# INDIVIDUAL AND COOPERATIVE MODELS FOR CHILEAN WORKERS' TIME USE: CLOSING THE GAPS IN THE VALUES OF LEISURE AND WORK

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## 1. Introduction

Microeconomic consumer theory considers individuals as if what they do is what they prefer within what is feasible. This generates models where preferences are represented by a utility function to be maximized and some constraints that limit the choice space. In its origins, this theory considered only goods consumption as a source of utility, and a money budget constraint. Becker (1965) incorporated the time assigned to consumption and paid work into this type of analysis, arguing that consumption time (leisure) should be added in the utility function. As paid work time was only a source of income, a single value of time resulted from his framework: the wage rate. Two important contributions were made soon after: the introduction of technical constraints by DeSerpa (1971), who explicitly considered that the consumption of goods requires a minimum amount of time allocated to it; and the formulation by Evans (1972), who was the first that developed a model of consumer behavior where the utility function depends only on the time assigned to each and every activity; goods consumption entered the formulation through the money budget constraint by transforming activities into the market goods that are required to performed them.

DeSerpa (1971) included **all** activities (consumption time and work) as a source of utility and defined "leisure" as those that are assigned more time than the minimum imposed by the corresponding technical constraint. As leisure activities can be adjusted, at equilibrium the individual will make their value equal. This value of leisure was shown to be the ratio of the marginal utilities of time and income. Moreover, the individual assigns time and money in such a way that the value of leisure is equal to the total value of work, given by the wage rate plus the value of time assigned to work (the ratio between the marginal utilities of work and income).

Jara-Díaz (2003) generalized the models by DeSerpa (1971) and Evans (1972) by incorporating technical relations between goods consumption and time allocated to activities. Jara-Díaz *et al.* (2008) considered simplified technical relations in the form of minimum consumption and minimum time assigned to activities, obtaining explicit equations for time allocated to paid work and to leisure activities, and for those goods that are assigned more than the minimum. The most relevant contributions from this model are the expressions for the values of leisure and work, such that both depend on the utility parameters, the wage rate, the time allocated to committed activities and expenses assigned

to committed consumption[1]. We refer to this as a **basic model**, which has been expanded in many directions, considering the nature of the technical relations between goods and activities (Jara-Díaz *et al.,* 2016) or the incorporation of work that could be hired to third parties (Rosales-Salas and Jara-Díaz, 2017). In this paper we expand this individual model to consider interaction with other individuals (workers) in the house, using elements of household economic theory, which has been developed in parallel to individual approaches. The application uses a sample of Chilean workers extracted from the first National Time Use Survey (NTUS) collected  by the Chilean National Institute for Statistics in 2015 covering the whole country. Results show that the new model yields higher values for both leisure and work than what is obtained with the basic model for all segments considered, and that the gaps between comparable segments are significantly reduced.

In Section 2 we present a synthesis of the data used and the results from the basic (individual) model. In Section 3 we introduce a cooperative time use model and the new values of leisure and work for selected segments. Section 4 concludes.


## 2. Chilean workers' time use and values of time from the basic model.

Using the data collected in NTUS, we selected those workers that declared a total amount of daily time that deviate minimally from 24 hours. This resulted on a sample of 3,412 Chilean workers. First, we analyzed the daily data, obtaining that working days are not statistically different between them, and that Saturday and Sunday are different from working days and between them. This allowed us to build a weekly data for the analysis of time use and estimation of models.

Table 1 shows the weekly time allocation of Chilean workers including mean and standard deviation of seven aggregated activities: leisure, paid work, unpaid work, sleep, personal care, education and transport, which only includes travel to work and to health and education centers, as in other activities the NTUS asks the individual to add the travel time to the time reported. We focused on four socio-economic variables: gender, income, age and region, but only gender and income are included in this paper. Table 1 shows important gender differences in time allocation, where women, despite spending less time on average on paid work than men, assume a larger total workload, due to a large difference in unpaid work time. Significant differences regarding income can also be observed: as income increases from the first to the fifth quintile, the time allocated to leisure generally increases and the time allocated to unpaid work decreases.

We estimated the basic model (Jara-Díaz *et al*., 2008) for selected socio-economic segments, using the Chilean workers sample and imputing the necessary data for committed expenses from an external source. The results show values that are similar to previous reported models using Chilean data for Santiago and its zones (Jara-Díaz *et al*., 2008; Jara-

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[1] Committed or restricted activities and consumption refer to those activities or goods that stick to the minimum imposed by the technical constraints.

Díaz *et al.*, 2013). For synthesis, the value of leisure is higher for men than for women when controlled by income and age; and higher for richer segments when controlled by gender and age. Regarding the value of work, youngsters (men and women) present negative values, and the other segments present values non-different from zero or positive. Detailed results are reported in Jara-Diaz and Candia (2017).

**Table 1: Mean (standard deviation) of weekly hours allocated to activities by gender and income**

| | Gender | | Income quintile | | | | |
|---|---|---|---|---|---|---|---|
| | Men | Women | I | II | III | IV | V |
| **Leisure** | 36.05 (14.08) | 32.07 (14.38) | 31.23 (14.11) | 33.89 (14.40) | 33.63 (14.47) | 35.25 (14.08) | 37.70 (13.89) |
| **Paid work** | 46.53 (15.27) | 38.91 (15.81) | 40.55 (17.58) | 43.26 (16.57) | 44.68 (16.11) | 44.60 (14.89) | 42.94 (14.58) |
| **Unpaid work** | 13.78 (10.05) | 26.16 (14.74) | 23.07 (16.15) | 19.36 (14.14) | 17.57 (12.93) | 17.52 (12.98) | 17.71 (11.36) |
| **Sleep** | 51.76 (10.49) | 51.69 (10.42) | 54.26 (10.57) | 52.75 (10.41) | 52.11 (10.80) | 50.60 (10.26) | 49.53 (9.66) |
| **Personal care** | 13.04 (4.44) | 13.20 (4.44) | 13.00 (4.59) | 12.66 (4.40) | 13.14 (4.44) | 13.05 (4.46) | 13.81 (4.25) |
| **Education** | 0.96 (5.04) | 1.00 (5.35) | 0.84 (4.43) | 0.69 (4.35) | 1.18 (6.58) | 0.98 (4.80) | 1.18 (5.00) |
| **Transport** | 5.87 (4.97) | 4.96 (4.53) | 4.98 (4.28) | 5.40 (4.98) | 5.69 (4.77) | 6.00 (5.02) | 5.13 (4.73) |

## 3. A cooperative time use model and values of time.

Household economic theory considers principally two types of models: cooperative and non-cooperative. As stated by Beblo (2001), cooperative models assume that individuals form a household when it is more beneficial to them than remaining alone. Family members might also benefit from economies of scale in the sharing of goods. So, individuals interact with symmetric information and symmetric bargaining power inside a household in order to maximize the gains. Non-cooperative models do not consider symmetric information. Quoting Beblo (2001), in cooperative models "Although one partner cannot coordinate his or her choices with the other, individual utility maximization depends on the decisions made by one's partner, for instance due to household public goods that only have to be produced by one partner but can then be consumed by both.".

In this paper we develop (and estimate) a cooperative time use model (CTUM) that integrates elements from Manser and Brown (1980), Chiappori (1988) and Apps and Rees, (1996) among others, into the approach developed by Jara-Díaz (2003). In the CTUM, a household of two workers ($a$ and $b$) is modeled as if they maximized a conjoint utility function with three components: one corresponding to each individual that depends on the time allocated to activities, $T^n$, $T_D^n$), and one at a household level, which depends on the market and domestic goods consumption. We considered a conjoint budged constraint where individual incomes are added; individual time constraints; and technical relations between goods and activities, including functions that relate the time assigned to domestic work with intermediate and final domestic goods. From this formulation, we obtained analytical expressions for the values of time, which in this case reflect the valuation made by the household for the leisure and work of each individual, differing from the individual values of time obtained by DeSerpa (1971).

The CTUM is shown in Equations (1) to (9), where individual $n = a, b$ can assign time to paid work ($T_w^n$), unpaid work ($T_D^n$) and to all other activities $j$ ($T^n$). Utility also depends on market ($X$) and final domestic ($Z_D$) goods consumption, both at a household level. Paid work has a wage rate $w^n$ and there is an income $I$ from sources different from work. Each market good $i$ has a market price $P_i$, and each domestic good $d$ requires a quantity of intermediate domestic good $X_d$ (that has a market price $P_d$) to be produced. There are exogenous (individual) minimum $T_j^{n\,min}$ and (collective) $X_i^{\,min}$ for each activity different from paid and unpaid work and for each good respectively. Domestic goods (intermediate and final) and time assigned to unpaid work are related by $g_1$ and $g_2$ production functions.

$$Max\ U = U\big[U^a(T_w^a,\ T^a,\ T_D^a), U^b(T_w^b,\ T^b,\ T_D^b), X,\ Z_D\big] \tag{1}$$

$s.a$

$$\sum_i P_i X_i + \sum_d P_d X_d = w^a T_w^a + w^b T_w^b + I \tag{2}$$

$$T_w^a + \sum_j T_j^a + \sum_d T_d^a = \tau \tag{3}$$

$$T_w^b + \sum_j T_j^b + \sum_d T_d^b = \tau \tag{4}$$

$$X_i \geq X_i^{\,min} \qquad \forall i \tag{5}$$

$$T_j^a \geq T_j^{a\,min} \qquad \forall j \tag{6}$$

$$T_j^b \geq T_j^{b\,min} \qquad \forall j \tag{7}$$

$$g_1(X_d,\ T_d^a,\ T_d^b) - Z_d = 0 \qquad \forall d \tag{8}$$

$$g_2(\ T_d^a,\ T_d^b) - X_d = 0 \qquad \forall d \tag{9}$$

Due to the addition of individual incomes, the marginal utility of household income should be less than in the individual case, so we expected values of time larger than those obtained with the basic model. Another theoretical reason why the value of leisure should increase is that the household values an extra unit of time available to an individual considering that it benefits both members of the household, and not only the individual as in the basic model.

We assumed a Cobb-Douglas form for each of the three components of the utility function, a multiplicative form for the utility of the household (such that the household utility function is Cobb-Douglas as well), and a linear form for domestic production functions. First order conditions yield a system of equations for the model variables: time allocated to paid work, to unpaid work and to unrestricted activities for both members of the household. We do not consider the resulting equation for goods consumption due to lack of data on consumption (or expenses) of unrestricted goods. We assumed that unrestricted activities were leisure and sleep. For reasons of identifiability, we assumed that the parameter of the activity "sleep" was equal for the two members of the household.

The resulting system does not yield explicit analytical solutions for the variables, and certain assumptions are made in order to generate a likelihood function for estimation. We assumed that time allocated to an individual paid work was known to the other member of the household (the value observed), while the time allocated to unpaid work was considered as a restricted activity.

We built a sample of households with two workers based on the individual Chilean sample. For econometric estimation we needed to identify two subsets of individuals across households. We used three criteria to create those subsets, according to who has the highest wage rate, according to who has the highest total income, and by gender. For the latter case, we used a sub-sample of households that only contains workers of different gender. The values of time obtained with the CTUM and a comparison with the results of the basic model applied to the same sample are shown in Table 2.

**Table 2: Values of time from cooperative and basic model (CLP/h)[2]**

| | | Value of leisure | | Value of work | |
|---|---|---|---|---|---|
| | | **Basic** | **Cooperative** | **Basic** | **Cooperative** |
| **Wage rate** | **Highest** | 5,467.5 | 7,645.5 | 2,039.9 | 4,217.8 |
| | **Lowest** | 2,505.1 | 6,942.3 | 819.0 | 5,265.2 |
| **Income** | **Highest** | 3,894.8 | 12,908.2 | 569.6 | 9,376.2 |
| | **Lowest** | 2,719.7 | 11,538.3 | 931.1 | 9,583.1 |
| **Gender** | **Men** | 4,851.1 | 12,661.1 | 1,566.3 | 9,376.2 |
| | **Women** | 2,738.7 | 11,457.6 | 433.2 | 9,152.1 |

The results show that the values of time increase with respect to the basic model, as expected, and – notably - that the relative differences in both values of work and leisure decrease among individuals in the household, particularly between men and women, from 44% to 10% in the value of leisure and from 72% to 2% in the value of work.

## 4. Conclusions

The principal theoretical contribution of this paper is the formulation of a cooperative time use model and the definition of the value that individuals assign to leisure and work when workers household members consider each other. The estimation of these values shows that the differences observed when using the basic individual model diminishes with the cooperative approach, suggesting that differences in the values of time of different socio-economic segments can be overestimated when interactions between members of a household are not considered.

These results are particularly interesting as the data used is a novel sample from the only Chilean national time use survey, which shows large inequities in time allocation by socio-economic variables, particularly gender and income. Men and people with higher income enjoy more leisure time in general. Women assume a total weekly workload 4.76 hours larger than men, although women allocate less time to paid work, the difference is explained by a large gap in unpaid work.

This cooperative formulation opens new perspectives on the value of time. By incorporating the interactions of individuals with other members of their household, the improvements in the time allocation perceived by one of the members benefits the household as a whole. Capturing this effect is a step forward in understanding the decisions of allocation of time and consumption of individuals and their monetary valuation.

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