switching, the augmented model instead suggests a value of time of 94 SEK, which is more or less equal to the net hourly wage rate in the sample.

Key words: Value of commuting time, Revealed preferences, Relative earnings

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1 Introduction

One of the most important components in cost-benefit analyses of investments in the transport infrastructure is individuals' willingness to pay for reductions in travel time.¹ Nevertheless, it is hard to establish any secular reductions in the population's average commuting times, which is a significant part of total travel time. One possible explanation for the small decrease in commuting time is that individuals use improved commuting possibilities within and between regions to get a better job, e.g. change to a job that is located further away but has a better wage. Hence, reductions in commuting times between different nodes in a transportation network may induce people to commute over larger geographical areas. Such changes in the time restrictions facing an individual may, thus, increase the geographical size of the individual's local labour market.

The previous line of argument is based on the idea that the individual considers short commuting time as a desirable job attribute like a high wage or a good working environment; the shorter the commuting time and the higher the wage the better is the job. In general, if the individual is prepared to exchange longer commuting time (or distance) for a higher wage, the theory of compensating wage differentials² suggests that we can obtain estimates of the individuals valuation of commuting time (or distance). The argument also hinges on the theory of on-the-job search, i.e. the presumption that employed individuals search for new and better jobs in the labour market. Gronberg and Reed (1994) suggest that when the labour market is characterized by search, compensating wage differentials may be obtained from an empirical search model. In a pioneering application, Van Ommeren et al. (2000) demonstrate

¹ Hensher and Brewer (2001) p. 85 note that travel time savings usually amount to more than 70 percent of the total user benefits in many transport investments.

² Also known as equalizing differences. See Rosen (1986) for a comprehensive overview of the theory.

the usefulness of an empirical on-the-job search model to obtain estimates of the value of commuting time. They estimate a job duration model on Dutch data using commuting distances and hourly wages. Combining the estimated model with external information on the relationship between commuting distances and commuting times they arrive at an estimated marginal willingness to pay for commuting time savings amounting to around two-thirds of the hourly net wage rate.

The purpose of this paper is to estimate the average value of commuting time (VoCT) in Sweden in an empirical search model. To this end, we use a large Swedish sample of employee-establishment linked data obtained from administrative registers that contain detailed geographical information on household and establishment locations. This sample is combined with information on travel times and travel distances in the road network obtained from the Swedish National Road Administration. The paper replicates the work by Van Ommeren et al. (2000) on a substantially larger sample with more detailed information on commuting times and commuting costs.

We also extend their analyses by considering an augmented model with preferences defined over other individuals' earnings and commuting times. These variables are intended to capture interpersonal comparisons for earnings and commuting time that might be relevant for the choice of switching establishment (workplace). A number of empirical studies have documented preferences for relative standing suggesting that individuals' subjective well-being or happiness is affected by interpersonal comparisons of income. For example, Clark and Oswald (1996) report that workers in the UK are less satisfied when their reference or comparison wage increases. Solnick and Hemenway (1998) provide another example and report that some 50 percent of the individuals in their sample prefer a world where they have half the real purchasing power as long as they have high relative income. A more recent investigation is provided by

Ferrer-i-Carbonell (2005) who uses German data on self-reported satisfaction with life and finds, *inter alia*, the income of the reference group to be almost as important for individual happiness as the own income. In addition, Akerlof et al. (1988) argue that job satisfaction is negatively related to job switching. Thus, it seems reasonable to investigate whether relative earnings³ are important in our model. Since most empirical work on preferences defined over relative earnings is based on measures of individuals' subjective well being and our model is based on observable actions (revealed preferences), we also believe that the results from our augmented model are relevant to the literature on relative earnings.⁴ Since commuting behaviour also might be related to the norms of other individuals, we also include variables for the individual's comparison commuting time.

Furthermore, this type of model suggests a distinction between own earnings as a means for raising absolute levels of consumption and relative levels of consumption. If we are interested in the latter, which is conventionally the case when evaluating investments in the transport infrastructure by a cost-benefit analysis, it may be useful to discard the effects of interpersonal comparisons on utility when estimating the VoCT. We therefore report two separate estimates of the VoCT from the augmented model: one that discards the effects of interpersonal comparisons of earnings and commuting times and one that includes them. We shall refer to the former as 'comparison free' and the latter as 'comparison dependent'.

A related issue in valuation studies is the large number of studies reporting differences between an individual's willingness-to-pay (WTP) and the cor-

³ We use the term 'relative earnings' but the literature in this field also speaks of 'relative utility', 'comparison income', 'relative income' or 'relative standing'.

⁴ The investigation by Neumark and Postlewaite (1998) is one example of the relatively few studies of relative income concerns that use action based or revealed preference data. See also the paper by Charness and Grosskopf (2001) which uses action based experimental laboratory data to investigate the relationship between relative payoffs and happiness.

responding willingness-to-accept (WTA).⁵ Such differences may result from reference points in the utility function but could also result from large income and substitution effects (Tversky and Kahneman, 1991; Randall and Stoll, 1980 and Hanemann, 1991). In the context of the value of travel time, Hultkrantz and Mortazavi (2001) find that the willingness to pay (WTP) for a specific travel time saving is significantly lower than the willingness to accept (WTA) a corresponding travel time delay. The difference appears to be of a factor two in their model. Furthermore, De Borger and Fosgerau (2007) develop a reference-dependent model for estimating the value of travel time and report a gap between WTA and WTP for travel time changes of a factor four. They also suggest that we consider the ‘reference free’ value of time as the marginal rate of substitution between time and money evaluated at the reference point (the status quo in their case) for a reference free utility function. Our ‘comparison free’ VoCT parallels this idea of a ‘reference free’ value of time. Nevertheless, our way of modelling the effect of the comparison levels for earnings and commuting times may best be described as introducing a ‘comparison’ utility function rather than introducing a discontinuity of the utility function around a reference point. In this respect we follow the empirical literature on the effect of relative standing on subjective well-being rather than the literature on reference-dependent preferences (see e.g. Tversky and Kahneman, 1991; Munro and Sugden, 2003; Köszegi and Rabin, 2006 and De Borger and Fosgerau, 2007).

The paper is organized as follows. Section 2 presents the theoretical framework and section 3 presents the empirical models. The data are presented in section 4 and the results in section 5. Finally, section 6 concludes the paper.

⁵ See Horowitz and McConell (2002) for a survey of WTA/WTP studies.

2 Theoretical framework

2.1 Basic model

Our empirical models of the VoCT are based on the framework suggested by DeSerpa (1971). In the present application this amounts to defining an individual's utility over consumption of goods (G), leisure (L) and commuting time (T). The model also includes a minimum time constraint related to T . Thus, the individual is assumed to maximize the following utility function

$$U = u(G, L, T), \quad \text{s.t.} \quad (1)$$

$$G = wH + i - C, \quad (\text{R1})$$

$$\tau = H + L + T \quad \text{and} \quad (\text{R2})$$

$$T \geq T^{\min}, \quad (\text{R3})$$

where w denotes the after tax hourly wage rate, H denotes hours of work, i is unearned income, C is the monetary cost of commuting, τ is the total amount of time to be divided among hours of work, commuting time and leisure and T^{\min} denotes the minimum required time of that variable. Hence, if R3 is binding, the marginal utility of commuting time (T) may well differ from the marginal utility of time (τ). If this constraint is not binding and the hours of work are chosen so as to maximize utility, the value of commuting time is simply equal to the net wage rate.⁶ In the present application it may well be the case that this kind of technical restriction is less important than in a mode choice context.

However, assume that the constraint pertaining to T is indeed binding so that $T = T^{\min}$ and let H^* denote the optimal hours of work and define the following

⁶ This is the conclusion from the standard goods-leisure model.

indirect utility function

$$V = u(W + i, \tau - H^* - T^{\min}, T^{\min}), \quad (2)$$

where W now denotes the net daily wage after subtracting commuting costs. The following partial derivatives may be obtained from (2)

$$\frac{\partial V}{\partial W} = \lambda_1, \quad \frac{\partial V}{\partial \tau} = \lambda_2, \quad \frac{\partial V}{\partial T} = \lambda_3 - \lambda_2,$$

where λ_1 is the marginal utility of money which is equivalent to the marginal utility of consumption in this model (this is the Lagrangian multiplier associated with the budget constraint, R1), λ_2 is the marginal utility of time (the Lagrangian multiplier associated with the time constraint, R2), and $(\lambda_3 - \lambda_2)$ is the marginal (dis)utility of commuting time (the difference between the Lagrangian multipliers associated with the two constraints, R2 and R3). Thus, the value of time (VoT) is obtained from the ratio λ_2/λ_1 and it may well differ from the value of commuting time (VoCT) which is obtained from the ratio $(\lambda_3 - \lambda_2)/\lambda_1$.

What level of the average VoCT is reasonable? Small (1992) provides a survey of the literature based on estimates obtained in a mode choice context and concludes that a reasonable estimate of the average VoCT is around 50 percent of the gross hourly wage rate. But he also notes that the average value varies between different cities and is within a range of 20 and 100 percent of the gross hourly wage rate. The value of time used in infrastructure investment analysis in Sweden today is about 45 Swedish kronor (SEK) per hour for short and private trips, which include commuting trips. This can be compared to an average gross hourly wage rate of about 140 SEK for workers included in

the estimation sample used in this paper.⁷

There are examples of studies reporting both high and low estimates of the average value of travel time. Calfee and Winston (1998) report relatively low estimates for the average value of congested time in a US sample based on stated preferences. Their estimates range between 3.17 to 5.47 US dollars per hour which is in the range 14 to 26 percent of the gross hourly wage rate. Brownstone and Small (2005) report substantially higher estimates that are in the interval 20 to 40 US dollars per hour for commutes by car in a US sample based on revealed preferences.⁸ Vredin Johansson et al. (2006) also report relatively high estimates of the VoCT in a Swedish revealed preference data set. This is also the case in Rouwendal and Meijer (2001) who use a Dutch stated preference data set. Vredin Johansson et al. report two estimates of 224 and 175 SEK, and Rouwendal and Meijer find that a commuter is willing to pay about 45 Dutch guilders, which is about 190 SEK, to avoid one hour of commuting.

A different way to assess a plausible magnitude of the average VoCT is to look at how individuals perceive time spent commuting in relation to time spent at work. Kahneman and Krueger (2006) discuss different ways of measuring subjective well-being. They report, *inter alia*, the mean ‘net affect’, or mood, in different activities. Their results indicate that net affect is lowest during morning commutes and that it is somewhat higher at work. The net affect during the evening commute is, however, somewhat higher than net affect during work. But all these three activities appear ‘close’ to each other in terms of net affect. Hence, if the individual would require a monetary compensation for the displeasure of commuting, it might seem reasonable that the compensation per unit of time would be close to the compensation per unit

⁷ See section 4 for presentation of the sample.

⁸ The exchange rate between US dollars and SEK in recent years has been in the interval 6 to 7 SEK for one US dollar.

of time at work. In other words, a reasonable conjecture about the value of commuting one hour might come close to the net hourly wage rate.

2.2 *Augmented model*

To extend the basic model, we assume the individual's utility to be affected by his co-workers' earnings and consider them as a job attribute just like a good working environment.⁹ Thus, like Clark and Oswald (1996) we include a comparison wage in the individual's indirect utility function. We use the median after tax daily wage net of commuting cost of a comparison group in the individual's establishment. This group is defined by the same sample restrictions that we apply on the sample of individuals used to estimate the models (see below in section 4).¹⁰ The reason for choosing the median wage rather than the mean wage is that some of the comparison groups are rather small and the mean might therefore be more influenced by outliers.¹¹ We denote the comparison wage by m in the following.

Furthermore, preferences defined over commuting time might depend on other individuals' commuting behaviour through the effect of behavioural norms on preference formation. So there may be an effect on an individual's utility and the marginal (dis)utility from commuting time in the comparison group. We therefore also include a comparison level for commuting time in the model.

⁹ The results of Bygren (2004) suggest that the relevant reference income may be at a more aggregate level such as the national labour market. However, here we are specifically interested in treating the reference earnings as a characteristic of the current job to fit the framework of compensating wage differentials. In addition, Frank (1985, chapter 2) provides several motivations for comparisons to be relatively local rather than more global.

¹⁰ Note that this choice of reference earnings resembles the choice made by Clark and Oswald (1996) who use predicted earnings from an individual wage regression. The difference is, thus, that we use a non-parametric approach to obtain the relevant reference point for earnings.

¹¹ We also tested the mean of the reference group's earnings. But this did not change the results substantially.

The comparison group is the same as that used to obtain the comparison wage and we also use the median commuting time of the comparison group. We denote the comparison level of commuting time by n in the following.

Therefore, we add ‘comparison utility’ functions to the model outlined in section 2.1 to allow for such effects of interpersonal comparisons on the individual’s utility. The resulting indirect utility function can consequently be written as

$$V = u(W + i, \tau - H^* - T^{\min}, T^{\min}) + \nu(m, W) + \mu(n, T^{\min}), \quad (3)$$

where $\nu(m, W)$ and $\mu(n, T^{\min})$ denote the parts of the indirect utility function that are related to the comparison of own earnings to reference earnings and the effect of other individuals’ commuting time on own utility, respectively. Note that the first function on the right hand side is the same as in the basic model. In other words, this corresponds to the conventional ‘comparison free’ utility function encountered in microeconomic textbooks. The partial derivatives of the indirect utility function may thus be summarized as

$$\frac{\partial V}{\partial W} = \lambda_1 + \frac{\partial \nu}{\partial W}, \quad \frac{\partial V}{\partial \tau} = \lambda_2, \quad \frac{\partial V}{\partial T} = \lambda_3 - \lambda_2 + \frac{\partial \mu}{\partial T}, \quad \frac{\partial V}{\partial m} = \frac{\partial \nu}{\partial m}, \quad \frac{\partial V}{\partial n} = \frac{\partial \mu}{\partial n}.$$

Thus, in the augmented model the marginal utility of wages also involves a ‘comparison component’ ($\frac{\partial \nu}{\partial W}$) and the marginal (dis)utility of commuting time also depend on the commuting time of others through the ‘comparison component’ ($\frac{\partial \mu}{\partial T}$).

2.3 Search framework

The basic idea of the search framework is that workers continuously search for new jobs and that job offers arrive exogenously from some distribution.¹² Jobs are often characterized in terms of the wage only, so that the relevant distribution is simply a wage offer distribution. However, Gronberg and Reed (1994) suggest an on-the-job search model where jobs are characterized both in terms of wage and non-wage characteristics assumed to affect the utility of the individual.

Denote the vector of wage and non-wage characteristics by \mathbf{x} and assume a quasi-concave utility function $V(\mathbf{x})$. The search model suggested by Gronberg and Reed is then summarized by the following relationship

$$\phi(\mathbf{x}) = \delta + \lambda s^*(V(\mathbf{x}))[1 - F(V(\mathbf{x}))], \quad (4)$$

where $\phi(\mathbf{x})$ is the hazard rate, i.e. the probability of an individual quitting or being laid off from his/her job in time t conditional on the job lasting up until t ; δ is the exogenously determined job separation rate, λ is a market determined search efficiency parameter, $s^*(V(\mathbf{x}))$ is the optimal search effort and $F(V(\mathbf{x}))$ is the cumulative distribution function of jobs faced by a worker. Thus, the last term on the right-hand side of the above equation is simply the product between the probability of receiving a job offer and the probability of accepting the job offer.

From this model it follows that the willingness to pay (WTP) for improving a certain non-wage job characteristic, i , is given by the ratio of the marginal effect of that attribute and the marginal effect of the wage on the indirect

¹² See for example Mortensen (1986) or Devine and Kiefer (1991) for earlier surveys of this literature.

utility function respectively,¹³

$$WTP_i(\mathbf{x}) = \frac{\partial \phi(\mathbf{x})}{\partial \mathbf{x}_i} \bigg/ \frac{\partial \phi(\mathbf{x})}{\partial w} = \frac{\partial V(\mathbf{x})}{\partial \mathbf{x}_i} \bigg/ \frac{\partial V(\mathbf{x})}{\partial w}. \quad (5)$$

Van Ommeren et al. (2000) also investigate the potential limitations of the approach suggested by Gronberg and Reed (1994) through various extensions of a basic on-the-job search model. They find that the basic result in Gronberg and Reed is valid even when several assumptions of the basic model are relaxed. However, they also note that whenever the utility function is nonlinear in the job attributes, it must be assumed that search intensity is exogenously determined for applying the results in Gronberg and Reed. In other words, strong restrictions must be imposed either on the utility function or on search behaviour for using the Gronberg and Reed-approach to estimate compensating wage differentials. Since we use a non-linear utility function we will consequently assume an exogenous search intensity.

3 Empirical framework

In the following, we show how we adapt the general framework of section 2 to an empirical model suitable for our data.

3.1 *The utility function*

Our empirical counterpart of the basic indirect utility function as formulated in section 2.1 is a quadratic specification for the wage and commuting time

¹³In the case of a deterioration of the non-wage job characteristic we can define the corresponding willingness to accept (WTA) as the wage gain required for the individual to be compensated for the utility loss. In a conventional utility model WTP and WTA should be equal if the income effects and the substitution effects are small (see Randall and Stoll, 1980 and Hanemann, 1991).

variables

$$V(W, T) = \alpha_0 + \alpha_1 W + \alpha_2 T + \frac{1}{2} \alpha_3 W^2 + \frac{1}{2} \alpha_4 T^2. \quad (6)$$

The VoCT can thus be obtained as $-(\alpha_2 + \alpha_4 T)/(\alpha_1 + \alpha_3 W)$. Since this model ignores potential reference points, we will refer to the value of time from this model as ‘comparison free’ when discussing the results below.

The parameterization of the augmented model of section 2.2 adds variables for comparison wages and commuting times. In addition, the results presented by McBride (2001) suggest that relative income effects on subjective well-being are smaller at lower income levels. Thus, it may be relevant to consider the effect of relative earnings through an interaction between the reference net daily wage (m) and the individual’s own net daily wage in our model. Hence, we also include interaction terms between the individual’s wage and the comparison wage, and between commuting time and comparison commuting time

$$\begin{aligned} V(W, T, m, n) = & \alpha_0 + \alpha_1 W + \alpha_2 T + \frac{1}{2} \alpha_3 W^2 + \frac{1}{2} \alpha_4 T^2 \\ & + \beta_1 m + \beta_2 (W \times m) + \beta_3 n + \beta_4 (T \times n), \end{aligned} \quad (7)$$

where the last four terms intend to capture the effects on indirect utility from the ‘comparison utilities’. The marginal utility of an increase in the own after tax daily wage net of commuting cost is, thus, $\alpha_1 + \alpha_3 W + \beta_2 m$ and the marginal (dis)utility of an increase in reference earnings is $\beta_1 + \beta_2 W$. The marginal (dis)utility of increasing commuting time is, furthermore, given by $\alpha_2 + \alpha_4 T + \beta_4 n$, where the first two terms are related to the ‘comparison free’ utility function defined over the individual’s commuting and the last term is intended to capture the effect of norms on this marginal utility.

From the augmented model we can obtain two estimates of the VoCT: one discarding the effects related to interpersonal comparisons of commuting time and wages and one including them. The former would correspond to the VoCT derived from the basic model that does not include the arguments related to relative standing. Accordingly, we define a ‘comparison free’ VoCT in the augmented model as the ratio $-(\alpha_2 + \alpha_4 T)/(\alpha_1 + \alpha_3 W)$ and a ‘comparison dependent’ VoCT in the augmented model as the ratio $-(\alpha_2 + \alpha_4 T + \beta_4 n)/(\alpha_1 + \alpha_3 W + \beta_2 m)$.

In the empirical models, we control for individual and geographical heterogeneity. Variables related to observable individual characteristics included in the models are years of schooling, age, marital status, and the number of children of age 0-6 years. We also included a set of dummy variables for the county (län) in which the individual lives to account for unobserved regional differences in labour market outcomes.¹⁴ These dummy variables also control for unobserved regional differences related to the transport infrastructure that may otherwise be correlated with the commuting time of the individual. We also control for differences in the local economic activity by including measures of accessibility to jobs and earnings. We use these variables with the intention to control for local variation in the probabilities of being offered a job and regional differences in the wage offer distribution. The two measures of accessibility are both constructed from the information on travel times and the population of establishments and their location (see section 4 for further details). Here, we have defined the two accessibility measures from the following formula

$$\text{Accessibility}_j = \sum_{k=1}^K e^{-T_{jk}}(X_k), \quad (8)$$

where T_{jk} is the commuting time between areas j and k and X_k is the number

¹⁴ There are 21 distinct counties in the data set used here

of jobs in area k or the average gross annual earnings of workers in area k .

3.2 *The empirical search model*

Gronberg and Reed (1994) and Van Ommeren et al. (2000) both use survival analysis with the logarithm of the job spell as the dependent variable in the empirical model. A specific feature of our sample is that it is obtained from the stock of ongoing job spells. This implies that our observed durations are length-biased; i.e. the probability of including longer spells of employment is larger than the probability of including shorter spells. Flinn (1986) demonstrates how to adjust right-censored length-biased data to estimate the population density of completed spells. If, however, the density is exponential the length-biased data need not be adjusted, since the density of the length-biased data coincides with the density of the completed spells.

More specifically, Lancaster (1990) shows that when employment is in a stationary equilibrium and the duration of completed job spells is exponentially distributed, the expected value of observed ongoing spells will equal the expected value of complete spells (see Lancaster, 1990, sections 5.3 and 8.3). In sum, under these assumptions, we can use the length of ongoing spells to estimate β from the following constant hazard function

$$\phi(\mathbf{x}) = \lambda \exp(\mathbf{x}'\beta), \quad (9)$$

from which we obtain the following relationship between the observed duration t of a job

$$\ln t = \alpha - \mathbf{x}'\beta + \varepsilon, \quad (10)$$

where $\alpha = -\ln\lambda$ and ε has the extreme value distribution (see Kalbfleisch and

Prentice, 2002).¹⁵

In addition, a latent variable formulation of the model above is necessary for our data. The reason is that the true duration of ongoing job spells is unobserved and the data only record the intervals within which a spell started. Thus, we model the probability that the unobserved spell falls into one of J distinct intervals as

$$P(y = j|\mathbf{x}) = \alpha + \mathbf{x}'\boldsymbol{\beta} + u, \quad (11)$$

where $j = 1, 2, \dots, J$ and u conditional on \mathbf{x} is assumed to be logistically distributed with homoscedastic variance. More specifically, in our case:

$$\begin{aligned} y = 1 & \quad \text{if } 0 < t < 5, \\ y = 2 & \quad \text{if } 5 < t < 8, \\ y = 3 & \quad \text{if } 8 < t < 12, \\ y = 4 & \quad \text{if } 12 < t. \end{aligned}$$

Hence, we estimate the empirical model as an ordered logit model.

¹⁵It has recently been shown that the parameters of the covariates in a linear regression model of the complete population lifetime distribution in an accelerated failure time model like (10) may be directly estimated from a linear regression of the length-biased lifetime data on the set of covariates. In other words, the estimated parameters in this setting seem to be invariant under a length-biased sampling scheme (see Chen and Wang, 2005 and Keiding et al., 2005). Since we are primarily interested in the effect of the covariates on the durations rather than recovering the distributions of the completed spells, the assumption of exponentially distributed spells thus appears to be less restrictive than it may seem at first.

4 Data

The data used here are based on administrative records held by Statistics Sweden. We collected information on a sample of individuals and the population of all establishments in Sweden. The sample of individuals was taken from the stock of ongoing employment spells and covers nearly 10 percent of all employed individuals in 1998. The sampling unit was the establishment and the sample was stratified with respect to the size-distribution of establishments, with larger sample-weights on large establishments.

Information on the individuals was collected in four different years: 1998, 1993, 1990 and 1986. In this paper we use the individuals' gross annual earnings, educational attainment, age, sex, civil status (married or not married), number of children between 0 and 6 years of age, information on the location of the place of residence, car ownership (0, 1 and 2 or more cars) and a unique identification number for his/her establishment(s) in 1998, 1993, 1990 and 1986, respectively. The information on the establishments includes, *inter alia*: a unique identification number, total employment in the establishment, the average gross annual earnings and detailed geographic information on location of the establishment.

The duration variable used in the analysis is obtained by linking each individual to his/her establishment in each of the four years. Thus, if the individual was not employed in the same establishment in 1993 as in 1998 we take this to imply that the duration of the current employment spell (the latent variable of section 3.2) was between 0 and 5 years. Furthermore, if the individual was employed in the same establishment in 1998 and 1993 but not in 1990 we assume that the current employment spell lasted between 5 and 8 years. By using the establishment code in 1986 in a similar manner we can also determine the length of the current employment spell to be in the intervals 8-12

years and 12 years or more.

The individual's commuting time and commuting distance have been obtained by combining two sources of data. First, we use the geographical information on the location of the individuals' place of residence and place of work (the establishments' location) to define the origin and destination of each individual's commute. The geographical information is quite detailed and is given in terms of so-called 'SAMS areas' of which there are 9230 distinct units.¹⁶ The information on place of residence and place of work thus allows us to assess each individual's travel time and travel distance in the central government's road network.¹⁷ This is achieved by using a second source of information provided by the Swedish National Road Administration - the government administration of the road network. The information on travel times and travel distances is also longitudinal and pertains to 1998, 1993 and 1990. Since this measure of travel times does not include, say, walking time to the car, we have also calibrated the travel time measure against individually reported information on travel time to the job from the 1991 wave of the Swedish Level of Living Survey (the SLLS, for short). The calibration simply adjusts the travel times in our sample so that the mean of the travel distribution equals the mean in the SLLS (see Erikson and Åberg, 1987 and Fritzell and Lundberg, 1994). The information on travel distance in the road network is used to compute a cost of commuting by private car. Here, we use the tax rules pertaining to commutes by own car to arrive at a commuting cost by car for each individual.¹⁸ In 1998

¹⁶ 'SAMS' is short for 'Small Area Market Statistic' and is defined by Statistics Sweden in collaboration with the Swedish municipalities. The intention of this geographical unit of measurement is to obtain homogeneous neighbourhoods.

¹⁷ Some individuals live and work in the same SAMS area. The commuting time and distance for these individuals are unfortunately equal to zero. But the frequency of such observations is relatively low. It amounts to 9 percent in the sample used to estimate the empirical models. The corresponding figure in Van Ommeren et al. (2000) was 40 percent. We have tested to estimate the empirical model excluding such observations. The effect on the estimated parameters is modest, however.

¹⁸ These rules stipulate that individuals that meet certain criteria may deduct their cost for commuting by car to reduce their taxable income.

this cost was 1.5 SEK per kilometre.¹⁹

Information on the individuals' gross annual earnings was collected from tax records. Since the empirical model is defined in terms of the net daily wage, we assessed net annual earnings, number of weeks worked and weekly hours to arrive at an assessed net hourly wage rate. Thus, the individual's net annual earnings were obtained by using the municipality tax rates pertaining to the relevant year and the corresponding national tax rate. Here we assumed that no individuals deducted their potential car commuting costs from taxable income. To convert net annual earnings to a net daily wage we assumed that each individual had 5 weeks of holiday per year and assessed the average weekly hours of work in 1998, 1993, 1990 and 1986 from information in the Swedish Labour Force Survey. The latter piece of information was obtained separately for males and females and the following age-intervals: 16-19, 20-24, 25-34, 35-44, 45-54, and 55-64 years.²⁰ Since the sampling unit is the establishment and all individuals working in the establishment are included in the sample, we can readily obtain the median net daily wage in each individual's establishment

¹⁹ The correlation is high between commuting time and commuting cost variables although they are not perfectly linearly dependent. The correlation in the sample used for the empirical models is equal to 0.993. Even though this would in principle allow us to identify the effect of commuting cost separately on the durations, trials with such specifications suggested that the estimates related to the two commuting variables were very sensitive to the choice of covariates. Therefore, we decided to constrain the marginal utility of the cost variable to equal that of the net daily wage variable by subtracting the commuting cost from the net daily wage variable in the empirical models.

²⁰ We have also tested other ways of estimating net annual earnings. First, we assumed that all car-owning individuals did deduct their potential car commuting costs to reduce their taxable income. Second, we used the 1991 wave of the Swedish Level of Living Survey to estimate a model between net annual earnings and gross annual earnings and use this model to impute net annual earnings in our sample. However, the empirical results were not specifically sensitive to the way in which we assessed net annual earnings. We also tried another way of assessing the individuals weekly hours of work by using information from the Swedish Level of Living Survey on weekly hours of work and gross annual earnings within each of the twelve different sex-age groups mentioned in the text. But the results were not sensitive to how we assessed hours of work.

from the assessed information on net daily wages. This is also the case for commuting times and costs.

Information on educational attainment was collected from administrative records on completed degrees within the regular educational system. Educational attainment is expressed in terms of the individual's highest attained educational level. In all, there are seven mutually exclusive educational categories. Based on these categories we constructed a years of schooling variable by imputing the average years of schooling estimated on a sample of individuals that contain both information on educational level and information on years of schooling. The 1991 wave of the Swedish Level of Living Survey was used to this end (see Erikson and Åberg, 1987 and Fritzell and Lundberg, 1994).²¹

We employed the following restrictions on the original sample. Only men living in a household with at least one car are included. The reason is that men are more likely to use the car as mode of transportation and that both the commuting cost variable and the commuting time variable are based on commutes by car. We also exclude men who had gross annual earnings below 100 000 SEK or above 1 000 000 SEK in 1998. The motivation is related to hours of work that we do not directly observe in the data. Men who earn less than 100 000 SEK are likely to be working part time or to be weakly attached to the labour market. They could, for example, be students with a part-time job. Men earning above 1 000 000 SEK might be exempted from overtime compensation so their high annual earnings might result from working many hours. The sample is, in addition, restricted to only include individuals aged between

²¹ Since we are effectively imputing information from an estimated model for the years of schooling, the standard errors should be adjusted for this fact. Previous work suggests, however, that these corrections only have a modest effect on the standard errors when the estimated 'imputation-model' is precisely estimated and has a low residual variation (see Isacsson, 2004, who presents an application of such a procedure regarding the years of schooling variable). In addition, we were not primarily interested in the effect of the years of schooling variable on durations. Therefore, we choose not to adjust the standard errors for this fact.

20 and 65 years in 1998. The motivation for the lower age limit is to exclude younger individuals that may still not be truly established on the labour market. The motivation for the upper age limit is that this is the mandatory age of retirement in Sweden. Furthermore, we have excluded individuals that have commuting times above a total of 5 hours per day, since such individuals may have two different places of residence and it may be the case that they do not commute the long distance every work day. We also excluded individuals whose difference between net daily wages and commuting costs were below 100 SEK, since such values also could reflect some kind of distance work. Due to the sample restrictions we also defined the accessibility measures of equation (8) in terms of jobs held by men and average male earnings.

Table 1 presents descriptive statistics of the sample used to estimate the empirical models. The share of individuals with an employment spell between 0 and 5 years is 50 percent. The share with an employment spell between 5 and 8 years is 12 percent. 15 percent have an employment spell between 8 and 12 years and 23 percent have been employed at the same establishment for 12 years or more. The average net daily wage in 1998 is 717 SEK. Note that this value does not exclude commuting costs. The sample's average net hourly wage in 1998 is 88.65 SEK, approximately equal to 10 Euros (this figure is not reported in the table). The average commuting time is 30 minutes and the average commuting cost is 54 SEK, both defined per commuting day. The average of comparison earnings; that is, the median after tax daily wage (net of commuting costs) is 651 SEK and average comparison commuting time is 0.40 hours, i.e. 24 minutes. Furthermore, 'the average individual' is aged 42 years and has 12 years of schooling. The share married is 55 percent and the average number of children aged 0 to 6 years in 1998 is 0.32.

[Insert table 1 about here]

5 Results

The results of the estimated models are presented in table 2. Starting with the basic model we see that the linear wage and commuting time variables have the expected signs and are significantly different from zero at the 1 percent level. A higher after tax daily wage net of commuting cost implies, *ceteris paribus*, a longer job spell, whilst a longer commuting time is related to shorter job durations. The squared wage and commuting time variables are also significant at the 1 percent level of significance and they have the expected signs, namely the opposite of their corresponding linear term.

Furthermore, most of the control variables in the basic model are also significant and have the expected signs. First, older employees tend to have longer durations than younger ones. Second, more educated workers have shorter expected job spells, which is also true for married workers whereas the opposite is true for workers with young children. The accessibility to other (male) jobs has a negative effect on the job spell, so that individuals working in areas with more nearby jobs tend to have shorter employment spells. The accessibility to average (male) earnings affects the job spell in a negative although statistically insignificant way. All county dummy variables were also positive and significantly different from zero with Stockholm acting as the reference category. The latter results are not reported in the table.

[Insert table 2 about here]

Table 2 also presents an estimate of the VoCT evaluated at the means of the wage and commuting time variables in the basic model. The estimate is equal to some 232 SEK per commuting hour and is significantly different from zero at the 1 percent level of significance. Compared to the mean net daily wage of 717 SEK in Table 1 (the average mean net hourly wage is 88.65 SEK but it is

not reported in Table 1), this value seems quite high. However, as noted above there are previous examples of studies reporting relatively high estimates of the VoCT (see e.g. Vredin Johansson et al., 2006 and Rouwendal and Meijer, 2001). Thus, our basic estimate is close to, but still rather high compared with some previous high estimates of the VoCT.

In the second column of Table 2, we see that the four additional variables in the augmented model are all significantly different from zero at the 1 percent level. The linear comparison wage variable and the interaction between the individual's wage and the comparison wage suggest an increase in the latter to have a positive effect at lower levels of the individual's wage, but a negative effect at higher levels. The effect changes sign around an individual wage of 700 SEK. McBride (2001) also finds that the effect of increasing relative earnings is more negative at higher levels. Furthermore, the effect of the linear comparison commuting time and the interaction between own commuting time and comparison commuting time suggest that increases in comparison commuting time are negative at lower levels of commuting but that the effect may be positive at higher commuting times. Note, however, that individual commuting times range between 0 and 5 hours in the present data set. Thus, at the highest level of own commuting time in the sample, the effect of increasing comparison commuting time is close to zero.

Turning to the variables that were also included in the basic model, we see that the effect of the linear wage variable in the augmented model is larger than in the basic model. The opposite holds for the linear commuting time variable which is now smaller in absolute magnitude. The quadratic wage and commuting time variables also seem somewhat smaller in absolute terms. The latter is actually of different sign as compared to the basic model, but it is insignificantly different from zero at conventional levels of significance. Note also that most of the estimated parameters related to the control variables are

more or less the same as in the basic model.

From the augmented model we estimate a ‘comparison dependent’ VoCT evaluated at the sample averages of the relevant variables to be 168 SEK. Furthermore, the estimate is significantly different from zero at the 1 percent level. But it still seems somewhat on the high side compared with the net hourly wage rate. The ‘comparison free’ VoCT evaluated at the sample averages of the relevant variables is smaller and amounts to 94 SEK. This estimate is also significantly different from zero at the 1 percent level. Furthermore, it is quite close to the average net hourly wage rate in the sample.

6 Conclusions

The purpose of this paper was to empirically investigate the effect of commuting time and wage earnings on an individual’s probability of changing jobs and estimate the value of commuting time from this model. We estimated this model on a sample of men who are likely to be well established in the labour market. Our basic model suggested that the value of commuting time (VoCT) evaluated at the sample averages was 232 SEK per commuting hour which seems quite high since the mean net hourly wage rate was equal to 89 SEK.

We augmented the basic model with comparison points for the individual’s net daily wage and his commuting time, defined as the medians of the net daily wage and commuting time in his establishment. In this augmented model we derived a ‘comparison dependent’ VoCT of 168 SEK and a ‘comparison free’ VoCT of 94 SEK. The latter is hence more or less equal to the average hourly after tax wage rate in the sample. In addition, our estimates all indicate a higher willingness to pay for saving commuting time than the value of time used in infrastructure investment analysis in Sweden today, which is about 45 SEK per hour for short and private trips.

Our model suggested that the sign of the effect of the comparison wage depended on the level of the individual's wage. More specifically, the effect was negative at higher levels of earnings but positive at lower levels. This would, in other words, suggest a negative effect of the 'rat race' on utility in the top of the earnings distribution but a positive effect at the lower end of the distribution.

Clearly, there are other ways of interpreting the effects of the establishments' median net daily wage earnings and commuting time in the empirical utility model. Such variables may, for example, reflect unobservable characteristics of establishments and jobs rather than being related to relative earnings concerns. For example, a positive effect of increasing comparison earnings at the bottom of the earnings distribution could reflect that the prospects for increasing future earnings are higher when median earnings are high at the individual's workplace. Hence, low-wage individuals prefer a job in such a workplace. Furthermore, it might be the case that working in a high wage establishment is considered prestigious for wage earners at the bottom of the distribution, with a positive effect on their job spells. Nevertheless, even though future earnings growth and status concerns may offer alternative explanations regarding our results on the comparison levels for wages and commuting times, it might be reasonable to discard such effects to obtain an estimate of the VoCT in the theoretical framework where the individual is assumed to care about his own current wage and commuting time.

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Table 1

Descriptive statistics

Variable	Mean	Std. Dev.
0 yrs \leq Job duration < 5 yrs	0.50	0.50
5 yrs \leq Job duration < 8 yrs	0.12	0.33
8 yrs \leq Job duration < 12 yrs	0.15	0.36
12 yrs \leq Job duration	0.23	0.42
Net daily wage (SEK)	717.3	214.0
Daily commuting time (hours)	0.51	0.57
Daily commuting cost (SEK)	54.31	67.21
Reference net daily wage (SEK)	651.3	131.1
Reference daily commuting time (hours)	0.40	0.32
Age	42.49	10.81
Years of Schooling	11.74	2.68
Married	0.55	0.50
Number of children between age 0 and 6	0.32	0.65
Accessibility to male jobs	864.1	1 861
Accessibility to average earnings ^(a)	2.93	6.57

Notes: (a) Divided by 10 000 000. The total number of observations is 102 055.

Table 2

Estimated Models

Variable	Basic model		Augmented model	
(Net daily wage - Commuting costs) ^(a)	0.455**	(0.012)	0.539**	(0.014)
Daily commuting time (hours)	-0.447**	(0.026)	-0.330**	(0.028)
(Net daily wage - Commuting costs) ^{2(b)}	-0.041**	(0.001)	-0.026**	(0.002)
(Daily commuting time) ² (hours)	0.055**	(0.019)	-0.023	(0.022)
Comparison wage ^(a)	-		0.206**	(0.016)
Wage*Comparison wage ^(b)	-		-2.906**	(0.191)
Comparison commuting time	-		-0.470**	(0.036)
Commuting time*Comparison time	-		0.116**	(0.022)
Age	0.062**	(0.001)	0.062**	(0.001)
Years of schooling	-0.116**	(0.003)	-0.115**	(0.003)
Married	-0.082**	(0.014)	-0.083**	(0.014)
Number of children (age 0-6)	0.086**	(0.010)	0.089**	(0.010)
Accessibility to male jobs ^(c)	-451.2**	(107.9)	-455.5**	(108.1)
Accessibility to average earnings ^(c)	-0.002	(0.003)	-0.001	(0.003)
Intercept 0	-4.886**	(0.067)	-4.908**	(0.067)
Intercept 1	-4.032**	(0.066)	-4.055**	(0.066)
Intercept 2	-3.461**	(0.066)	-3.482**	(0.066)
Log-likelihood	-230 670		-230 159	
VoCT - 'Comparison dependent' (SEK)	-		168.1**	(12.10)
VoCT - 'Comparison free' (SEK)	231.9**	(12.36)	93.55**	(6.52)

Notes: Standard errors are given in parenthesis. ** and * denotes significance of the one-percent and five-percent level respectively. The models also include a set of 21 dummy variables for the county (län) in which the individual lives where the omitted category is Stockholm. (a) divided by 100, (b) divided by 10000, (c) divided by 10 000 000. The total number of observations is 102 055.