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Publication date:
2006

Permanent link:
https://doi.org/10.3929/ethz-a-005228664

Originally published in:
Arbeitsberichte Verkehrs- und Raumplanung 353

ESTIMATING THE VALUE OF WORK AND LEISURE.

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Abstract

From a consumer behaviour approach including goods and activities, a model system encompassing a labour supply and time assignment equations is explicitly derived. From this, it is shown that the values of both leisure and work can be obtained. The theoretical framework is applied using fairly detailed data from three samples in Santiago (Chile), Karlsruhe (Germany), and Thurgau (Switzerland).

1. INTRODUCTION

We are witnessing an increased interest in the perception of the quality of life by individuals. Many authors have investigated the relations between each of many variables, at a macro and individual level, and what is generically called happiness (see the very good synthesis by Frey and Stutzer, 2002, and Layard's 2003 lectures). We believe that time assignment theories can make a contribution to a better understanding of individual well-being within the ever evolving work and social environments, since they have since long established theoretical relations among the different values of time. After all, understanding time allocation is just as understanding life itself.

By 1971, De Serpa identified three concepts of time value: the value of time *as a resource*, the value of *assigning time* to an activity, and the value of *saving time* in a constrained activity. The first corresponds to the money value of an increase in available time. The second is the ratio between the marginal utility of an activity and the marginal utility of money, i.e. the trade-off between the activity and money at the margin. The third, finally, is the willingness to pay to reduce the (constrained) time assigned to an activity. As evident, this latter value would be zero for each of those activities that are freely assigned more time than the minimum (exogenously) required. De Serpa called these *leisure* activities, and they have the property of having the same value assigned at the margin, otherwise time would be relocated

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from the less to the more valuable activities. This single value is exactly the value of time as a resource, which, because of this, is also known as the value of leisure. So far, the value of leisure has never been estimated from observed consumers' behaviour.

Following the general framework proposed by Jara-Díaz (1994, 1998), a De Serpa (1971) like model including all activities and consumption was proposed and used by Jara-Díaz and Guevara (2003) to generate a system of equations for the joint estimation of labour supply and travel choice models. Later on, Jara-Díaz and Guerra (2003) expanded this system to model time assigned to all activities. Both of these recent developments provide the tools to estimate the values of time assigned to work and the value of leisure from data sets that include fairly detailed, but not onerous levels of information on activity times assignment.

In this paper, this new approach to model activity duration and to calculate values of time is presented and experimentally applied to three data sets collected in the cities of Karlsruhe, Germany (Axhausen et al, 2002), Santiago, Chile (Jara-Díaz et al, 2003), and in the Canton Thurgau, Switzerland (Löchl et al, 2005), using different methods and with different levels of detail regarding activities and income. The model is presented in the following section and the three data sets are briefly described in section 3. The model system is used to estimate the value of time assigned to work and the value of leisure for the three samples, which are compared using the corresponding wage rates as the reference.

2. A MODEL OF TIME ALLOCATION

After many years of discussion and contributions from research into home production, labour supply and transport, an implicit agreement has been reached regarding a fairly complete microeconomic formulation of consumer behaviour encompassing not only goods consumption but also time assigned to activities. After Becker (1965), who introduced time as an input to obtain final goods, authors like Johnson (!966), Oort (1969) and De Serpa (1971) included all activity duration as a direct source of utility in a consumer's behaviour framework. The quite elegant piece by Evans (1972) went further to postulate activities as the only source of utility. Later on, and from different perspectives, the consumption-activity model has been gradually settling in the literature. Gronau (1986) expanded Becker's framework in this direction, and both Winston (1987) and Juster (1990) adopted the more general approach as well.

In a general model encompassing activities and goods, four types of relations have to be taken into account. First, individual satisfaction (utility), which arises from what individuals do as well as from the goods consumed during those activities. Second, a money budget constraint that accounts for all expenses and all types of income. Third, a time constraint, accounting for total activity times limited by social and biological cycles (days, weeks, months). Fourth, technical constraints linking goods consumption and minimum time assignments. The following model accounts for all these dimensions in a complete though analytically workable framework. It corresponds to the expansion by Jara-Díaz and Guerra (2003) of the framework proposed by Jara-Díaz and Guevara (2003).

Let T_i be the time assigned to activity i and X_j the amount of good j consumed during period τ, with minima given by T_i^{Min} and X_j^{Min}, respectively. Define T_w as the time assigned to work, P_j as the price of good j, η_j and θ_i as the exponents associated with good j and activity i respectively, w as the wage rate, and I_f as the exogenous fixed income. If utility is given a Cobb-Douglas form where Ω is a positive constant, then consumer behaviour can be seen as if time assignment and goods consumption was commanded by

$$\text{Max.}\quad U = \Omega T_w^{\theta_w} \prod_i T_i^{\theta_i} \prod_j X_j^{\eta_j} \tag{1}$$

subject to

$$I_f + wT_w - \sum_j P_j X_j \geq 0 \leftarrow \lambda \tag{2}$$

$$\tau - T_w - \sum_i T_i = 0 \leftarrow \mu \tag{3}$$

$$T_i - T_i^{Min.} \geq 0 \leftarrow \kappa_i \quad \forall i \tag{4}$$

$$X_j - X_j^{Min} \geq 0 \leftarrow \varphi_j \quad \forall j \tag{5}$$

where the Lagrange multipliers have been included. Note that, by definition, μ/λ is the value of time as a resource or value of leisure. Let *I* be the set of freely chosen activities, *R* the set of activities assigned the minimum required T_r^{Min}, *K* the set of freely chosen goods, and *J* the set of goods of which the minimum required X_j^{Min} is consumed.

The first order conditions for goods are

$$\frac{\eta_k U}{X_k} - \lambda P_k = 0 \quad \forall k \in K \tag{6}$$

$$\frac{\eta_j U}{X_j^{Min.}} + \varphi_j - \lambda P_j = 0 \quad \forall j \in J \tag{7}$$

For activities but work

$$\frac{\theta_i U}{T_i} - \mu = 0 \quad \forall i \in I \tag{8}$$

$$\frac{\theta_r U}{T_r^{Min.}} + \kappa_r - \mu = 0 \quad \forall r \in R \tag{9}$$

and for work

$$\frac{\theta_w U}{T_w} + \lambda w - \mu = 0 \tag{10}$$

Note that unconstrained activities (those that are freely assigned more time than the minimum) must have equal positive marginal utilities (all equal to μ), otherwise they would not be undertaken. Besides, every unpleasant activity will be assigned the exogenous minimum, because the sign of its marginal utility is the same irrespective of duration under this specification. This does not mean that an activity that is assigned the minimum time is necessarily unpleasant, because the optimal time assignment could be less than the exogenous minimum. First order conditions for all activities in *I* plus constraints (3) and (4) yield

$$\frac{\mu}{U} = \frac{A}{\left(\tau - T_w - \sum_{r \in R} T_r^{Min.}\right)} \quad , \tag{11}$$

where A is the summation of the exponents over all unrestricted activities. Note that the denominator is simply the uncommitted time. Similarly, if B is the summation of the exponents over all unrestricted goods, first order conditions over all goods in K plus constraints (2) and (5) yield

$$\frac{\lambda}{U} = \frac{B}{\left(wT_w + \left(I_f - \sum_{j\in J} P_j X_j^{Min.}\right)\right)} \qquad (12)$$

From this, a general labour supply model (equation 13), and the equations for time assigned to activities (14) and for goods consumption (15) are obtained.

$$T_w^* = \beta(\tau - T_f) + \alpha\frac{G_f}{w} + \sqrt{\left(\beta(\tau - T_f) + \alpha\frac{G_f}{w}\right)^2 - (2\alpha + 2\beta - 1)(\tau - T_f)\frac{G_f}{w}} \qquad (13)$$

$$T_i^* = \frac{\gamma_i}{(1-2\beta)}\left(\tau - T_w^* - T_f\right) \qquad \forall i \in I \qquad (14)$$

$$X_k^* = \frac{\rho_k}{P_k(1-2\alpha)}\left(wT_w^* - G_f\right) \qquad \forall k \in K \qquad (15)$$

where $\beta=(B+\theta_w)/2(A+B+\theta_w)$, $\alpha=(A+\theta_w)/2(A+B+\theta_w)$ and

$$G_f = \left(\sum_{j\in J} P_j X_j^{Min} - I_f\right),\ T_f = \sum_{r\in R} T_r^{Min.}\ ,\ \gamma_i = \frac{\theta_i}{(A+B+\theta_w)}\ ,\ \rho_k = \frac{\eta_k}{(A+B+\theta_w)} \qquad (16)$$

Equation (13) involves α and β as parameters to be estimated. Equation (14) adds one parameter (γ_i) to be estimated for each freely chosen activity i. In the same way, equation (15) adds one parameter (ρ_k) for each goods consumption equation included. Because of the restrictions on consumption and time, only up to n-1 time assignment or good consumption models can be estimated (with n the cardinal of the corresponding set of unrestricted activities or goods). In many cases one does not know exactly which activities (or goods) are restricted, which is something that can be explored empirically. Although α and β can be estimated using equation (13) only, they would be more efficiently estimated together with γ_i and ρ_k using equations (14) and (15). Note that, depending on the available information, one can choose to estimate the whole system of equations or a subset, as for example labour supply and activities.

One of the advantages of the model system as derived here is that data can be accommodated to different degrees of aggregation in the variables, because adding activities (or goods) does not change the structure of the model. This can be observed directly from the definition of both A and B, which can be associated with the exponents of leisure and a generalised good respectively in a fully aggregated goods-leisure-work-restricted activities model. But the most interesting property of the model is the empirical estimation of the value of leisure and the value of assigning time to work. From equations (11) and (12) and the definitions of α and β one gets the following expression of the value of leisure

$$\frac{\mu}{\lambda} = \frac{1-2\beta}{1-2\alpha}\frac{\left(wT_w^* - G_f\right)}{\left(\tau - T_w^* - T_f\right)} \quad . \tag{17}$$

First order conditions also yield that the value of leisure equals the total value of work, given by the wage rate plus the value of assigning time to work (equation 10). Therefore, this latter happens to be given by

$$\frac{\partial U/\partial T_w}{\lambda} = \frac{2\alpha + 2\beta - 1}{1-2\alpha}\frac{\left(wT_w^* - G_f\right)}{T_w^*} \tag{18}$$

3. DESCRIPTION OF THE DATA

3.1 Information directly collected

This recently developed microeconomic model system of time assignment to activities requires more detailed information on activities and income structure of individuals than usual. We present three such data sets collected in the cities of Karlsruhe, Germany, and Santiago, Chile, and in the Canton Thurgau, Switzerland, using different methods and with different levels of detail. The German and Swiss data were based on a six-weeks travel diary and personal interviews at home. In Karlsruhe 159 individuals older than six years participated (MOBIDRIVE: Axhausen et al, 2002), of which 90 are workers. The Swiss sample consists of 230 individuals, of which 126 are workers (THURGAU: Löchl et al, 2005). The Chilean data is based on a three day activity diary (workday and weekend) and personal interviews at the work place with 290 downtown workers (TASTI: Jara-Díaz et al, 2003). Table 1 summarises the general characteristics of each sample of workers, including all types of works: full/part time, self employed workers and apprentices. We assume that our samples have achieved their long run equilibrium regarding work by adjusting work duration through job search and negotiation.

Table 1. Aggregate description of the workers in the samples.

Characteristic	**Santiago**	**Karlsruhe**	**Thurgau**
Gender [% women]	42.4	46.7	37.3
Marital status [% married]	67.6	63.3	74.6
Most frequent age range and its share (%)	35-49 (47.9)	≥ 50 (37.8)	35-49 (39.7)
Average household size	3.8	2.5	2.5
One worker households [%]	32.8	48.1	62.4
Mobile phone ownership [%]	73.5	51.1**	n. a.
e-mail access [%]	47.2	47.8**	n. a.
Individuals with more than one work [%]	14.1	5.6	19.8[+]
Average working hours per week	45.2	32.5	36.5
Average workers income [US$/month]***	867.7	-	-
Average household income [US$/month]***	-	2,546	6,922
Share of full time workers	100.0	63.3	77.8
Sample size (diary duration)	290 (3 days)	90 (6 weeks)	126 (6 weeks)
Country indicators*			
Life expectancy at birth (years)	76.4	78.3	80.5
GNI per capita [US$/year]	4,360	25,270	40,680

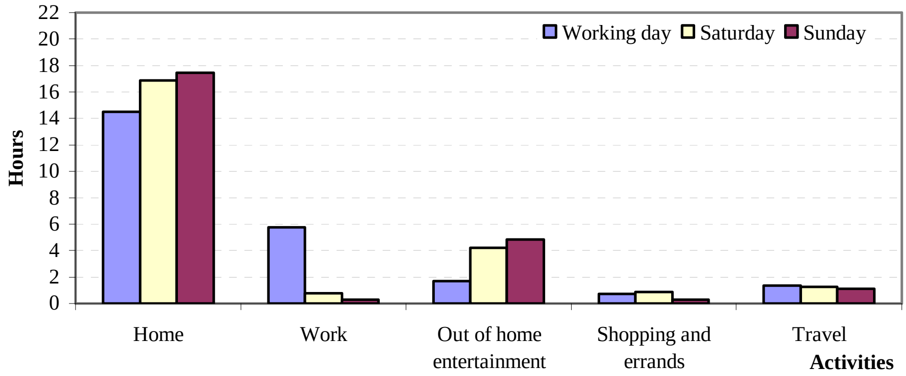
n. a. no information available
* Source: World Bank web page, 2003. ** Household information, not individual.
***One dollar = 634.94 pesos (average 2001) = 1.863 DM (average September 1999) = 1.345 CHF (average 2003). [+] Individuals reported to have an additional occupation.

Besides the difference in national income *per capita*, German and Swiss households are smaller in size. A smaller proportion of workers have more than one work in the German sample compared with the Chilean sample. This analysis cannot be done for the Swiss sample because the question was formulated in a different manner. Swiss and German workers work nearly one day less per week than their Chilean counterparts. Compared with both Chilean and German samples, the Swiss one has more men, more one worker households and more married people.

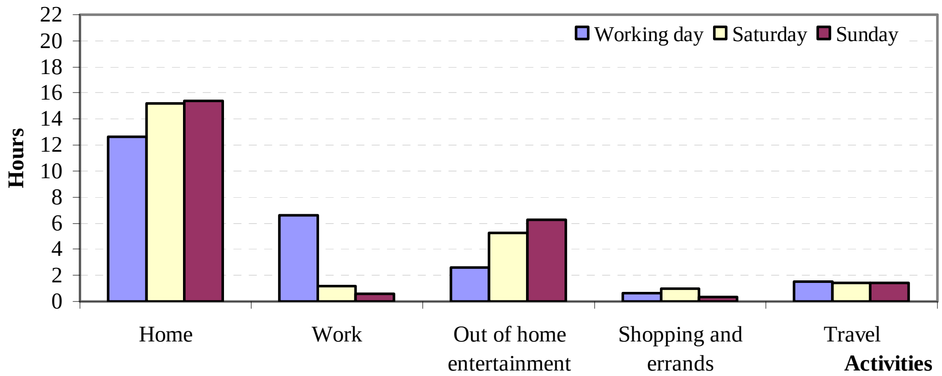
Regarding activities, Figure 1 shows average time assignment for working and the two weekend days, grouped into five comparable activity types, constrained mostly by MOBIDRIVE and THURGAU classifications as TASTI was much more disaggregate (39 activities).

Figure 1. Average duration of activities for workers

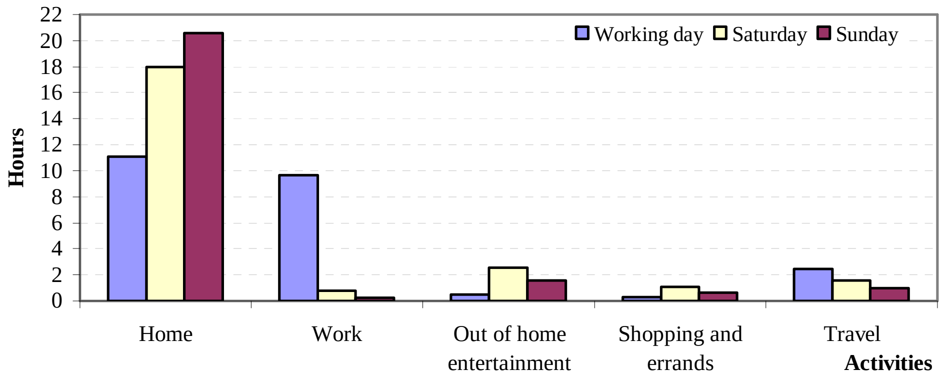
MOBIDRIVE, Karlsruhe



Thurgau



TASTI, Santiago



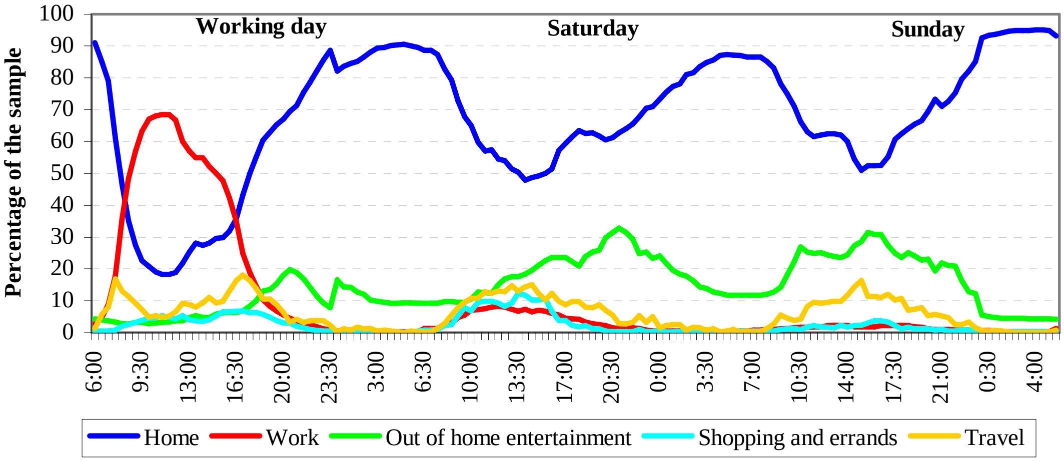
We can appreciate important differences among samples. Chileans assign more time to work (nearly 10 hours) and to travel (2.5 hours) during a working day. Individuals in the Swiss and German samples work almost 7 and 6 hours on a working day respectively, and travel slightly more than 1 hour. Work time drops on Saturday and Sunday to 1 hour and 30 minutes respectively for all three samples. Travel time decreases on weekends, notably for the Chilean sample. Larger differences are present in the time assigned to home and out of home entertainment. Swiss allocate systematically 1 hour more than their German counterparts to out of home entertainment every day, which is at the expense of time at home. The Chileans assign more time to being at home on weekends and less on workdays. All the three samples reveal similar relatively low assignments of time to shopping and errands

Figure 2 shows the complete activity patterns for all three samples. These patterns represent the proportion of individuals who were engaged in a particular activity at any moment during the day. It is apparent that the work-home patterns differ during the working day and that out of home entertainment is more intense in the German and Swiss cases for all three days. The most noticeable working day difference takes place at lunch time, since in the German case the workers stay at the work place during this time, whereas many of their Swiss counterparts go home for lunch (Chileans go somewhere nearby). Shopping and errands are concentrated strongly during Saturday morning for all three samples.

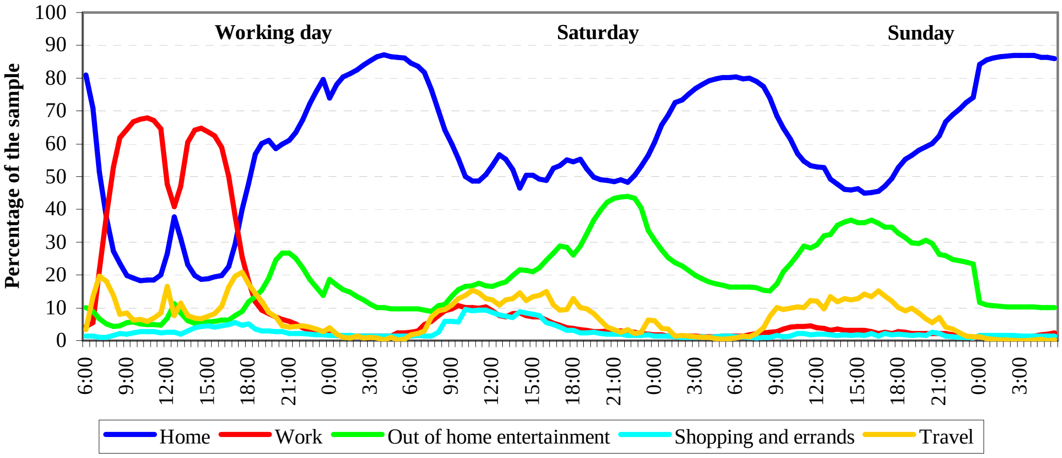
In order to illustrate further differences behind these aggregate figures, the three graphs in Figure 3 show the patterns for entertainment (Santiago) and out of home entertainment (Karlsruhe and Thurgau) by gender. Although not strictly comparable, they show opposite relative positions of the two curves, as both German and Swiss women nearly always devote more time to entertainment than men. Figure 1 to Figure 3 reflect structural and some specific differences regarding time assignment behaviours between samples.

Figure 2. Activity patterns for workers

MOBIDRIVE, Karlsruhe



Thurgau



TASTI, Santiago

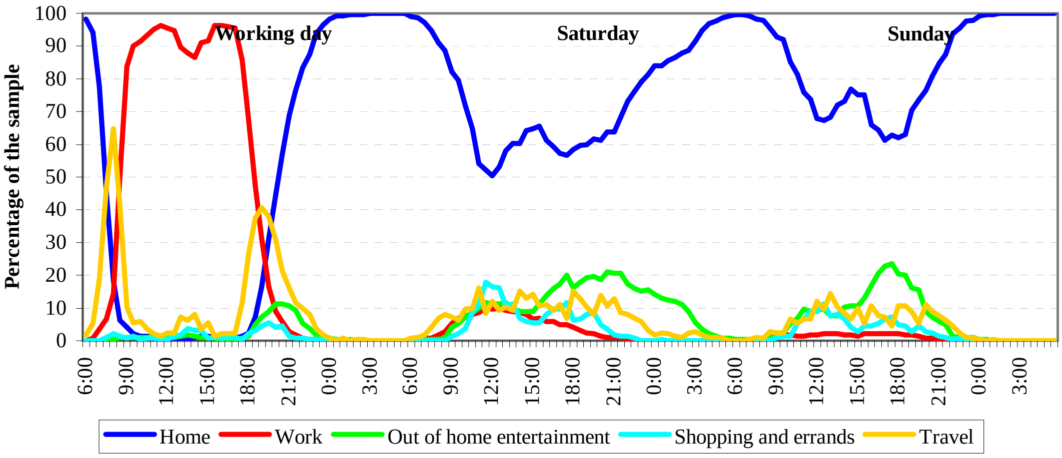
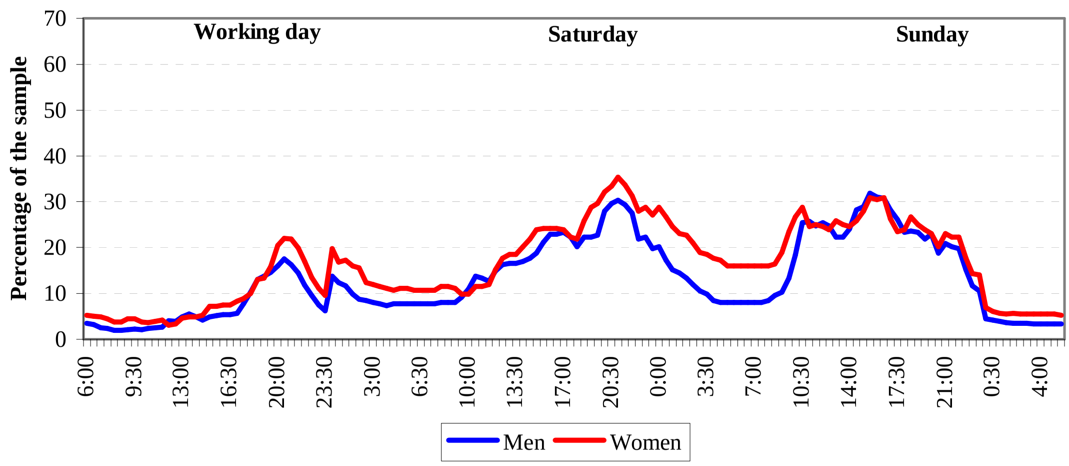
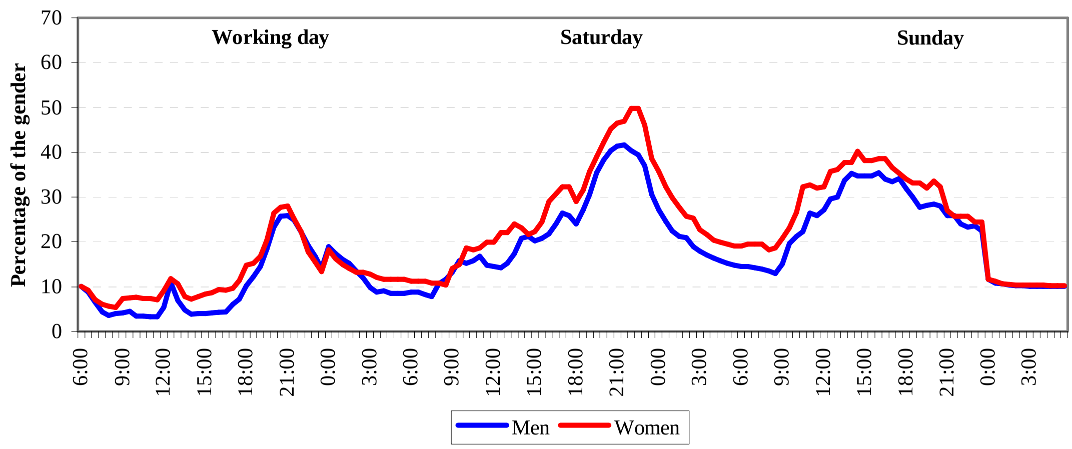


Figure 3. Entertainment pattern of workers by gender

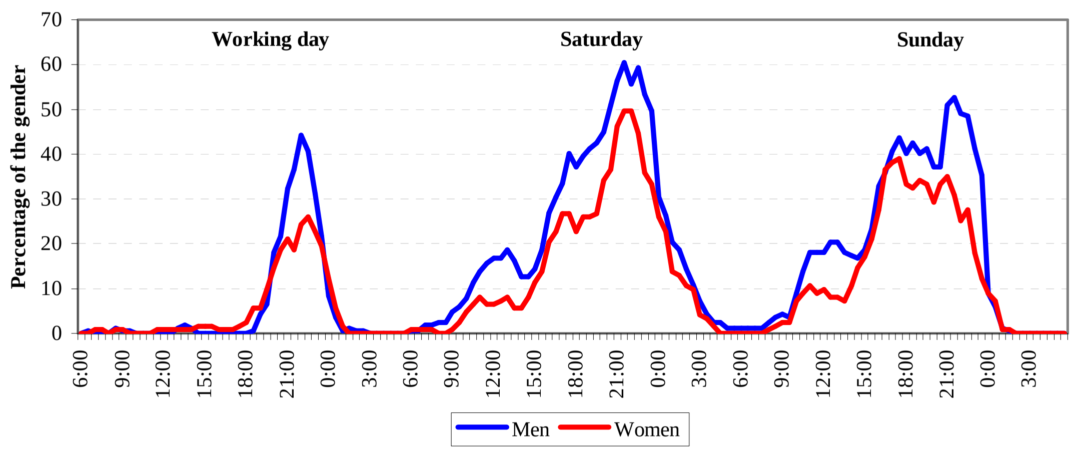
Mobidrive*, Karlsruhe



Thurgau*



TASTI, Santiago



* Out of home entertainment

Note that little can be advanced from this comparative description regarding expected values of leisure and work time. For example, one would expect a smaller marginal disutility of work for the German sample, as they work less, but also a smaller marginal utility of income, which makes their ratio difficult to asses *a priori*.

3.2 Generation of additional data

All the information needed to calibrate equations (13) and (14) is directly available in the databases, except for the expenditure in restricted consumption (G_f), and the wage rate in MOBIDRIVE and THURGAU. As these databases are available for external users, we describe in detail the steps followed to complement the original databases with additional information. In both samples the income information recorded was at household level and expressed in ranges which requires the imputation of the wage rate for each worker inside a household. Each income range was assigned a mean value. A wage rate model was estimated using the available information in the *Einkommens- und Verbrauchserhebung 2000* survey (Bundesamt für Statistik, 2000). This survey has information about incomes and expenses for the representative Swiss household. Since the idea is to find a model for the individual wage rate, only one person households were used, because in that case the household income is the personal income. The wage rate was calculated from the weekly working hours that individuals reported and their labour income.

For the specification of the model four explanatory variables were included as sets of dummy variables: Age (five groups: <=25, 26-35, 36-45, 46-55, >55), Gender, Education (three levels: low, medium and high) and Work schedule (full and part time). Self-employed individuals were not considered, because their income is frequently missing or underreported and their working hours are difficult to assign. A linear regression model was estimated with the following specification:

$$\begin{aligned} log(wage\ rate) = {} & \beta_0 + \beta_1 (age_{26\text{-}35}) + \beta_2 (age_{36\text{-}45}) + \beta_3 (age_{46\text{-}55}) + \beta_4 (age_{>55}) + \\ & \beta_5 (man) + \beta_6 (education_{medium}) + \beta_7 (education_{high}) + \\ & \beta_8 (man)(age_{>55})(education_{high}) + \beta_9 (age_{>55})(education_{high}) + \\ & \beta_{10} (full\ time) + \beta_{11} (full\ time)(education_{medium}) \end{aligned} \quad (19)$$

The parameters estimated are shown in Appendix A. Using these results, a wage rate was imputed for each individual in a household and the percentage differences between them were computed as well. The persons in a household were ranked on their imputed wage rates. The way to update the imputed wage rates to match the reported household income was

$$I_N = \sum_{i \in N} w_i WH_i = \sum_{i \in N} w_b (1 + p_i) WH_i \quad \Rightarrow \quad w_b = \frac{I_N}{\sum_{i \in N} (1 + p_i) WH_i} \tag{20}$$

where I_N corresponds to the income of the household N, WH_i represents the working hours of the person i inside the household N, w_i is the wage rate of the person i inside the household N (these are the unknown variables that we want to update). w_b is the base wage rate, which is assigned to the person of lower income within the household according to the model. The wage rates of the other household members can be expressed relative to the base rate using the percentages of difference (p_i) that were obtained earlier. This way to calculate the wage rate made us exclude from the final sub-sample households with retired people (no work hours), with apprentices (incomplete education) and/or self employed members, which reduced the German and Swiss sample sizes substantially.

The fixed expenses, G_f, for Mobidrive and Thurgau are travel, cost of season tickets for public transport, insurance and tax for cars and rents or mortgages. It was necessary to calculate the cost of every trip that the individuals undertook. For this calculation, different assumptions were used depending on the chosen mode. The different assumptions for Mobidrive and Thurgau are listed in Appendix B for each mode and each survey. A monthly season ticket cost 60 DEM (10.68 EURO) in Karlsruhe in the survey year. A wider variety of season tickets were used by the Swiss respondents (See Appendix B).

With regard to insurance and tax, the assumptions used differ from one sample to the other. For Mobidrive, there was detailed information available about the automobiles owned by the households and therefore this information was used together with the available information from the Mobiplan project (Kreitz *et al.*, 2002) to obtain insurance and tax expenditure for the different cars of a household. For the Thurgau sample, there was no information on the types of cars owned by the households. This required an approximation. As stated before, the *Einkommens- und Verbrauchserhebung 2000* survey has information on all expenses of Swiss households, including car expenditures. Average of the insurance premiums and taxes paid were calculated for each income level, as defined in the Thurgau survey and these averages were used as an approximation. Both samples had information on rents or mortgages and extra costs (electricity, heating, etc.). All household expenditures (housing, cars) were allocated to its members proportionally to their incomes.

In the case of TASTI, G_f was approximated using information from the Fifth Survey on Family Budget conducted by the National Statistical Institute (INE) during 1996 – 1997, which includes expenses, income and socio-demographic characteristics of each home. Taking into account the level of disaggregation in the survey, the following expenses were regarded as mandatory: housing, water, gas and electricity; domestic service; medical expenses; communications; school. For each income quintile, the proportion of income that each item represented was calculated, obtaining a total by quintile, which varied from 0.38 (poorest quintile) to 0.26 (third and fourth quintiles). These proportions were applied to the individuals in the sub-sample, previously classified within a quintile. In the Chilean data, travel cost is directly available, as well as income from non work sources, which were added (deducted) to obtain G_f .

4. MODEL AND RESULTS

Neither sample included precise data on goods expenditure, which is the reason why we estimated the activity model system represented by equations (13) and (14) only. As stated in section 2, up to *n*-1 freely chosen activities can be estimated in the system.

The final sub-samples were constructed excluding individual weeks that reported zero values for the time assigned to the modelled activities (work, personal care and entertainment for TASTI, and work and out of home entertainment for the other two), and those that presented missing or incorrect values (wage rate, rent/mortgage). In the case of the Swiss sample there were individuals that did not report a day for some weeks (reported as holiday, for instance), such that weekly time assignment was impossible to reproduce; those weeks were excluded as well. The Swiss sample had to be further reduced because trips were sometimes inconsistently reported. The wage rate model (explained above) and the assumption on fixed expenses yielded a few incompatible income budget constraints for both Swiss and German respondents. The final sub-samples of workers for MOBIDRIVE and THURGAU exhibit similar working time, much lower than in the Chilean sample.

Time assigned to work is modelled through equation (13); personal care and entertainment (TASTI) or out-of-home entertainment (MOBIDRIVE, THURGAU) were identified as activities that are freely assigned time until their marginal utility equals the value of time as a resource, modelled by equation (14). The work and free activities equations of this model could in fact be estimated separately. Equation (13) allows to calibrate α and β using information on the time assigned to work, the time assigned to the restricted activities (travel, domestic work, shopping and errands in the case of TASTI), the expenditure on those restricted activities and the wage rate. Equation (14) allows to calculate $\gamma_i/(1\text{-}2\beta)$ using information about the time dedicated to free activity *i* and to the restricted activities, fixed expenditures and the wage rate.

To be able to estimate this model system an error structure must be assumed. The error sources to be considered in the definition of the error structure are: measurement errors in all the observed variables, differences among individuals, specification errors and the randomness inherent to human nature. We can separate them into two groups: measurements errors that affect all the observed variables, and the rest, that affects all the model parameters. If the parameters are assumed to be deterministic, then both groups of errors can be assumed to add to a Normal additive error term, because they arise from different independent sources. There are no reasons to assume homoscedasticity among equations, and the presence of common components is expected to cause correlation. For example, the T_f variable measurement error will contribute to the error term of all activity equations, causing correlation. Also, the β parameter appears in these equations, with the same consequence. Furthermore, as shown in section 2, α and β depend on the same parameters of the original direct utility function, so if there are differences among individual tastes, not explicitly considered within the model, then α and β will be inherently correlated. For the results presented in Table 2, we calibrated the model with a full information maximum likelihood procedure, allowing for correlation and heteroscedasticity.

In each case we report the estimators of α, β and γ_i, and those of the standard deviation of each equation and the correlation among the error terms. In all cases where the most general possible specification resulted in some non significant correlation terms, then those were eliminated and the best specification was found using the likelihood ratio test. So, we also report the likelihood ratio test for the model reported against one with no correlation parameters (LR no correlation) and the likelihood ratio test for the most general model against the reported model (LR full correlation).

Table 2. Parameter estimates

	Santiago		**Karlsruhe**		**Thurgau**	
Parameter	Coefficient	t-stat	Coefficient	t-stat	Coefficient	t-stat
α	0,303	34,4	0.432	23.8	0.396	19.9
β	0,098	35,5	0.090	10.6	0.086	12.1
θ Personal care	0,181	48,4	-	-	-	-
θ Entertainment	0,155	28,9	0.116*	10.5	0.183*	22.0
σ Work	396,01	22,5	605.38	15.7	740.40	25.5
σ Personal care	415,06	22,5	-	-	-	-
σ Entertainment	611,09	22,5	1030.46*	15.7	1170.71*	25.5
ρ Work – P. Care	-0,253	-4,3	-	-	-	-
ρ Work – Entertainment	-0,288	-5,0	-	-	-0.227	-4.3
ρ P. Care – Entertainment	-0,515	-11,1	-	-	-	-
LR (no correlation)	$168.9>7.8=\chi^2(5\%,3)$			-	$17.1>3.8=\chi^2(5\%,1)$	
LR (full correlation)		-	$2.2<3.8=\chi^2(5\%,1)$			-
Log-likelihood		-5653.99		-2006.57		-5357.30
Sample size		253 individuals (253 weeks)		26 individuals (124 weeks)		75 individuals (325 weeks)

* Out of home entertainment

The coefficients obtained are quite attractive intuitively. First, note from equation (12) and the definition of α that the marginal utility of income, λ, is proportional to $1\text{-}2\alpha$, which means that the smaller α for the Chilean sample reflects a larger λ *ceteris* *paribus*. Something similar occurs regarding β with the marginal utility of time as a resource, μ, which in this case is smaller for the Swiss sample. Nothing can be inferred from these observations on the value of leisure, though, as it is obtained from the ratio of μ/λ.

Before reporting and analysing the values of leisure and work, it is convenient to recall the basic equality in a De Serpa like model, firstly pointed out by Oort (1969), which establishes the individual equilibrium between the value of leisure and the total value of work, which includes the wage rate. Intuitively, this equality arises because if the value of leisure was larger (smaller) than the total value of work, the individual would diminish (increase) time at work. On the other hand, the total value of work has two components, namely the wage rate (the money value of the goods that can be bought with a unit time worth of work) and the value of assigning time to work (the money value of the marginal utility of a unit time at work). For short, the pleasure from freely assigning time to leisure equals the money reward from work plus the pleasure of working. Formally,

$$\frac{\mu}{\lambda} = w + \frac{\partial U/\partial T_w}{\lambda} \qquad (21)$$

As the difference in income should be taken into account across countries, let us first point out that equality (21) between the values of work and leisure at the margin can be rewritten as

$$\frac{\mu/\lambda}{w} + \frac{-(\partial U/\partial T_w)/\lambda}{w} = 1 \quad . \qquad (22)$$

This means that the proportions of the values of leisure and time assigned to work (with a minus sign) with respect to the wage rate, should add up to one.

In Table 3 we report the main results, which are the average values of time in US$/hour and as a percentage of the corresponding wage rate calculated for each sample. Note that these results are calculated for each individual-week, as shown by equations (17) and (18), which involve available income, available time and work time. The reported values are the averages among observations.

Table 3. Average Values of Time [US$/hour]

	Santiago			Karlsruhe			Thurgau		
Value of	Value	t	%wage	Value	t	%wage	Value	t	%wage
Leisure μ/λ	2.9	24.1	65.9	12.7	4.0	119.8	26.7	5.6	87.8
Work $(\partial U/\partial T_w)/\lambda$	-1.5	-15.3	34.1	2.1	0.7	19.8	-3.7	-0.8	12.2
Wage rate	4.4	-	100.0	10.6	-	100.0	30.4	-	100.0

***One dollar = 634.94 pesos (average 2001) = 1.863 DM (average September 1999) = 1.345 CHF (average 2003).

The first important observation is that the value of leisure is positive (as expected) and significantly different from the wage rate for all three samples, and that the value of time assigned to work is negative for two samples (Santiago and Thurgau) and slightly positive for Karlsruhe, although not significantly different from zero for both Thurgau and Karlsruhe. This would be consistent with a picture of a decreasing work utility. This is not a minor point, particularly because the presence of work in utility has been challenged in practice by suggesting that the wage rate is the only "opportunity cost" of leisure.

The value of the marginal utility of work in money terms is not that different across samples, unlike the values of leisure, which are all positive as expected, and exhibit very large differences. Leisure is much more valuable to the Swiss individuals than to Germans, who come on top of the Chileans. Recalling that this value represents the money equivalent of the marginal utility of freely chosen activities, it makes sense to compare these subjective values with the reported subjective well-being in various countries from the World Values Survey, reproduced in Frey and Stutzer (2002). In a 1 to 10 scale that represents average satisfaction with life, Switzerland shows 8.02, Germany reaches 7.12 and Chile 6.92, exactly the same order we have obtained for the value of leisure with our samples within the same countries.

Equation (22) facilitates the view of the values as a proportion of the corresponding wage rates in Table 3. Grossly speaking, the Chilean sample reflects marginal values of leisure and work that approximates 66% and 34% respectively, while the Swiss and German samples approximate completely different proportions, 88% - 12% and 120 - (-)20 respectively. This means that, relative to their own income, the dislike for work is remarkably larger for the Chileans and the contrary happens regarding leisure.

The interpretation for these strikingly different relative values of work and leisure are not straightforward, as many variables are involved including not only marginal utilities for work and leisure but also the wage rate and the marginal utility of income. But the fact is that, in the samples, Germans devote less time to work and more time to leisure than Chileans, with the Swiss in between, which means that the equilibrium reflected by equations (21) and (22) takes place at different points in the time space. Although we do not have a detailed description of other activities for the German and Swiss samples, which would help understanding this picture, we do know that Chileans exhibit longer travel times (2.4 hours) than both Swiss (1.7 hours) and Germans (1.3 hours) during weekdays. On the other hand, to understand the numerical results obtained, the qualitative aspects of the time assigned to work and leisure should be better understood as well. For example, in a recently released survey conducted by a provincial University, 40% of workers in Santiago have answered that their greatest fear is to loose their jobs (newspaper La Tercera, August 9, 2004). In a recent interview, the former director of the regional branch of the International Labour Organization said that only one third of the Chilean workers have access to a “decent job”, defined as one with a formal contract, with health, unemployment, maternity and retirement coverage (magazine Mensaje, August 2004). According to Layard (2003), job insecurity has a negative impact on subjective happiness, with an effect larger than that arising from a reduction in income by 33% relative to the average. Thus, unstable jobs and low quality of work might help explaining the different values.

5. CONCLUSIONS

Understanding the hidden values behind the way individuals assign their time to activities is a relevant task. The modeller-observer has to take into account that some of these activities are constrained from above, i.e. they can not be assigned less than a certain minimum, even if the individual wanted. On the other hand, the individual has to earn an income that requires time assigned to work, but this assignment is not only dependent on the money reward but also on the satisfaction (or dissatisfaction) that work causes.

The theoretical microeconomic framework developed to model time assignment to activities and to calculate the values of work and leisure developed here, has been shown to be perfectly suited to account for the preceding elements and to analyse different type of samples collected in very different environments. The application was made using sub-samples of smaller size due to the many restrictions imposed by the information requirements. The calibrated model systems yield credible results both in absolute and comparative terms. The estimated values of leisure are significantly different from the corresponding wage rates and follow the same order as the subjective perception of well being reported in the specialized literature for the three countries. Results also show that work time is a relevant element in utility.

When the values are viewed relative to the wage rate, leisure is more valued at the margin by the German and Swiss samples than by the Chilean one. On the other hand, Chileans dislike work to a larger extent This could be caused not only by a longer work period in Chile but also by longer travel times and poorer quality of both work and leisure, something that requires additional information to be properly detected.

Acknowledgements

This research was partially funded by Fondecyt, Chile, through grants 1010687 and 1030694, and the Millenium Nucleus “Complex Engineering Systems”. The Mobidrive data were collected with support of the German Ministry of Research and Education. The Thurgau 2003 data collection was funded by the Swiss Fonds for Strassen, Brücken und Tunnel – research. All of this support is gratefully acknowledged.

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Appendix A. Wage rate model

Table A1 Classification of education levels in low, medium and high for the three samples

Education level	*Einkommens- und Verbrauchserhebung 2000*	MOBIDRIVE	THURGAU
Low	1. Obligatorische Schule 2. Keine Ausbildung abgeschlossen 3. Anlehre (in Betrieb und Schule) 4. Haushaltlehrjahr, 1 – 2 jährige Handelsschule	0. Noch keine 1. Grundschule 2. Hauptschule	1. Primarschule
Medium	5. Diplommittelschule, allgemeinbildende Schule (Verkehrsschule) 6. Berufslehre (Eidg. Fähigkeitsausweis) 7. Vollzeitberufsschule (Handelsmittelschule / Lehrwerkstätte) 8. Berufsmaturität 9. Maturitätsschule, Lehrerseminar 10. Höhere Berufsausbildung mit Meisterdiplom, Eidg. Fachausweis	3. Mittlere Reife 4. Fachabitur 5. Abitur 6. Polytechnische Oberschule 7. Lehre 8. Meister	2. Ober-, Real-, Sekundarschule 3. Mittelschule (Gymnasium, Kantonsschule) 4. Berufsfachschule / Berufsschule mit Abschluss / Diplom
High	11. Techniker- oder Fachschule (2 Jahre Vollzeit, 3 Jahre Teilzeit) 12. Höhere Fachschule, HTL, HWV (3 Jahre Vollzeit oder 4 Jahre Teilzeit) 13. Universität, Hochschule (Lizentiat, Dissertation, Nachdiplom)	9. Fachhochschule / Pädagog. Hochschule 10. Universität, natur-/ingenieurwiss. Studium 11. Universität, geistes-/sozialwiss. Studium.	5. Fachhochschule 6. Universität

Table A. 2 Parameter estimates for the wage rate model

Variable	Coefficient	t-stat.
Constant	2.939	30.3
Age 26-35	0.154	2.3
Age 36-45	0.287	4.1
Age 46-55	0.345	4.8
Age > 55	0.208	2.6
Man	0.067	1.8
Education medium	0.184	2.0
Education high	0.711	10.0
(Man)(Age > 55)(Education high)	1.660	6.1
(Age > 55)(Education high)	-0.685	-3.6
Full time	-0.153	-2.0
(Full time)(Education medium)	0.240	2.6
R^2	0.286	
N	524	

Appendix B. MOBIDRIVE and THURGAU: assumptions for trip costs by mode, insurance and tax costs for cars and cost of public transport season tickets.

In MOBIDRIVE there is information on trip costs, which includes single tickets for the public transport, parking cost, taxi, etc. In spite of this, it was preferred to calculate the cost again when this was possible and to use the reported cost elsewhere. For THURGAU, there is no information about trip costs, therefore for all the modes it had to be imputed.

Walk: A cost of zero was assumed for both samples.

Bike: A cost of zero was assumed for both samples.

Car passenger: A cost of zero was assumed for both samples.

Others: The reported cost was used for the German sample, whereas a cost of zero was assumed for the Swiss sample.

Motorcycle

$$CT=\frac{Price\_gasoline*distance[km]}{28.6[km/l]} \tag{23}$$

where the price of the gasoline corresponds to 1.9 DEM/lt. (0.97 EURO/lt.) for the German sample (this value was used by König and Axhausen, 2001) and 1.4 CHF/lt. (0.92 EURO/lt.) for the Swiss sample. The value of 28.6 [km/lt.] corresponds to the consumption of a motorcycle of 125 cc. Parking cost was not included.

Car driver

For the German sample, the researchers of the project generated fuel consumption and variable costs per kilometre from the available vehicle information. In THURGAU, there is no detailed information on the vehicles. We use the average values from the German sample instead. A value of 7.4 lt./100 km. was used for the consumption and 0.69 DEM/km = 0.54 CHF/km (1 DEM=0.51 EUR=0.78 CHF average 2003) for the variable cost. For the value of the variable cost, which includes repair and maintenance, we tried to use a similar approach to the used one for the insurance and tax expenses, but the costs of repair and maintenance in the Einkommens- und Verbrauchserhebung 2000 survey did not have a clear link between income and cost, and the variation inside of a group was very large. Besides, this information was not available for all households that reported insurance and tax costs. The cost per kilometre together with the travelled distance of the trip allowed to calculate the fuel and variable costs of the trip. Finally, in German case, a parking cost was added if the destination of the trip was the centre of the city, this value corresponds to 2 DEM/hour. For the Swiss sample this cost was not considered. The gasoline prices used were the same as that for motorcycle.

Public transport

For both samples, a cost of zero was assumed if the person had public transport season ticket, otherwise a cost of 2.50 DEM (1.28 EURO) was used for the German sample and a cost of 2 CHF (1.31 EURO) for the Swiss sample.

Train

The reported cost was used in the German case. For the Swiss sample, a cost of zero was assumed if the person had some season ticket for the train, otherwise we used information on cost of tickets depending on the distance travelled.

Combined modes

For the combined modes with car driver, the travelled distance in this mode was calculated using the average speed observed in the pure mode and the time reported in this stage of the trip. With this distance, the assumptions mentioned earlier for the car driver were applied (without considering parking cost) and the costs of the other modes were added. For the Swiss sample, the same idea was used in combined modes with train and motorcycle where it was necessary to know the travelled distance in this mode to obtain the cost of this stage of the trip. The speeds used in this approach can be seen in the Table B. 1. For the rest of the combined modes, the same assumptions used for the pure modes were utilized.

Table B. 1 Average speeds by mode [km/hr]

Mode	Speed	
	MOBIDRIVE	THURGAU
Car	32.0	45.1
Train	-	47.6
Motorcycle	-	35.0

Table B. 2 Types of season tickets for Switzerland, validity and prices

	Type of ticket	Price
1	General season ticket for public transport in Switzerland	
	Adult GA, 2nd class	275, per month
	Junior GA, 2nd class	205, per month
	Senior GA, 2nd class	210, per month
2	Halbtax	
	Adult	150, per year
3	Gleis 7	
	Gleis 7 combined with one-year Half-Fare Card	249, per year
4	Yearly or monthly ticket for train/bus (i.e. Ostwind)	
	Adult, 2nd class, 1-2 zones	73, per month
	Junior, 2nd class, 1-2 zones	53, per month
5	Yearly or monthly ticket for city bus Frauenfeld	
	Adult	52, per month
	Junior	39, per month
	Senior	39, per month
6	Multiple ticket (regular)	
	12 trips	18
7	Route pass	
	It depends on the route, which were identified in each case.	
8	Other season tickets	
	Adult	62.5, per month (average between the prices of 4 and 5)
	Junior	46, per month (average between the prices of 4 and 5)

Table B. 3 Insurance and tax costs for vehicles by income group for THURGAU [CHF/month]

Income	Number of observations	Average vehicle tax	Average vehicle insurance premiums
<= 2000	22	28.77	66.89
2001 – 3000	76	34.40	67.76
3001 – 4000	133	35.15	79.04
4001 – 5000	189	35.72	93.67
5001 – 7500	713	38.87	102.72
7501 – 10000	759	44.31	116.33
> 10000	1029	52.92	153.75
Total	2921	44.67	121.39