Analysis of Flexibility in Working Hours by Activity Sectors. Implications for Productivity and Family Life

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- The objective is to model the determination of work schedules and analyze their differences by activity sectors

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- We center on flexibility in working hours as the way to reach an efficient assignment of the working time
- Flexibility implies that workers have some control or choice over their work schedules
- The objective is to model the determination of work schedules and analyze their differences by activity sectors
- We draw up a general equilibrium model that determines work schedules as an equilibrium outcome between the firm's decision and workers' preferences

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- Looking deeper into the theoretical foundations of the organization of working time can help getting more rational and efficient results

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- Deery and Jago (2009): work – life balance practices: Addressing the needs of the tourism industry

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- Workers are heterogeneous in relation to their leisure preferences
- Firms organize their production in plants with different working hours
- Working time arrangement arises so that the preferences of workers coincide with the firm's needs.

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  that is the preferred moment to work in a day for this individual type or when leisure is less valued.
- Individuals i prefer their work schedule to be organized around that moment

The model

- Endowments: a time endowment of 1, and $\overline{k} > 0$ units of capital
- Definition: **A workday s is a pair (t, h) where t is the moment at which work starts and h is the length**
- The function $v^i(s)$ that sums up the instantaneous value of leisure between t and $t + h$, is

$$v^i(s) = \int_t^{t+h} \vartheta^i(\tau)\, d\tau \tag{1}$$

The model

- A production plant is characterized by the ratio of capital per worker k and by the workday s
- **An individual production plant is a pair** (k, s)
- The output per worker in a type (k, s) plant is: $f(k)\, g(s)$ where $g(s)$ measures the effective working time of a workday starting at t and ending at $t + h$, so

$$g(s) = \int_{t}^{t+h} \gamma(\tau)\, d\tau \tag{2}$$

- The set of feasible workdays, $S = \{s_1, s_2, ...s_{N_s}\}$, $S \subset T \times H$, where $H = \{h_0, h_1, ...h_{N_H}\}$is the set of possible workday lengths

and the set $T = \{t_0, t_1, ...t_{N_T}\}$ contains the possible starting times

The model

- The production possibility set, Y, is defined as:

$$Y \equiv \{\{C, \mathrm{K}, N\} : \textit{there exists a production plan } m \in R_{+}^{N_J} \textit{ such that}$$

$$C \leq \sum_{j} m_j \, f(k_j) \, g(s_j)$$

$$\sum_{\{j:\, t_j \leq t < t_j + h_j\}} m_j \, k_j \leq \mathrm{K}, \qquad \textit{for each} \qquad t \in T \tag{3}$$

$$\sum_{\{j:\, h_j = h,\, t_j = t\}} m_j \leq N(s), \qquad \textit{for each} \qquad s \in S \; \}$$

The model

- The utility of a type $i \in I$ person choosing the commodity point $x = (c, \mathrm{k}, n)$ is given by:

$$U^i(x) = u(c) - \sum_s n^i(s)\ v^i(s) \tag{4}$$

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- Given prices (r, w), the firm solves:

$$\max \quad C - r\mathrm{K} - \sum_s w(s)\ N(s) \tag{5}$$

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- A type i person faces the decision problem:

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

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

$$c \leq r\mathrm{k} + \sum_s w(s)\ n^i(s) \tag{7}$$

Competitive Equilibrium

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2. y^* maximizes (5) subject to $y \in Y$.
3. $\sum_{i\in I} \lambda^i x^{i*} = y^*$

Competitive equilibrium

- From the individual maximization problem (6) and (7) and from the firm's problem (5), we get the conditions of 0 profit for the plants that are going to be operated:

$$f(k_j)g(s_j)\lambda^i \rho_0 - k_j(\sum_{p=t_j}^{p=t_{z-1}} \rho_p)\lambda^i - v^i(s_j)\lambda^i - \mu_i \leq 0 \qquad \forall\, n_j^i \quad (8)$$

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- The number of different plants that will start to run, the measure and the type of workers allocated to them depend on: k_j, $f(k_j)$, $g(s_j)$, $v^i(s_j)$, and $\overline{k}$.
- Rewritting the condition (8), the plants and types that work fulfill the condition:

$$F(k_j, s_j) - R_j - W^i(s_j) = 0 \quad (9)$$

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- Flexible working hours $\Longrightarrow$ the elements of S are determined jointly by firm and workers
- Any plant that is operated in equilibrium and the type of worker in it must maximize the left hand side of (8) with respect to k, t and h.
- It is necessary to consider that the set of feasible workday S is no longer a finite set, but it is the convex set

$$\widehat{S} = \{(t,h) \mid t \in [0,1], h \in [0,1], t+h \leq 1, \quad \textit{and} \quad h = 0 \Rightarrow t = 0\}$$

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- For a given k, the optimal working hours that each type i should perform will be obtained from

$$\max_{(t,h)\in\widehat{S}} f(k)g(s) - v^i(s) \tag{10}$$

The economy with flexible workday

- The optimal moment to start, t, and the optimal moment to finish, $t+h$, for a worker i in a plant with k are respectively:

$$f(k)\gamma(t) = \vartheta^i(t) \quad (9)$$

$$f(k)\gamma(t+h) = \vartheta^i(t+h) \quad (10)$$

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

The economy with flexible workday

As demostrated in problem (10), we get

PROPOSITION 1: *The net output of each plant is maximized with the workday resulting from the interaction between workers preferences and technology.*

It is easy to see that $\frac{\partial t}{\partial k} < 0$ and $\frac{\partial h}{\partial k} > 0$, greater capital per worker ratio implies that the optimal workday starts earlier and finishes later

The optimal workday depends on k and τ_i, that is, $t(k, \tau_i)$ and $h(k, \tau_i)$

Work scheduled by shifts and continuous time

Case 1 The types distribution determines shift work

Now the left hand side of condition in (8) that we denote as $\Pi(k)$ is:

$$\Pi(k) = f(k)g(k,\tau_i)\rho_o - k\rho - v^i(k,\tau_i) - \mu_i/\lambda^i \qquad (11)$$

The ratio k assigned to the plants that operate in equilibrium is such that it maximizes $\Pi(k)$. From the first and second order conditions:

- this ratio is k_i^*, such that the marginal productivity in this plant is equal to the value imputed to the utilization of capital during this time
- for this ratio the decreasing effect on marginal productivity is greater than the increasing effect on the effective working time

Analysis of flexibility in working schedules

Work scheduled by shifts and continuous time

- **PROPOSITION 2:** *This activity sector consists of plants whose respective ratios of capital per worker, k_i^*, are such that $k_i^* > \overline{k}$, and the employment within each type depends on λ^i, $\overline{k}$, and k_i^*.*

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- As types are heterogeneous enough, capital can be fully utilized and full employment is possible
- The ratio can be higher only when decrease in the marginal productivity is compensated by an increase in effective time as the type of worker is more appropriate.

Continuous demand at unusual hours

Case 2 **Different types of workers must coincide in peak hours**

The capital is assigned between different plants so that:

$$\begin{aligned} f'(k_1)g(\tau_1,k_1)\,\rho_0-\rho_1 &= f'(k_2)g(\tau_2,k_2)\,\rho_0-\rho_3; \\ f'(k_3)g(\tau_3,k_3)\,\rho_0-\rho_4 &= f'(k_4)g(\tau_4,k_4)\,\rho_0-\rho_{5\ldots\ldots} \end{aligned} \tag{12}$$

when two types work simultaneously during part of their workday, the type with less distance $\left|\widehat{\tau}-\tau_i\right|$ attains greater $g(\tau_i,k_i)$ and utilizes larger k, which implies lower f'. In this way, both types will have the same imputed value to fulfill the conditions in (12).

Analysis of flexibility in working schedules

Continuous demand at unusual hours

Proposition 3 *This activity sector consists of plants whose respective ratios of capital per worker, k_i^*, are such that $k_i^* \lessgtr \overline{k}$ and depends negatively on the distance $\left|\widehat{\tau} - \tau_i\right|$.*

The result is ambiguous with respect to employment

Empirical evidence

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- The use of unusual work hours is greater in the industry. Greater capital/labor ratio with the objective of extending the running times of the machinery
- 42% of the establishments of Electricity, Gas and Water Supply and 22% of the ones included in Manufacturing Industries employ workers during unusual work hours
- Also in services sector that provide around the clock services: 45% of the establishments in hotels and restaurants, 43% in Health and Social Work, 41% in Transport, storage and communication, 29% in social and personal services

Empirical evidence

- Establishments in subsectors with lower capital/labour ratio like construction, offer flexible working time schemes less frequently (36%) than in others subsectors, like Electricity and water supply with higher k/l offer flexible working time more often (42)

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- To apply flexible working time, the reason most frequently stated (68%) by the personnel managers interviewed in their establishments was enabling employees to better combine work and family (or personal) life

Empirical evidence

- Respect to the relationship between flexible working time and productivity and in the opinion of managers and employees‘ representatives, the two most important effects of the flexible working time are a better adaptation of the labor to the workload (64%)

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- Respect to the relationship between flexible working time and productivity and in the opinion of managers and employees‘ representatives, the two most important effects of the flexible working time are a better adaptation of the labor to the workload (64%)
- The other important effect is higher job satisfaction (74%) which implies both higher productivity in the firms and higher employees satisfaction

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- The result obtained is an efficient assignment and, after comparing with what we observe in reality, it enables guidelines to improve the efficiency of the productive system
- Variations in productivity and the assessment of leisure throughout the day are key factors

Thank you for your attention