EVIDENCE ON WORKING SCHEDULES.

WHAT CAN BE EXPLAINED FROM A THEORETICAL PERSPECTIVE?

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Abstract

The timing of the workday conditions the timing of the rest of activities in the normal life. The statistics about work schedules confirm that most of people work at the same time. This paper studies the determination of working schedules in an economy with heterogeneous agents. Firstly we elaborate a model to explain the assignment of different types of workers to different teams under a competitive equilibrium. Secondly a search matching model is formulated where jobs and workers bargain about the workday. Both models stress the technology, the capital-labor rate and the preferences as the principal determinants of the working schedule.

1 Introduction

As noted by Hamermesh (1999) studying the *instantaneous* use of time, as opposed to time used integrated over days, weeks, years or a working life, can yield insights into questions about behavior that are not obtainable from examining other labour market outcomes. Timing is inherent in work: Effort is made during certain parts of the day or week, and the timing of that effort affects workers' well-being and firms' profitability.

However, the timing of work has received little attention in the economic analysis literature. Some exception is found in the cited Hamermesh (1999) and Weiss (1996).

Recently some countries have begun to provide data on how its citizens spend their time. In Burda, Hamermesh and Weil (2006) are analyzed the denominated Time Use Survey of

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different countries: Italy, Germany, The Netherlands and US, and for different years. In the case of Spain, in 2004, was published the *Encuesta de Empleo del Tiempo 2002/03*. In this way it is possible to know the time allocation between market and non market activities. These statistics also show the results about non market activities disaggregated between household production and leisure. Respect to a working schedules, the data supply information about at what time people is working. For example, in Spain the percentage of working population who are at work at 11:00 AM is 73.4%. This is the moment of the day at what most people are working simultaneously. The percentage increase until that moment and decrease onward, in the interval between midnight and the subsequent midnight.

By other side, data confirm the widely-held belief that Americans do work more than Europeans. Too, Americans tend to work at odd hours of the day and in weekends more often than Europeans.

In this paper, we look for the variables that determine the similarity or variety of work schedules. Is it a matter of preferences, incentives, culture, institutional benchmark, technology, capital-labor intensity, or inclusive the opportunity cost of idle firms?. Perhaps all that variables are important. For the sake of simplicity, we propose an economy with workers heterogeneous respect to their preferences over leisure and firms that organize their production in teams or jobs with different workday. These agents trade in two different scenarios: one is general equilibrium and the other is a market with frictions. Our bench mark is Teulings and Gautier (2004) for the second part, although in that paper the problem is the assignment of workers with different skill levels to jobs with different complexity level. In the first part, we extended a previous model in Garcia-Sanchez and Vazquez (2005) to allow for heterogeneity.

This paper presents in Section 2 a suvey of some statistics about time use, forms of working time organization, timing of work, etc. Section 3 contains the theoretical perspective. In subsection 3.1 we elaborate the model of general equilibrium with teams. The search-matching model is in subsection 3.2. The determination of work schedules is formulated in subsection 3.3. Section 4 concludes.

2 Some evidence on work schedules

In this section we are going to summary the studies and statistics about working schedules specially those which deal with the timetable of the workday, although, as we said, both the literature and the statistics are scarce. In addition, the revision implies to manage data from different sources and with different methodology.

Both in theoretical or applied economic literature to deal with working time normally implies to analyze the number of hours. At this respect, there is a lot of studies about the determination of working week or about the effects of its reduction by law. Recently, the issue that has been raised for discussion is that Alessina, Glaeser and Sacerdote (2005) address like a most puzzling observation on American and European employment outcomes: "In the early 1970s, hours worked per person were about the same in the United States and in Western Europe" but today "Americans average 25.1 working hours per person of working age; Italians, 16.7; the French, 18.0; and Germans, 18.7". Their thesis is that these different developments are due to trade union policies and labor market regulations in Europe. They contrast their explanation to alternative views on the American-European labor market divide, like Prescott (2004), Blanchard (2004) and others. Let's look over some contributions to that debate because its relation with the question of the working timetable.

Prescott (2004) attributes the relative fall in hours worked in Europe to the sharp increase in taxes experienced by several European countries (combination of tax and spending programs). Blanchard (2004) argues that Europeans work less than Americans because they have a stronger preference toward leisure. A large part of the decrease in hours per capita over the last 30 years in Europe reflects a decrease in hours worked per full-time worker, a choice that is likely to be made voluntarily by workers. Although there is some effect of taxes, the larger role is left for preferences.

In Michelacci and Pijoan-Mas (2006) it is analyzed the effects of labor market conditions on working time. They show that a higher probability of becoming unemployed, a longer duration of unemployment, and in general a less tight labor market discourage working time. Then, the different evolution of the labor market in the US and the EU (in terms of inequality and unemployment) explain between one half and two thirds of the US-EU differences in the evolution of working time.

In Ljungqvist's (2005) comment about Alessina, Glaeser and Sacerdote (2005) it is explained why the labor supply elasticity is different between macro and micro level. The theoretical high macro elasticity is the reason espoused by Prescott (2004) for understanding the effects of taxation. This high elasticity results in an economy where labor is indivisible and markets are complete, and households supply lotteries over employment. Then, the fraction of households optimally assigned to work by the employment lottery responds sensitively to the after-tax return to work. Ljungqvist concludes "it is not policies and institutions that changed in the 1970s but rather the economic environment that became more turbulent. Turbulence is modeled as negative shocks to individual workers' skills at the time of involuntary layoffs. Turbulence causes employment to fall in Europe because workers who experience skill losses in a welfare state with generous benefits based on past earnings set reservation earnings that are high compared to their current earnings potential. Since such jobs are hard to find, these workers optimally choose low search intensities and hence they become discouraged and are likely to fall into long-term unemployment or end up in other government programs, such as disability insurance and early retirement." So following Ljungqvist (2005) greater turbulence implies less hours per worker given that is more likely to become unemployed during recessions.

Rogerson (2005) argues that a simple look at the data suggests that changes in union density, union coverage, and employment protection are unlikely to have been major driving forces in shaping the differing evolutions of hours worked across countries. One important factor is differences in technology. Since Europe initially lags the United States in productivity in the mid-1950s, but largely caught up during the subsequent forty years, this effect could be relevant for partly explaining why hours in Europe were initially higher and decreased over time.

Obviously the debate is not finish. But our interest is center on *when* people work. At this respect, that we observe is the resulting match between workers and firms, that quite often have different interest. Next we analyze separately data from the perspective of workers and from the point of view of the firms.

2.1 Data from workers

The studies about the time use include obviously working time. The basic theory underlying most of these studies is that of home production (Becker, 1965; Gronau, 1980). The idea is that people combine time and market goods in producing non-market commodities. The fundamental contribution of this idea is that on average those people with higher prices of time (higher wage rates) will substitute purchased goods for time in producing "commodities" that contribute to their well-being.

In order to examine the data on the timing of work across a day or a week, we must look for the statistics on time use that some countries have recently begun to provide. These data sets, denominated time-diary survey, are collected from households that provide information about how they spend their time. So, each respondent is given a diary for one recent day and ask him/her to start at the day's beginning with the activity then underway and then indicate the time each new activity was undertaken and what that activity was. The nearly infinite number of possible activities that the households do are classified into economic categories. The cross-country comparisons must be treated with caution because the different countries' time-diary data are based on different categorizations of activities.

In Burda et al (2006) the activities are aggregated in four categories: market work, household production activities, tertiary activities and leisure. They present data describing the time that people spend in each of these main activities for Germany, Italy, the Netherlands and the US, and also they analyze when the activities are performed. The data showed confirm the widely-held belief that Americans do work more than Europeans. They also confirm the supposition that Americans tend to work at odd hours of the day and on weekends more often than Europeans. Assuming that underlying tastes are common to both continents, while technologies, institutions may differ and evolve differently, they consider that this fact may simply represent a bad equilibrium that no individual agent can improve upon, given what all others are doing.

In Spain, the first nationally-representative survey of time use is the Spanish Time Use Survey 2002-03 (STUS) from INE (2004). This study presents information about (among others) the percentage of people that take up an activity across the day and the average time that people spend on it.

First, we can look at the distribution of the working time between weekdays and weekends, from data in Burda et al. (2006) and from the STUS. The average number of hours people spend performing market work as principal activity is:

	weekdays	weekend
Germany	5.67	1.12
Italy	5.95	2.05
Netherlands	5.54	0.95
Spain	5.23	2.44
US	6.53	1.86

although the comparison is not accurate because data are getting from different years, and different groups of age.

From the STUS the percentage of currently employed people that are working at the beginning of each hour between midnight and the subsequent midnight are shown in TABLE 1. During weekdays this percentage is increasing from 1.9 at 3AM until 73.4 at 11AM. There is an important decrease in the percentage of people working between 2PM and 4PM, and afterwards there is another peak at 5PM followed by an important reduction during the late night. Although the percentages are lesser in weekends, the distribution of the work done over the day is similar to weekdays.

Respect to a gender differences, we observe that both men and women follow the same work pattern. Normally the percentage of women working is less than the men's at every time. Only in weekends, between 1PM and 10PM there is more incidence of female work (see TABLE 2).

In Burda et al (2006) we can see a more or less similar behavior in Germany, Netherlands, US and Australia, maintaining the necessary care to draw comparisons. "Until 6AM, and after 10 PM, a higher fraction of those who work at all on the day are at work in the US than in the other three countries. Workers in Germany and the Netherlands are at work disproportionately only during prime daylight hours, very few are working between midnight and 4PM, and not very many are working after 8PM. The timing of work in Australia is somewhere between that in the US and northern Europe". In Figure 3 are shown these data.

Other interesting point of view about working time from the workers perspective is to examine the relevance of shifts, overtime and flexible time among the labor force. All of them are ways of increasing the level of capital utilization and the operating time.

The principle means of extending the period of daily productivity are shift work and staggered working times and overtime. From the Labour Force Survey (LFS) (exactly, in an ad hoc survey in addition to the regular survey) of Eurostat, referred to 2001, we observe data about shift work, overtime and work schedules. Therefore, in European Union of 15 [EU 15], 15% of employees work shifts, men relatively more than women. In Belgium, Italy, Austria, Finland and Sweden the proportion of shift work exceeds 20%. In Denmark, France, and the Netherlands, on the contrary, it is 10% or less. Too, a double day shift is the most common pattern, that is, the employees perform shift work on a rotating basis in the early morning and the late afternoon. Looking at the economic activity, a double day shift is prevalent in the services sector of trade, hotels and restaurants and transport. Continuous shift work is prevalent in the public services (health).

Respect to overtime, in 2001, almost 18% of male full-time employees work overtime and 13% of female full-time employees, although there is a considerable variation across the Member States. In Greece, Spain, Ireland and Italy this proportion is far below the EU 15 average (only 5% or less). In contrast with full-time employees, relatively more female part-time employees work overtime than male part-time employees. The total amount of overtime is equivalent to almost 3% of total hours actually worked by female employees and 4% of male employees. In the Netherlands and the United kingdom, this relative amount is more than 8%.

The cited LFS shows that in the EU 15, 24% of employees work outside normal daytime hours during weekdays: this means that they work at least two Saturdays or Sundays per month or for half the period in the evening or during the night. In most Member States, more women work outside these normal hours on weekdays, but in Greece, Ireland, Portugal and the United Kingdom, more men do so. Looking at occupations, low-skilled, non-manual employees and employees in elementary occupations, particularly men, mostly work outside normal daytime hours during weekdays. In several Member States, Denmark, Spain, the Netherlands, Finland and the United Kingdom, at least half of low-skilled, non manual employees work outside these normal hours.

By other side, in the EU, one in five employees have flexitime. They can schedule their daily working hours beyond (or below) their contractual number of hours within certain limits. The credit hours can be accumulated and can be taken off as days of leave. The incidence of flexible working time arrangements varies across the Member States. In Denmark, Germany, France, Finland, Sweden and the United Kingdom, over 20% of employees work under some form of flexitime. In Greece, Spain, Italy, Luxembourg and Portugal on the other hand, less than 10% do so. In most Member States, men more frequently use flexitime, but in France, Ireland and Finland, women are more likely to use flexitime. From an occupational point of view, flexitime is prevalent among highly skilled, non-manual employees but relatively rare among employees in elementary occupations.

2.2 Data from firms

The decoupling of operating hours and working times - a necessary condition for the extension of operating hours - is the driving factor of the flexibilisation of working times. Determinants of the level of capital utilization include the capital-labour intensity, economies of scale, fluctuations in demand and supply of inputs and outputs and forms of industrial organization and institutional factors. Capital intensive industries tend to operate relatively longer hours. Labour intensive processes often had low capital utilization rates to avoid payment of higher costs of night and weekend shift. Hence, the relative cost of capital and labour is essential to choice the level of capital utilization.

Delsen et al. (2007) present some first analytical results from the 2003 representative European Union Company survey of Operating hours, Working times and Employment (EUCOWE) in France, Germany, the Netherlands, Portugal, Spain and the United Kingdom. The main objective of the EUCOWE project was the collection and analysis of comparative and representative data on the relationship between operating hours and working time arrangements, and their consequences for employment in the six EU-member countries. For analysis and comparison purposes it is necessary a homogeneous concept of operating hours for all sectors of activity (industry, private services and public service sector). Then, this study have used two different procedures to measure operating hours. The first, a direct measure, is just the actual number of hours of operation of the establishment during a given period of time, usually a week. The second measure of operating hours, the indirect measure, takes into consideration not only the number of hours the establishment is open, but also the intensity of the production process at different hours of the working day. That is, the duration of operating hours in shift work, in staggered working times, and in effective working times, each weighted with the employees in these three types of working time patterns which are constitutive for the extension of operating hours (the adjective "effective" refers to the consideration of overtime hours in the formula for the calculation)[1].

Over a net sample of 5,957 establishments, the EUCOWE-Spain survey (Muñoz de Bustillo and Fernández, 2007) analyses the operating times in Spain. With reference to the direct measurement of operating hours, 71% of Spanish establishments operate 8 hours per day, and 52% operate 40 hours per week. Too, 49% of employees work in establishments operating 8 hours a day, and 38% in establishments that operate 40 hours per week. By other side, although only 2.1% of establishments operate 24 hours a day, and only 1.6% operate 168 hours a week, these establishments employ, respectively, 18.5% and 14.1% of Spanish workers.

[1] For instance, if in an establishment with 100 employees, 50 employees work on a single shift of 8 hours per day and the other 50 are on a continuous shift-system (three 8 hours shift per day), the number of indirectly measured daily operating hours would be: (8 hours * 50 employees + 24 hours * 50 employees)/ 100 employees = 16 operating hours per day. The direct measure of operating hours would be 24.

Respect to de distribution of operating times in Spain by sector: the two extremes are construction, on the low side, and personal services on the high side. 93% of construction establishments operate 8 hours a day. At the opposite extreme, 55% of the establishments in personal services are open more than 8 hours per day. The industrial sector, as expected, shows the highest use of continuous production (24 hours): 4% of the establishments and 30% of the employees of this sector operate on a 24-hours basis. Measured in terms of direct weekly operating hours, Spanish establishments, weighted by number of employees, operate 69.1 hours a week. In personal services operating hours are 81.07, in secondary sector 78.0 and in construction 42.6.

Following the contribution to ECOWE project from Muñoz de Bustillo and Fernández (2007), the indirect operating hours indicator is lower than the direct equivalent, because that is a measure of the intensity in terms of the amount of labour employed throughout the different opening hours of operating time. By other side, there is an important relationship between operating hours and number of employees; the larger establishments operate many more hours than the smaller ones. This relationship can be observed both in the direct and in the indirect measure. Respect to the results by sector of activity, in the indirect measure the longer hours are in industry (40.5 weekly indirect operating hours). Personal services open more hours, but makes a less intensive use of labour than the secondary sector (40.49).

In sum, the organization of operating time that predominates in Spain is the traditional working time norm of our culture, that is, the 8 hour-5(6) day working week. The work pattern most used to extend operating hours is shift work, especially in sectors like industry and personal services. The other working time systems that could reflect more flexible working time forms are hardly used.

3 Theoretical perspective

The model is an attempt to integrate the issue of assigning heterogeneous workers to heterogeneous jobs with the literature on search and matching models. This question have been previously analyzed in Teulings and Gautier (2004). In that paper analytical instruments are proposed to solve the assignment of workers with different skill level to jobs characterized by their complexity level. In our model, we propose heterogeneous agents respect to the working time, and will make specific assumption to get more simplicity.

This economy lasts for one period (a day) and the length of the day is normalized to unity. It is populated by a continuum of people with measure 1. There are different agent types, $i \in I$, but the number of types is finite, N_I. The measure of agent type i is λ^i and $\sum_i \lambda^i = 1$.

People types are distinguished by their different preferences over leisure, especially respect to when they prefer enjoy leisure time. Individuals are identical in their endowment: a time endowment of 1 that can be allocated to either work or leisure, and $\overline{k} > 0$ units of capital, and individuals are also identical in their preferences about consumption.

Workdays are distinguished by the number of hours and by the moment at which work starts. So, we define a workday s, like a pair (t, h) where t is the moment at which work starts and h is the length.

The analysis of the preferences over leisure will be approach in Section 3.3 just to determine the effective workdays. Nevertheless, in advance we can say that each individual is represented by a function $\upsilon^i(t, h)$ that sums up the instantaneous value of leisure between t and $t + h$, which is measured by the function $\upsilon^i(\tau)$:

$$\upsilon^i(s) = \int_t^{t+h} \upsilon^i(\tau)\, d\tau$$

given that during the period the time pass continuously.

In the first part, the production is organized in teams consisting of a group of workers, using capital during one type of workday. Given the constant returns to scale in capital and labor, we consider a team only by the ratio capital per worker and the correspondent workday. The firm can create a team at zero cost and the free entry assumption drives profits down to cero. In the search part of the paper, firms have jobs occupied by one worker or they have open vacancies, where both jobs and vacancies imply certain workday. Firms with an open vacancy pay a cost to keep the vacancy posted.

Although workers and jobs are heterogeneous, output is effectively homogeneous. Then in Walrasian equilibrium only some types of teams will be operated. In the economy with frictions vacancies are opened in small number of job types only. Our purpose is to investigate how the workday influences on the chosen types.

The first part is an extension of a previous model in Garcia-Sanchez and Vazquez (2005). The model is extended by considering heterogeneous workers. In this manner, there will be a great variety of workdays, both determined by the shift system and determined by different preferences. In the second part, we elaborate a matching model with bargain about the workday. In line with the basic model in Pissarides (2000), the treatment of the heterogeneity follows Marimon and Zilibotti (1999) and Teulings and Gautier (2004) and we incorporate the issue of work schedules.

3.1 The workday in a model of teams and heterogeneous workers

The production is organized in teams consisting of a group of workers, using capital during one type of workday. We represent this economy in McKenzie-type general equilibrium language. Let a commodity point x be an element of the Euclidean space L. The consumption set X^i of a type i agent is a subset of the commodity space L. Preferences over consumption bundles in X^i are represented by the utility function $U^i : X^i \rightarrow R$. Production is described by some aggregate production possibility set Y, which is a convex cone in L. An allocation $[(x^i)_{i\in I}, y]$ is feasible if $x^i \in X^i$ for all $i \in I, y \in Y$, and $\sum_{i\in I} \lambda^i x^i = y$.

3.1.1 Technology

Output is produced by a large number of production teams which can operate in different workdays. Some of these teams operate in shift systems and then, the operating time of capital utilized is longer than a corresponding workday. Other teams operate during certain workday and they do not belong to a shift system. A production team is a group of workers, e, working during a workday s, with k units of capital. Thus, a production team type can be characterized by (k, e, s).

This way of defining a team is an extension of the *plant* in Hornstein and Prescott (1993), where both the length of time over which a plant can be operated and the number of workers operating it can be varied, and a plant is characterized by (k, e, h).Fitzgerald (1998) also extend the plant concept of Hornstein and Prescott in his general equilibrium model of team production. In each team of Fitzgerlad there are two differents types of workers, that must be coordinated. In comparison with those models, our technology allows, in addition, a plant to be operated for more than a workday, and different plants can be operated during the same workday. This logically implies that more than a team can use the same stock of capital if their workdays do not overlap. Too, the equilibrium determines the type of worker who work in each team.

Concerning the output of a team, we distinguish between the instantaneous production and the total production. The instantaneous production function is $f(k, e)$, which displays constant returns to scale, but the resulting output depends on the workday type that the team operates. Both the length and the moment of starting matter because we could consider, for example, that the productivity in a 8-hour workday is not the same during days and nights. So, the output of a type (k, e, s) team is: $F(k, e, s) = f(k, e)\ g(s)$, where $g(s)$ measures the effective working time of a workday starting at t and ending at $t + h$. If the set of feasible workdays is denoted by S, then $g : S \rightarrow R_+$, multiplies the instantaneous output of the team that operates the workday (t, h). Therefore, although both capital and labour are homogeneous, they become different inputs depending on the workday they work.

3.1.2 Traded commodities

The model is in continuous time. However, it is simplified by assuming that there is a finite number of feasible workdays, $S = \{s_1, s_2, ...s_{N_s}\}$ which is a subset of a bigger set of workdays, $T \times H$. That is, the set of possible workday lengths denoted by H, where $H \subset [0, 1]$, $H = \{h_0, h_1, ...h_{N_H}\}$ and the set $T = \{t_0, t_1, ...t_{N_T}\}, T \subset [0, 1[$, that contains the possible starting times, but we consider only some workdays that are undertake commonly, following the evidence previously cited.

Introducing a finite number of different workdays creates an indivisibility then, following Rogerson (1988), people supply a lottery contract that specifies the probability of working different workdays, and they will work only one workday depending of the lottery's outcome.

The commodity space, L, is $R^2 \times M(S)$, where $M(S)$ denotes the set of signed measures on the Borel sigma algebra of S. An element of L is given by (c, k, n), where c is the consumption good, k denotes the services of the capital stock, and n is a measure over labour workdays. One unit of capital produces one unit of capital services. When S is a finite set, n is a vector and $n(s)$ is the measure of type s workday (with start at t and length h). The agent who chooses a point in L receives c units of the consumption good in exchange for providing k units of capital[2] and some measure n over labour workdays.

3.1.3 Production possibility set

Let $\mathbf{K}$ and $\mathbf{E}$ be finite sets, and let J be $\mathbf{K} \times \mathbf{E} \times S$, the set of feasible teams, with generic element (k, e, s) and cardinality N_J. We can index team types by $j = \{1, 2, ..., N_J\}$. A production plan organizes the distribution of inputs across teams of different types, given that workers are available for certain workdays, while capital is available at the beginning of the period, and each time a shift finishes the capital utilized is available for another shift. Let m_j denote the measure of type j team operated, then the production plan is a vector of N_J numbers, $\{m_1, m_2, ..., m_{N_J}\}, m \in R_+^{N_J}$, $m_j \geq 0$, that describes how the inputs are allocated across teams of different types. The production possibility set, Y, is defined as:

[2] The component k of the commodity space is not the same as the element k of a team because the latter is an element of a finite set. Thus they are denoted differently.

$$
\begin{aligned}
Y \equiv \{\{C,K,N\} &: \textit{there exists a production plan } m \in R_{+}^{N_J} \textit{ such that} \\
& C \le \sum_j m_j\ f(k_j,e_j)\ g(s_j) \\
& \sum_{\{j:\, t_j\ \le t\ <\ t_j+h_j\}} m_j\ k_j \le K, \qquad \textit{for each} \qquad t \in T \\
& \sum_{\{j:\, h_j=h,\ t_j=t\}} m_j\ e_j \le N(s), \qquad \textit{for each} \qquad s \in S\ \}
\end{aligned} \tag{1}
$$

The first constraint says that the total amount of the consumption good is less than or equal to the total output produced by all team types. The second constraint states that, for each feasible starting time, the capital allocated across all the team types with this starting time or with the previous starting time but not finished yet is less than or equal to the total capital available. The third constraint states that the amount of type s workdays allocated across all team types is less than or equal to the total amount of type s workdays available. It is immediate that Y is a convex cone.

3.1.4 Preferences

Respect to individuals' preference ordering and their feasible consumption bundles: The utility of a type $i \in I$ person choosing the commodity point $x = (c, \mathrm{k}, n)$ is given by:

$$
U^i(x) = u(c) - \sum_s n^i(s)\ v^i(s) \tag{2}
$$

where $v^i : S \longrightarrow R_+$ represents the disutility of working the workday s, and : $u : R \longrightarrow R$; $v(0,0) = 0$, and $\lim_{c \to 0} u'(c) = \infty$. The function $u(c)$ is assumed to be continuously differentiable and strictly concave. Notice that $\sum_s n^i(s)\ v^i(s)$ is the expected disutility of working for a type i person. The consumption possibility set of an agent type i is:

$$
X^i(\ \overline{k}\ ) = \left\{ (c,\mathrm{k},n) : \mathrm{k} \le \overline{k},\ c \ge 0,\ \mathrm{k} \ge 0, \sum_{s\in S} n^i(s) = 1,\ n^i(s) \ge 0 \right\} \tag{3}
$$

which contains the standard nonnegativity constraints and the conditions that capital services are restricted by the capital stock endowment, and n is a probability measure.

3.1.5 Competitive equilibrium

The commodities traded are given by $x = (c, \mathrm{k}, n)$. Prices are in terms of the consumption good. The rental price of capital is r. The wage is a function w mapping signed measures into R. With a finite set of possible workdays, w is a vector of prices, where $w(s)$ is the price of the type s workday. That is, if a person works the workday s with probability 1, $w(s)$ units of the consumption good are received.

The firm rents capital, employs workers for workdays of different types and decides how to allocate these resources across all the teams. On hiring workers, the firm buys lottery contracts that specify the probability of a person working workdays of different types, possibly including a workday of length 0. All the individuals of the same type will sell the same lottery contract, but people of different types will choose different probabilities. In fact, each workday will be worked by a measure of agents similar to the sum of the probability specified by the contract of working that workday of each type multiplied by the measure of that type.

Given prices (r, w), the firm chooses quantities (C, K, N) to solve:

$$Max \;\; C - rK - \sum_s w(s)\; N(s) \tag{4}$$

$$s.t.: (C, K, N) \in Y \tag{5}$$

where $N(s)$ is the measure of workdays of type s.

In this economy individuals purchase the consumption good and sell capital and labor services to firms. The labor services are supplied in the shape of lottery contract that specifies the probability of working different workdays. The amount an individual receives for a given lottery contract does not depend on the lottery's outcome, that is, on the type of workday the individual works ex post, but the probabilities of work supplied. A type i person faces the decision problem:

$$Max \;\; u(c) - \sum_s n^i(s)\; v^i(s) \tag{6}$$

$$s.t.: (c, \mathrm{k}, n) \in X^i(\overline{k}) \tag{7}$$

$$c \leq r\mathrm{k} + \sum_s w(s)\; n^i(s) \tag{8}$$

Definition of equilibrium

A competitive equilibrium for this economy is an allocation $[(x^{i*})_{i\in I}, y^*]$ and a price system (r, w) such that:

i) x^{i*} maximizes $U^i(x)$ subject to $x^i \in X^i(\overline{k})$ and the budget constraint (8).

ii) y^* maximizes (4) subject to $y \in Y$.

iii) $\sum\limits_{i\in I} \lambda^i x^{i*} = y^*$.

In this economy with heterogeneous agents, individuals of the same type choose the same commodity point, although this does not imply that all of them work the same workday, since the chosen commodity point will involve randomizing over different workdays.

We can simplify the model and analyze a simpler equivalent problem. For this version, we define $\mathbf{k}$ $=k/e$ as the capital-labour ratio in a team. So, the event j is characterized by a pair ($\mathbf{k}$,s) which is interpreted as a team operating the workday s, and using $\mathbf{k}$ units of capital per worker. There is a finite number, N_J, of ($\mathbf{k}$,s) pairs indexed by $j = \{1, 2, ...N_J\}$. The measure of workers in each type of team, n_j, is the sum of different types of workers who supply work at the workday of this team. The problem that a social planner would solve is:

$$\underset{c^i, n^i_j}{Max} \sum_i \lambda^i \left[u(c) - \sum_j n^i_j \; v^i(s_j) \right] \tag{9}$$

$$s.t.: \sum_i \lambda^i c^i \leq \sum_j \; f(\mathbf{k}_j) \; g(s_j) n_j \tag{10}$$

$$\sum_{j:\, t_j \leq\, t\, < t_j + h_j} n_j \; \mathbf{k}_j \leq \overline{k} \qquad all\; t \in T \tag{11}$$

$$\sum_i \lambda^i n^i_j = n_j \quad all \quad j \in J \tag{12}$$

$$\sum_j n^i_j = 1 \quad all \quad i \in I \tag{13}$$

That is, the planner assign workers of different types to teams with different workdays. Given that $f(k, e)$ displays constant returns to scale, the solution to this problem has the same measure of agents working each workday (s) on shifts with $\mathbf{k}$ units of capital per worker as does the solution to the original problem.

In order to make the reasoning easier, let's suppose that all the types has the same measure: $\lambda^i = \lambda$ for all i, and then $\lambda = 1/N_I$.

We divide the Pareto problem into two subproblems: one that is a linear program and one that is a nonlinear problem. Let the function $V : R^{N_J x N_I} \to R$ be defined as:

$$V(n) = -\sum_i \sum_j n_j^i v^i(s_j)$$

This function returns the disutility of work associated with the working plan n. Notice that $V(n)$ is linear in n.

Given the division of the Pareto problem, and by substituting the constraint (12) in (10), it is possible to consider:

$$W(C) = \max_{n \geq 0} \; V(n) \tag{14}$$

$$s.t. : C \leq \sum_j \; f(\mathbf{k}_j) \; g(s_j) \sum_i n_j^i \tag{15}$$

$$\sum_{j:\, t_j \leq \, t \, < t_j + h_j} n_j \; \mathbf{k}_j \leq \overline{k} \qquad all \; t \in T \tag{16}$$

$$\sum_j n_j^i \leq 1 \quad all \quad i \in I \tag{17}$$

where $C = \sum c^i$. Let $C_{\max}$ be the solution to $\max_{n \geq 0} C$ subject to (15)-(17). $W(C)$ is the smallest sum of the disutilities of working associated with producing C units of output, and $C_{\max}$ is the maximum feasible value of C which can be produced. For $0 \leq C \leq C_{\max}$ there exists a solution which has at most a number of nonzero unknowns equal to the number of constraints, that is to say $N_T + N_I + 1$. The original problem can be rewritten as:

$$\begin{gathered} Max_{c^i \geq 0} \; \sum u(c^i) + W(C) \\ s.t : \sum c^i \leq C_{\max} \end{gathered}$$

where it is straightforward that the solution is $C_{\max}$ given the continuity and strict concavity of $u(c)$ and the concavity of W. Associated with this unique value of c is the unique n that solves (14-17), which has at most $N_T + N_I + 1$ nonzero elements.

Hence, the Pareto optimal allocation (which must be an equilibrium allocation) will assign positive value at most $N_T + N_I + 1$ different n_j^i. The number of different teams that will start to run, the measure of workers allocated to these and the type of workers depend on the coefficients both in the objective function and in the constraints, as well as the parameter values in the constraints. That is to say, it is a question of $\mathbf{k}_j$, $f(\mathbf{k}_j)$, $g(s_j)$, $v(s_j)$, and $\overline{k}$. We can see this through the dual constraints or first-order conditions with respect to n_j^i:

$$-v^i(s_j) + f(\mathbf{k}_j) g(s_j) \; \rho_0 - \mathbf{k}_j(\sum_{p=t_j}^{p=t_{z-1}} \rho_p) - \rho_i' \leq 0 \qquad \forall \, n_j^i \tag{18}$$

where ρ_0 is the Lagrange multiplier associated with the constraint (15); each ρ_p is the multiplier on the constraint of the capital corresponding to the starting time t_j, that is, the constraints denoted (16). Then, the condition (18) corresponding to a type j team, with starting time t_j and ending time $t_z = t_j + h_j$, includes the multipliers associated with the starting times from t_j to t_{z-1}, given that, at the moment t_z the capital allocated to this team can be used for another team. The multiplier ρ_i' is associated with the labour supply constraint of the individual type i. Equation (18) must hold with equality if n_j^i is strictly positive.

Now, we are interested in examining what type of workdays are determined by the interaction of the individuals' preferences and team technology. Individuals' preferences over workdays determine the shape of the wage schedules and the firm, then, chooses the teams that are going to be operated. Therefore, first we look at the equations (6)-(8), which show the individual's maximization problem. From the necessary conditions for a solution we obtain:

$$\begin{aligned} \rho v^i(s_j) + \rho_i &\geq w(s_j) \; for \; all \; s \in S \\ \rho v^i(s_j) + \rho_i &= w(s_j) \; if \; n_j^i \geq 0 \end{aligned} \tag{19}$$

where ρ is the inverse of the multiplier on the budget constraint. ρ_i is the multiplier on the constraint that an individual cannot place more than one unit of probability across different workdays. The multiplier ρ_i is nonnegative and equals zero if a positive weight is placed on working a workday of length 0. The condition in (19) holds with equality if a lottery contract is traded that has a strictly positive probability of individual type i of working a workday s_j. Then, individuals will supply their work only on the workdays that the wage reaches the level indicated by the left-hand side of the equations in (19). Given that ρ and ρ_i are determined in equilibrium, these levels can be interpreted as the supply reservation wages of the different workdays, and are defined as

$$\overline{w}_j^i = \rho^* v^i(s_j) + \rho_i^* \tag{20}$$

where ρ^* and ρ_i^* are equilibrium values. The supply reservation wages are the wages the firm must pay to attract workers at various workdays.

Now, we shall take a closer look at how workdays are determined in the firm's decision problem given in (4) and (5). If we bear in mind that the restriction of capital is applied to all starting times t, and that the amount of work available to each workday will be employed in it (the constraint about $N(s)$ will hold with equality), the necessary conditions for a solution are:

$$\begin{aligned} f(k_j, e_j)g(s_j) - w(s_j)e_j - k_j \sum_{p=t_j}^{p=t_{z-1}} \rho_p &\leq 0 \; for \; all \; j = (s_j, k_j, e_j) \in J \\ &= 0 \; for \; all \; j \; with \; m_j > 0 \end{aligned} \tag{21}$$

$$r = \sum_{i=t_0}^{t_{N_T}} \rho_p \tag{22}$$

where each ρ_p is the multiplier on the constraint that the capital is restricted in the starting time t_p and, if the shift type j lasts until $t_z = t_j + h_j$, then $\rho_{t_{z-1}}$ is the multiplier on the constraint corresponding to the previous starting time (as shown in the condition (18)). The condition in (21) states that no team type earns strictly positive profits in equilibrium, and the team types that are operated generate zero profit. The condition in (22) states that the cost of a unit of capital utilized sums up the *costs* resulting from every moment that this unit is utilized. Since the left-hand side of (21) is homogeneous of degree one in (k, e), only the ratio k/e (denoted $\mathbf{k}$) is determined for the workday type s among the team types that effectively work this workday in equilibrium. That is, in equilibrium, if more than one team operates during the same workday, the rate k/e is the same for them given the constant returns to scale in function f. Define the profit function:

$$\Pi(\mathbf{k},s) = f(\mathbf{k})\ g(s) - w(s) - \mathbf{k}\ r_k \tag{23}$$

where $r_k = \sum_{p=t}^{t+h-1} \rho_p$.

It is necessary to decide on what team are going to operate and what type of workers will operate them. Given the reservation wage for each workday and for each type of worker, the wage that will be paid in each team is:

$$w(s_j) = \min\{\overline{w}_j^1, \overline{w}_j^2, ...\overline{w}_j^I\}$$

We can state that any team type (k^*, e^*, s^*) that is operated in equilibrium must satisfy:

$$\{k^*/e^*, s^*\} \in \ \arg\ \max\ \Pi(\mathbf{k},s) \qquad s.t. : (k^*, e^*, s^*) \in J \tag{24}$$

Then, in order to gain insight into the equilibrium patterns of timing that arise in this model it is necessary to specify both the function $v(t, h)$, that describes individuals' preferences over workdays, and the function $g(t, h)$, that measures the effective working time of a workday starting at t and ending at $t + h$. This will be made in Section 3.3.

3.2 The workday in a search-matching equilibrium

We are going to consider a market with frictions. Then it is more difficult to find the optimal matching partner. Workers search for a job which workday fit in well with their preferences. Jobs search workers who prefer these workdays because they will be more willing to work. The wage is given by bargain at the individual level. That is, wages are fixed as if the firm engages in Nash bargains with each employee separately, by taking the wages of all other employees as given. This assumption is clearly the closest one to competitive wage determination in this market environment.

Now, in this economy firms open vacancies of different types denoted by j where $j \subset [0,1]$ represents the moment of the day in which the production is maxima. The measure of each type, denoted by $\vartheta(j)$, will be determined by the free-entry condition. The measure of each type of worker is λ_i. We consider a type i like a worker whose moment most preferable to work is i, being $i \subset [0,1]$ And the measure of unemployed of each type is $\mathfrak{u}(i)$.

The probability of a worker type i contacts with a vacant job type j, $p(i,j)$ is an increasing function of the measure of vacancies type j. Too, the probability of a job type j contacts with a worker type i, $q(i,j)$ increases with the measured of unemployed type i. We assume a simple linear contact rate, like in Teulings and Gautier (2004), such that:

$$\begin{aligned} p(i,j) &= \xi \ \vartheta(j) \\ q(i,j) &= \xi \ \mathfrak{u}(i) \end{aligned} \tag{25}$$

where ξ is a technological parameter which measures the efficiency of the contact process. That is a matching technology without congestion effects and increasing returns to scale. Teulings and Gautier (2004) offer arguments to support it, especially that this technology refers to the number of contacts between workers and firms, and not all contacts yield a match.

The worker and the firm bargain the working conditions (wage and workday) and any match with a value that exceeds the sum of the outside options of worker and firm is acceptable. When matched the worker-firm pair starts production, and the output is a function $g(s_j)$ of the workday operated in that job, that multiplies to the instantaneous production function $f(k_j)$. The value of being employed is the wage paid in that job minus the disutility of work the corresponding workday. Job destruction is exogenous and follows a Poisson process with arrival rate δ that is common for all jobs. After separation worker becomes unemployed. All unemployed get the same flow income z that bear no direct relation to their preferences over leisure time[3].

We can consider that k corresponds not only to the capital stock but also to the quality of the equipment, the type of job, such that each job has a $f(k)$ that conditions the workday to performance. Firms hire their capital stock in the previous period and it is natural that it has a high degree of irreversibility.

Next we derive the asset value equations for filled and unfilled jobs. Let r be the common discount rate for both firms and workers. The cost of maintaining an unfilled job is d. The value of firm holding an open vacancy type j is given by:

$$rV(j) = -d + \sum_i q(i,j)\{Max[J(i,j), V(j)]\} \tag{26}$$

[3] It is assumed that in the function $v(s)$ the workday $(0,0)$ represents unemployment, and $v(0,0) = 0$.

and $J(i,j)$ is the asset value of a job type j occupied by a worker type i, that satisfies:

$$rJ(i,j) = f(k_j)g(s_j) - w(i,j) - \delta J(i,j) \tag{27}$$

Respect to the workers' decisions, $R(i)$ denotes the reservation wage for type i, then the value of search for a worker is:

$$R(i) = z + \frac{1}{r+\delta} \sum_j p(i,j)[w(i,j) - v^i(j)] \tag{28}$$

In the bargaining, any match with a value that exceeds the sum of the outside options of worker and firm is acceptable. Let $m_j(i)$ be the subset of j such that the match is acceptable for the individual i, and $m_i(j)$ is the subset of types i with which the job j will match. These subsets are determined by:

$$J(i,j) - V(j) - R(i) > 0 \Longleftrightarrow j \in m_j(i) \Longleftrightarrow i \in m_i(j) \tag{31}$$

From these definitions, the value of search for a firm is:

$$d = \frac{\xi}{r+\delta} \sum_{i \in m_i(j)} \mathfrak{u}(i)[f(k_j)g(s_j) - w(i,j)] \tag{33}$$

and for a worker:

$$R(i) = z + \frac{\xi}{r+\delta} \sum_{j \in m_j(i)} \vartheta(j)[w(i,j) - v^i(j)] \tag{34}$$

Wage are sets by Nash bargainig over the match surplus. Hence

$$w(i,j)] = \beta[f(k_j)g(s_j)] + (1-\beta)v^i(j) \tag{35}$$

where $0 < \beta < 1$, denotes the workers' bargaining power. Substituting (35) in (33) and (34) yields:

$$d = \frac{\xi\ (1-\beta)}{r+\delta} \sum_{i \in m_i(j)} \mathfrak{u}(i)[f(k_j)g(s_j) - v^i(j)] \tag{36}$$

$$R(i) = z + \frac{\xi\beta}{r+\delta} \sum_{j \in m_j(i)} \vartheta(j)[f(k_j)g(s_j) - v^i(j)] \tag{37}$$

In the steady-state the number of workers finding a job must equal the number loosing their job:

$$\xi\ \mathfrak{u}(i) \sum_{j \in m_j(i)} \vartheta(j) = \delta(\lambda - \mathfrak{u}(i)) \tag{38}$$

The equilibrium is a quintet $\{\mathfrak{u}(i), \vartheta(j), m_i(j), m_j(i), s_j\}$ solving the equations (31), (36)-(38).

In order to determine the jobs type in acceptable matches and in what measure, it is necessary to specify the bargain about the workday. The next Section explores the way of consider the work schedules in both economies analyzed.

3.3 Determination of work schedules

From the evidence on working schedules showed in Section 2, most of people are working in the morning, between 8.00 and 13.00. This must be the result of the equilibrium both in the assignment of heterogeneous workers to heterogeneous jobs as in the bargainig between firm and worker.

In this Section, we alter the problem slightly. Now the set of feasible workday is given by:

$$S = \{(t, h)/t \in [0, 1[, h \in [0, 1], t + h \leq 1, h = 0 \Longrightarrow t = 0\}$$

The output produced by a team or in a job depends on the type of workday undertaken. Given the workday $s = (t, h)$ the function $g(s) : S \to R_+$ measure the effective working time that wears on from t until $t + h$ in the following manner:

$$g(s) = \int_t^{t+h} y(\tau) d\tau \tag{39}$$

This function allows the introduction of different assumptions about the instantaneous function y. First, we assume that the function y is the same for all teams.

Respect to the disutility of work certain workday, the function $v(s)$ sums up the instantaneous value of leisure between t and $t + h$, which is measured by the function $\upsilon(\tau)$:

$$v(s) = \int_t^{t+h} \upsilon(\tau)\, d\tau \tag{40}$$

Different types of workers have different function $\upsilon(\tau)$, that is $\upsilon^i(\tau)$, such that between the limits of a workday that individual likes the desutility $v^i(s)$ reaches a less value than in whichever other workday.

Then if there exist enough differences between the workdays individuals prefer, there is a suitable type of individual for each possible workday. Looking at condition (24) and for a given k, the team j is operated by the worker i if $v^i(s_j) < v^{i'}(s_j) \quad$ for all $i' \neq i$.

Substituting in (23) the functions (39), (40) and (20), the workday in a team is given by:

$$\max_{t,h} \; f(k_j)\int_t^{t+h} y(\tau)d\tau - \rho^* \int_t^{t+h} \upsilon^i(\tau)d(\tau) \tag{41}$$

and the necessary conditions are:

$$\begin{aligned} f(k_j)y(t) &= \rho^*\upsilon^i(t) \\ f(k_j)y(t+h) &= \rho^*\upsilon^i(t+h) \end{aligned} \tag{42}$$

that is, the optimal moment to start is the instant in which the marginal utility of leisure, weighted with the marginal utility of consumption, coincides with the marginal productivity at that instant, and the same concerning the optimal moment to finish.

Determination of working schedules under capital adjustments

It is assumed that the function $\upsilon^i(\tau)$, that measures the instantaneous value of leisure, depends on i. We adopt a piece-wise linear function, decreasing until i, the preferable moment to work, and increasing afterwards:

$$\upsilon^i(\tau) = \begin{cases} \alpha i - \alpha\tau & if \quad \tau < i \\ \alpha\tau - \alpha i & if \quad \tau \geq i \end{cases} \tag{43}$$

where $\alpha > 1$.

Respect to the firms, the instantaneous production function $y(\tau)$ increases from 0 to the moment $\overline{\tau}$, and then it decreases until the end of the day. We assume to simplify:

$$y(\tau) = \begin{cases} 1 - \mu(\overline{\tau} - \tau) & if \quad \tau < \overline{\tau} \\ 1 + \mu(\overline{\tau} - \tau) & if \quad \tau \geq \overline{\tau} \end{cases} \tag{44}$$

where $\mu > 1, 0 < \overline{\tau} < 1$, $\overline{\tau} < 1/\mu$ and $\mu \neq \alpha$.

Giving (43) and (44), we solve the conditions in (42) to get:

$$t(i,j) = \frac{\alpha i - f(k_j)[1-\mu\overline{\tau}]}{\alpha + \mu f(k_j)}; \qquad (t+h)(i,j) = \frac{\alpha i + f(k_j)[1+\mu\overline{\tau}]}{\alpha + \mu f(k_j)} \tag{45}$$

$$h(j) = \frac{2f(k_j)}{\alpha + \mu f(k_j)}$$

the starting time depends on the value of i and on the rate k utilized in the team j. The length of the workday only depends on k_j. It is straightforward to see that $\frac{\partial t}{\partial k} < 0$ and $\frac{\partial h}{\partial k} > 0$, that is the workday starts earlier and finish later in teams with a greater k.

In order to get a workday including in S the types i, j must satisfy the following:

$$i \leq \frac{1-\mu\overline{\tau}}{2-\mu} \qquad and \qquad f(k_j) \leq \frac{\alpha i}{1-\mu\overline{\tau}} \Longrightarrow i \in [\frac{(1-\mu\overline{\tau})\, f(k_j)}{\alpha}, \frac{(1-\mu\overline{\tau})}{2-\mu}]$$

Under certain relation between the function $f(k)$ and the parameters α, and μ, there is only a value of i that can be employed in the team j, and there is only an amount of k that can be utilized. This relation is: $f(k_j) = \frac{\alpha}{2-\mu}$

For values of k such that $f(k) < \frac{\alpha}{2-\mu}$ the interval of feasible types i is decreasing with k.

Then, to solve the problem in (24) requires that the teams running in equilibrium utilize the rate k such that $f(k) = \frac{\alpha}{2-\mu}$, the workers whose prefered moment is $i = \frac{1-\mu\overline{\tau}}{2-\mu}$, and the workday $t = 0, h = 1$. The measure of teams and the measure of people working in that optimal team depends on the relation between the k required and the available $\overline{k}$, and it depends also on the measure of type i.

Determination of working schedules without capital adjustments

Now, in the context of determination of work schedules after the job-worker match, we consider the following assumption. Firms open vacancies with the same capital-labor rate, but the quality of equipment or some other qualitative characteristic implies that each job has a moment of the day in which the production reachs the highest level. Then, the value of the function $f(k_j)$ is the same in all jobs, $f(k_j) = \overline{f}$, and could be $\overline{f} = 1$ and the function $g(s_j)$ is:

$$g_j(s) = \int_t^{t+h} y_j(\tau) d\tau \tag{46}$$

$$y_j(\tau) = \begin{cases} 1-\mu(j-\tau) & if \quad \tau < j \\ 1+\mu(j-\tau) & if \quad \tau \geq j \end{cases} \tag{47}$$

in order to consider that jobs differ respect to the instant j in which the production function changes, being $j \in [0, 1]$, too.

The workday that results from the Nash bargain satisfies:

$$\frac{\partial g}{\partial t} = \frac{\partial v}{\partial t} \qquad and \qquad \frac{\partial g}{\partial h} = \frac{\partial v}{\partial h}$$

and considering only the case $\alpha > \mu$, it is deduced:

$$t^* = \frac{\alpha i + \mu j - 1}{\alpha + \mu} \qquad with \quad t^* \leq j, t^* < i \tag{48}$$

$$(t+h)^* = \frac{\alpha i + \mu j + 1}{\alpha + \mu} \qquad with \quad (t+h)^* \geq j, (t+h)^* > i \tag{49}$$

and h is constant being $h = 2/(\alpha + \mu)$. By definition $(\alpha + \mu) > 2$, so $h < 1$.Given that j and i can take values in $[0, 1]$, it is necessary to delimit the set of pairs (i, j) such as the workday does not extend out of the limits of the considered period ($t \geq 0$ and $t + h \leq 1$). By that, only will be considered the restricted set:

$$(i, j) \in \left[\frac{1}{\alpha + \mu}, 1 - \frac{1}{\alpha + \mu}\right]^2$$

In addition, the fulfilment of the maximum conditions respect to t and h requires:

$$|j - i| \leq \frac{1}{\alpha}$$

it is to say, the bargained workday will be optimum if the distance between firm and worker does not exceed $1/\alpha$.

Then, as a result of the bargaining it is obtained:

$$g_j(i, j) = \int_{t^*}^{(t+h)^*} y_j(\tau) d\tau = \frac{\mu + 2\alpha - \alpha^2 \mu (j - i)^2}{(\alpha + \mu)^2}$$

$$v^i(i, j) = \int_{t^*}^{(t+h)^*} v^i(\tau) d\tau = \frac{\alpha + \alpha \mu^2 (j - i)^2}{(\alpha + \mu)^2}$$

$$\chi(i, j) = g_j(i, j) - v^i(i, j) = \frac{1 - \alpha \mu (j - i)^2}{(\alpha + \mu)} \tag{50}$$

The difference between j and i determines the *net output* of the match that is denoted by $\chi(j - i)$.

It possible to stablish that:

$$m_j(i) = \left\{ j \ / \ |j - i| \leq \frac{1}{\alpha} \right\} \qquad m_i(j) = \left\{ i \ / \ |j - i| \leq \frac{1}{\alpha} \right\}$$

4 Concluding remarks

In order to explain the determination of working schedules that prevail in most of firms, we elaborate a broad enough model which can be applied to different scenarios. Too, it is possible to consider various functions' specifications to stress the relevance of different variables. The technology wich organizes the production in teams is useful as well.

The equilibrium workdays are determined by the preferences over leisure, the capital-labor rate utilized, the capital constraints and the effect of time over the function of production.

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TABLE 1

Employees working at the begining of each hour (%)

Total ocupados

Tour	Total	Weekdays	Weekends
00:00	2,3	2,4	2,2
01:00	2,1	2,2	2,0
02:00	1,9	2,0	1,7
03:00	1,8	1,9	1,5
04:00	1,9	2,1	1,5
05:00	2,2	2,4	1,6
06:00	4,4	5,3	2,2
07:00	10,2	12,7	3,8
08:00	33,3	43,0	8,8
09:00	50,2	64,9	13,4
10:00	56,5	72,5	16,4
11:00	57,4	73,4	17,2
12:00	56,6	72,4	16,9
13:00	47,4	60,5	14,6
14:00	26,3	33,5	8,4
15:00	25,7	33,2	6,9
16:00	34,0	44,6	7,5
17:00	38,1	49,9	8,6
18:00	33,3	43,2	8,5
19:00	25,2	32,0	8,0
20:00	15,6	19,1	7,0
21:00	8,9	10,4	5,4
22:00	5,4	5,9	4,0
23:00	4,0	4,3	3,3

Source: STUS 2002-03

Figure 1

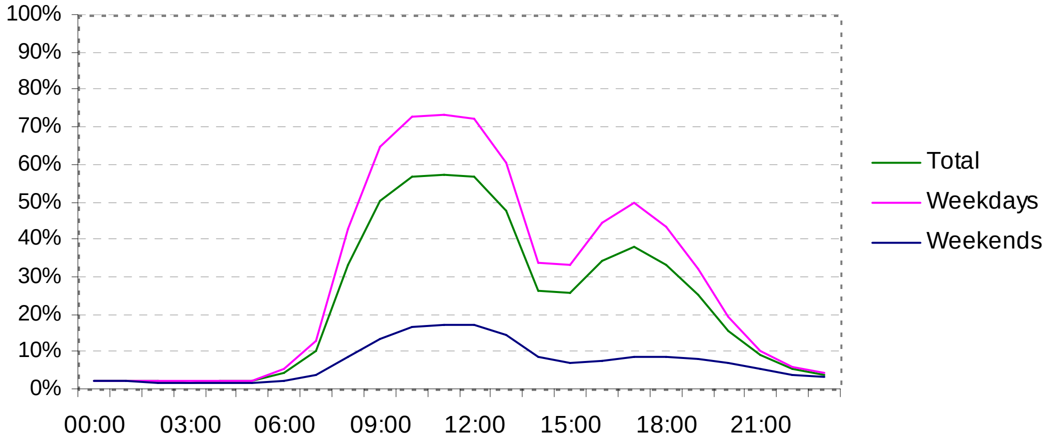


TABLE 2

Hour	Total men	Total women	Weekdays men	Weekdays women	Weekends men	Weekends women
00:00	2,7	1,7	2,8	1,7	2,5	1,6
01:00	2,5	1,4	2,6	1,5	2,3	1,3
02:00	2,3	1,2	2,5	1,3	2,0	1,1
03:00	2,2	1,1	2,4	1,2	1,8	0,9
04:00	2,4	1,1	2,6	1,2	2,0	0,9
05:00	2,8	1,2	3,0	1,3	2,0	0,9
06:00	5,5	2,7	6,6	3,3	2,7	1,3
07:00	12,6	6,4	15,8	7,8	4,5	2,8
08:00	40,1	22,1	52,1	28,3	10,2	6,7
09:00	55,3	41,8	71,7	53,9	14,4	11,7
10:00	59,7	51,4	76,9	65,5	16,7	16,0
11:00	60,4	52,5	77,6	66,7	17,4	16,9
12:00	59,9	51,2	77,0	65,0	17,0	16,8
13:00	49,4	44,2	63,5	55,8	14,3	15,1
14:00	26,7	25,7	34,2	32,3	7,9	9,2
15:00	28,9	20,5	37,8	25,8	6,5	7,5
16:00	38,9	26,0	51,5	33,5	7,6	7,4
17:00	42,5	31,0	56,1	39,9	8,4	8,8
18:00	36,1	28,7	47,3	36,6	8,3	8,9
19:00	26,1	23,7	33,5	29,6	7,6	8,8
20:00	15,5	15,8	19,2	19,0	6,5	7,8
21:00	9,0	8,8	10,5	10,0	5,1	5,9
22:00	5,5	5,1	6,1	5,4	4,0	4,1
23:00	4,3	3,5	4,6	3,7	3,5	2,9

Source: STUS 2002-03

Figure 2

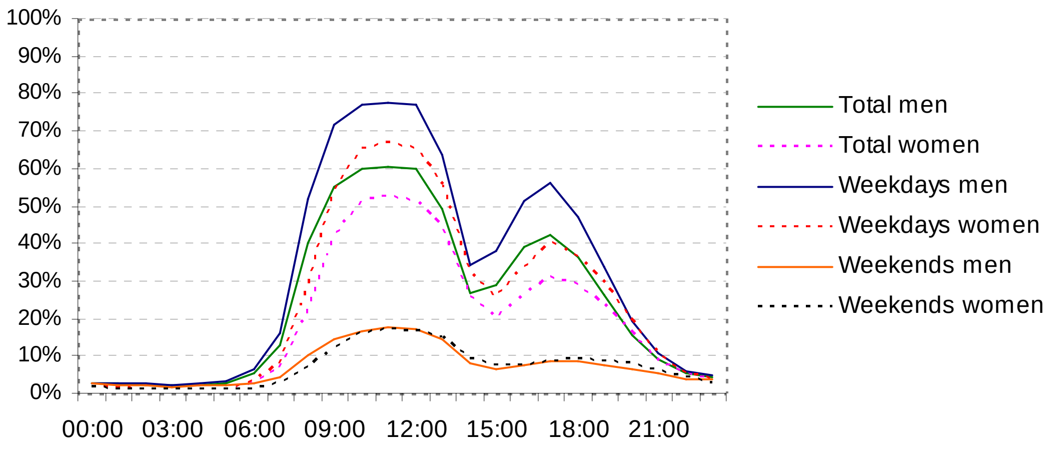
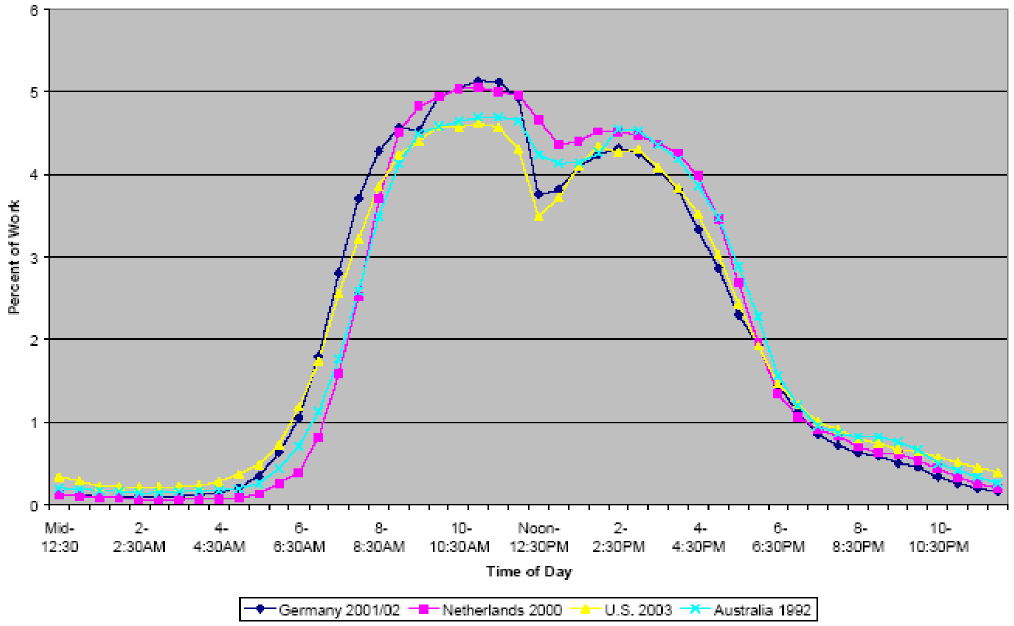


Figure 3



Source: Burda et al. (2006)