# The Division of Labor and the Market for Organizations

*by Assar Lindbeck and Dennis J. Snower*

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**Abstract:** The paper examines the determinants of the division of labor within firms. It provides an explanation of the pervasive observed changes in work organization away from the traditional functional departments and towards multi-tasking and job rotation. Whereas the existing literature on the division of labor within firms emphasizes the returns from specialization and the need for coordination of the work of different workers, the present analysis focuses on the returns from multi-tasking, which is shown to arise from informational and technological complementarities among tasks as well as from the exploitation of the versatility of human capital. The paper also explores how the move towards multi-tasking can affect the labor market, and the distribution of firms across organizational forms.

## *1. Introduction*

The division of labor, a central concept in economic analysis since the time of Adam Smith, has two aspects: (i) the division of labor within firms and (ii) the division of labor between firms. The former is concerned with the range of tasks performed by workers within any particular firm, while the latter deals with the range of products that any particular firm produces. Whereas these two developments have proceeded in tandem in the past, over the past decade there has been a well-documented tendency for them to move in opposite directions. On the one hand, the progressive specialization between firms continues, as large numbers of businesses in both the manufacturing and the service sectors concentrate more heavily on their "core competencies" in product lines. On the other hand, there is evidence of a progressive breakdown of occupational barriers within many firms, as corporate hierarchies are restructured and delayered, and workers are given wider ranges of responsibilities across tasks. Thus an increased division of labor *between* firms is often accompanied by a reduced division of labor *within* firms. These broad, widespread changes are documented in a growing body of empirical literature (summarized in the next section), though it is of course possible to find many specific cases where these generalizations do not apply.

This paper focuses on the division of labor *within* firms, examining the contemporary change in work organization away from the traditional “Tayloristic firms,” with highly specialized workers in functional departments (e.g. production, administration, finance, design, and marketing departments) towards “holistic firms” with multi-tasking and job rotation within relatively small customer-oriented teams. The purpose of this paper is (a) to identify some major determinants of this change and highlight some important channels whereby these determinants work, and (b) to explore some implications of this change for the labor market and the distribution of firms across organizational forms.

The paper is organized as follows. Section 2 summarizes some empirical evidence for the above organizational changes. Section 3 presents a simple model of work organization and examines how changes in the division of labor within firms can be driven by changes in the determinants of the organization of work. Section 4 presents the wage and employment decisions in this context and describes the labor market equilibrium, given the number of holistic and Tayloristic organizations. Section 5 allows restructuring of organizations and the entry of new firms, and examines the associated organizational equilibrium. Section 6 shows how advances in production and information technologies and changes in human capital and worker preferences can drive the restructuring process, whereby Tayloristic organizations turn into holistic ones and new holistic organizations enter the economy. In this context, we examine how this process can lead to a resegmentation of the labor market. Finally Section 7 concludes.

## 2. The Empirical Picture

Until recently, the empirical evidence of reorganization of work within firms was based on a large number of case studies.[1] Since the process is highly complex, and also gradual and uneven among firms and countries, it has been long before convincing, systematical empirical studies has emerged. The quantitative importance of the process, and its various parts, has therefore been uncertain. Nevertheless, various aspects of the process have been examined analytically in the economics literature.[2]

However, systematic representative empirical studies are now available. Studies for Japan established long ago the characteristics of new types of work organization, sometimes baptized "The Toyota model" (e.g. Aoki, 1984). Recent studies for the United States and Europe have documented that reorganization of work is a wide-ranging phenomenon in these parts of the world as well. For instance, a representative study by Osterman (1994) documents the process in U.S. manufacturing establishments (with 50 or more employees). One conclusion is that 55 percent of the establishments were using work teams, 43 percent work rotation, 34 percent "total quality control" (TQM) and 41 percent quality circles; only 21 percent had none of these features.[3] There is also evidence that these features are new phenomena. About

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[1] See, for example, Appelbaum and Bott (1994), Hammer and Champy (1993), Pfeiffer (1994), and Wikstrom and Norman (1994).

[2] See for instance, Carmichael and MacLeod (1993), Holmstrom and Milgrom (1991), Kramer and Mishkin (1995), Lindbeck and Snower (1996), Milgrom and Roberts (1990), and Yang and Borland (1991).

[3] For firms in which at least 50 percent of the workforce was engaged in such activities, the corresponding percentage figures are 41, 27, 24, 27 and 36.

half of the observed arrangements were introduced less than five years prior to the survey year of 1992.[4]

Employee participation in decision-making within firms seems also to have increased in major West European countries (OECD, 1996, Chapt. 6). Indeed in a systematic questionnaire study among managers in this part of the world, four out of five firms report that they have taken steps in this direction (European Foundation, 1997).

The most comprehensive documentation so far of the quantitative importance of the shifts to more flexible work organization apparently pertains to the Nordic countries (NUTEK, 1996 and 1999). These studies indicate that the majority of establishments (with more than 50 employees) in all Nordic countries – specifically, 68-75 percent of these establishments – moved to more flexible organization of work during the 1990s (NUTEK, 1999, Chapt. 4).[5] The most important elements of these reorganizations are delegation of responsibility to production workers, organized developments of human capital (training), team-work, job-rotation, and multi-tasking (reflected in an increase in the average number of tasks per employee). Daily planning of one's own work has been decentralized to individuals in 57 percent of Swedish establishments, and to work teams in 38 and 25 percent, respectively (NUTEK, 1999 chapt. 2). The figures for quality control and weekly planning of one's own work are somewhat lower, and for customer relations and maintenance considerably lower.[6] Internal information circulation within firms is also reported to have increased. Within the teams, informal work rotation (multi-tasking) is recorded in about a fifth of the studied firms. Another finding is that the education level among the employees is higher in reorganized firms than in traditional firms.

In short, there is now empirical evidence of quantitatively important reorganizations of work within firms, resulting in increased responsibilities for both production workers and white-collar workers. In particular, these groups are

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[4] 49 percent of the teams, 38 percent of the job rotation practices, 71 percent of TQM programs and 68 percent of problem-solving groups or quality circles were introduced in the period 1986-1992. These results are broadly consistent with a study for a sample of large firms by Lawler, Mohrman and Ledford (1992), according to which 66 percent of the firms in the sample have quality circles, 47 percent have self-managed work teams and 64 percent have TQM.

[5] If work places with 10-49 employees are included, the proportion of reorganized work places decreases with about 20 percentage points.

[6] For customer relations, the corresponding figure in Sweden (Finland) is 36 (19) percent in the case of individuals, and 13 (7) percent in the case of teams. For maintenance, the figure for Sweden (Finland) is 28 (10) percent in the case of individuals and 23 (9) percent in the case of teams.

increasingly assigned the task to organize, administer and maintain their own work, organize training, take new initiative; maintain work norms, often within teams that allocate and co-ordinate tasks among the team members; take responsibility for product specification and product quality; negotiate with customers etc. Thus, multi-task activities and job rotation are important characteristics of the emerging new organization of work.

## *3. A Simple Model of Work Organization and Restructuring*

For simplicity, consider a firm that employs two workers at two tasks (1 and 2) to produce a homogeneous output $q$. The first worker devotes the proportion $\tau$ of his available time to task 1 (and (1-$\tau$) to task 2), while the second worker devotes the proportion $T$ to task 2 (and (1-$T$) to task 1). Let $e_1$ and $e_2$ be the first worker's labor endowment (labor input in efficiency units) at tasks 1 and 2, respectively; and let $E_1$ and $E_2$ be the second worker's labor endowment at these two tasks. Denoting the labor services at the two tasks by $\lambda_1 = \tau e_1 + (1-\mathrm{T})E_1$ and $\lambda_2 = (1-\tau)e_2 + \mathrm{T}E_2$, the production function is

$$q = f\left(\lambda_1, \lambda_2\right),\ f_1, f_2 > 0, f_{11}, f_{22} < 0 \tag{1}$$

The workers' labor is assumed to enter the production function symmetrically, so that we can restrict our attention to the first worker.

The worker's labor endowment $e_i$ ($i$ = 1,2) at each task $i$ depends on:

(i) the *return to specialization*: the more time a worker devotes to a task, the more productive he becomes, due to learning by doing, and

(ii) the *informational task complementarity*: the more time a worker devotes to one task, the more productive he becomes at another task, since he is able to use the information acquired at the former task to improve his performance at the latter.

It will be possible to derive simple, intuitively appealing conditions for the firm's choice of work organization if we specify these two phenomena in constant-elasticity terms. Thus let the returns to specialization for the first worker at the first task be

$$s_1 = \sigma_1 \tau^{\eta_1^s} \tag{2a}$$

where $\sigma_1$ and $\eta_1^s$ are positive constants. In words, the returns to specialization at task 1 increase in the amount of time spent at this task.[7] Let the corresponding informational task complementarity be

$$c_1 = \chi_1 \tau^{-\eta_1^c} \tag{2b}$$

where $\chi_1$ and $\eta_1^c$ are positive constants, i.e. the greater the amount of time the worker spends at task one, the less time is available for task 2, and thus the smaller the informational task complementarity flowing from task 2 to task 1.

Let the worker's labor endowment at task 1 be

$$e_1 = s_1 c_1 \tag{3}$$

Another aspect of the firm's production technology that plays an important role in the analysis below is the degree of *technological complementarity* among the two tasks: $\varepsilon_{ij} = \frac{\partial f_i}{\partial \lambda_j}\frac{\lambda_j}{f_i}, i \neq j$, i.e. the elasticity of the marginal product of one task with respect to the other task, which we assume constant.

Let the firm's cost of production be $\kappa = w(\tau)n + W(\mathrm{T})N$, where $w$ and $W$ are the wages of the type-1 and type-2 workers, respectively. In general these wages depend on the time allocations $\tau$ and $T$ since workers have preference concerning specialization versus versatility at work. For simplicity, we assume that this cost function is symmetric across the two types of workers. The firm's profit is

$$\pi = q - \kappa - \phi_i \tag{4}$$

where $\phi_i$ is a constant restructuring cost (to be described in the next section).
The firm makes the employment decisions $n$ and $N$, and the time allocation decisions $\tau$ and $T$, so as to maximize profit.

The first-order conditions for maximizing profit with respect to the time allocation are $(\partial\pi/\partial\tau) \geq 0$ and $(\partial\pi/\partial\tau)(1-\tau) = 0$ where

$$\frac{\partial\pi}{\partial\tau} = f_1 \cdot (1+\eta_1^s+\eta_1^c)\cdot(s_1 \cdot c_1 \cdot n) - f_2 \cdot (1+\eta_2^s+\eta_2^c)\cdot(s_2 \cdot c_2 \cdot n).$$

This implies that

[7] These returns of course accrue only with the passage of time but, for analytic simplicity, we ignore this temporal dimension in our model.

$$\frac{\partial^2\pi}{\partial\tau^2} = \left(1+\eta_1^s+\eta_1^c\right)\cdot\left(s_1\cdot c_1\cdot n\right)\cdot\left[\frac{f_1}{\tau}\left[\varepsilon_{11}\left(1+\eta_1^s+\eta_1^c\right)+\left(\eta_1^s+\eta_1^c\right)\right]-\varepsilon_{12}\frac{f_1}{1-\tau}\left(1+\eta_2^s+\eta_2^c\right)\right]$$
$$+\left(1+\eta_2^s+\eta_2^c\right)\cdot\left(s_2\cdot c_2\cdot n\right)\cdot\left[\frac{f_2}{1-\tau}\left[\varepsilon_{22}\left(1+\eta_2^s+\eta_2^c\right)+\left(\eta_2^s+\eta_2^c\right)\right]-\varepsilon_{21}\frac{f_2}{\tau}\left(1+\eta_1^s+\eta_1^c\right)\right]$$

In this context, *if* $\left(\partial\pi/\partial\tau\right)=0$ *for* $0<\tau<1$, *and* $\left(\partial^2\pi/\partial\tau^2\right)<0$, *then the worker will be engaged in multi-tasking; otherwise the worker will specialize by task.*

Within this framework of analysis it is straightforward to show that Tayloristic firms have an incentive to restructure along holistic lines in response to the following changes (naturally, provided the changes are sufficiently large):

- increases in informational task complementarities that increase the absolute value of the elasticity $\eta_j^c, j=1,2$;
- technological improvements that raise the elasticity $\varepsilon_{ij}$, for $i\neq j$;
- advances in human capital that enable workers to become more versatile (viz., an increase of $s_2(x)$ relative to $s_1(x)$, for any positive $x$, $0\le x\le 1$); and
- changes in worker preferences that reduce their reservation wage for versatile work relative to that for specialized work (viz., an increase in $w'(\tau)$ for $\tau<½$, and a reduction in $w'(\tau)$ for $\tau>½$).

We hypothesize that changes along these lines are behind the empirically observed changes in the organization of work. An example of the first change is the introduction of computerized information systems that give employees easy access to task information within their firms and thereby encourage the exercise of multiple skills. An example of the second change is the application of flexible machine tools and programmable equipment that makes different skills more complementary to one another. Education and training are likely to contribute to the third and fourth types of change.

To gain insight into the determinants of the firm's work organization in the analytical context above, it is useful to begin with the special case in which both types of workers are "completely versatile," in the sense that each worker is equally productive at both tasks. For the type-1 worker this means $s_1(x)=s_2(x)=s(x)$ and $c_1(y)=c_2(y)=c(y)$ for any positive $x$ and $y$, $0\le x,y\le 1$. By our assumption of symmetry, $f_1=f_2=f'$, $\varepsilon_{11}=\varepsilon_{22}=\varepsilon_{ii}$, $\eta_1^s=\eta_2^s=\eta^s$, $\eta_1^c=\eta_2^c=\eta^c$ and $\varepsilon_{12}=\varepsilon_{21}=\varepsilon_{ij}$

for $i \neq j$. In this context, the following two propositions identify the determinants of the firm's work organization under specific conditions.

***Proposition 1****: If the marginal products of labor are constant (*$\varepsilon_{ij} = 0$ *for i, j = 1,2), then the organization of work depends only on the returns to specialization relative to the informational task complementarity. In particular, when* $\eta^s + \eta^c < 0$ *there is multi-tasking, and when* $\eta^s + \eta^c > 0$ *there is complete specialization.*

***Proposition 2****: Suppose that the returns to specialization and the associated informational task complementarities*[8] *are equally responsive to changes in the fraction of available time devoted to the relevant task (i.e.* $\eta^s + \eta^c = 0$*), then the organization of work depends only on the technological task complementarity relative to diminishing returns to labor. In particular, when* $\varepsilon_{ij} > \varepsilon_{ii}$*, for* $i \neq j$*, there is multi-tasking; and when* $\varepsilon_{ij} < \varepsilon_{ii}$*, for* $i \neq j$*, there is complete specialization.*

(The proofs are given in the Appendix A.)

Proposition 1 states that, under constant returns to labor, work will be specialized by task when an increase in the time spent at a task raises the productivity of labor at that task by more than it raises the productivity of labor at another task,[9] i.e. when $\eta^s + \eta^c > 0$. Conversely, there will be multi-tasking when an increase in experience at a task raises the informational task complementarities by more than the returns to specialization, i.e. when $\eta^s + \eta^c < 0$. Thus technological improvement that reduce $\eta^c$ (and thus increase the absolute value of $\eta^c$) give the firm an incentive to organize work along holistic lines.

To get an intuitive understanding of this, it is convenient to visualize the firm's profit maximization problem in terms of an opportunity locus and an isoquant in $\lambda_1 - \lambda_2$ space, as shown in Figures 1. In particular, the opportunity locus (*OL*) is given by $\lambda_1 = \tau e_1 + (1-\mathrm{T})E_1$ and $\lambda_2 = (1-\tau)e_2 + \mathrm{T}E_2$, and the isoquant (*IQ*) is given by $f(\lambda_1, \lambda_2) = \overline{q}$ (a constant). The firm's problem is to choose the time allocation $\tau$ so as to reach the highest isoquant achievable along its opportunity locus. It can be shown that when $\eta^s + \eta^c > 0$, the opportunity locus *OL* is convex (in Figure 1a). If $\varepsilon_{ij} = 0$ for *i*, *j* = 1,2, then the isoquant *IQ* is linear in $\lambda_1 - \lambda_2$ space. When workers are completely

[8] In other words, the returns to specialization at task *i* and the informational task complementarity flowing from task *j* to task *i*, where $i \neq j$.

versatile, the opportunity locus is symmetric in $\lambda_1 - \lambda_2$ space, and by our symmetry assumption across tasks, the isoquant is symmetric in the same sense. Then highest isoquant is reached at the two end-points of the opportunity locus: $\left(0, \bar{\lambda}_2\right)$ and $\left(\bar{\lambda}_1, 0\right)$, which implies complete specialization, as shown in Fig. 1a.[10]

On the other hand, when $\eta^s + \eta^c < 0$, the opportunity locus *OL* is concave, as illustrated in Figure 1b. Then, clearly, the highest linear isoquant is attained in the interior of the opportunity locus, at $\left(\lambda_1^*, \lambda_2^*\right)$ in the figure. This implies multi-tasking, with $\tau^* = 1/2$ in this special case.

Proposition 2 states that if an increase in the fraction of time devoted to a task raises the returns to specialization at that task by the same proportional amount as the associated informational task complementarities ($\eta^s + \eta^c = 0$), the organization of work will involve complete specialization when the marginal product of labor service *i* ( i=1,2) diminishes more rapidly with labor service *j* ( $j \neq i$ ) than with labor service *i*: $\varepsilon_{ij} < \varepsilon_{ii}$. Conversely, there will be multi-tasking when $\varepsilon_{ij} > \varepsilon_{ii}$. Thus technological improvements that raise the elasticity $\varepsilon_{ij}$, for $i \neq j$, provide an incentive for holistic work organization.

It can be shown that if $\eta^s + \eta^c = 0$, the opportunity locus *OL* is linear; and if $\varepsilon_{ij} < \varepsilon_{ii}$, the isoquant *IQ* is concave to the origin, as shown in Figure 1c. Thus, the highest isoquant is once again attained at the end-points of the opportunity, and workers will specialize by task. However, if $\varepsilon_{ij} > \varepsilon_{ii}$, the isoquant is convex to the origin, as illustrated in Figure 1d. Here the highest isoquant is reached in the interior of the linear opportunity locus, so that workers engage in multi-tasking.

We are now in a position to embed our analysis of work organization into a simple model of the labor market.

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[9] In other words, there will be complete specialization when an increase in experience at a task raises the proportional returns to specialization at that task by more than it raises the associated informational task complementarities.

[10] Needless to say, this solution should not be characterized as one of multiple equilibria. Rather, when the workers are completely versatile, both types of workers are identical, and thus the firm finds it worthwhile to devote half its workforce to task 1 and the other half to task 2.

## *4. Wage and Employment Determination*

Let us examine how the reorganization of work leads to a resegmentation of the labor market, in which the traditional occupational (task-oriented) boundaries break down and the distinction between versatile workers (who can perform multiple tasks) and non-versatile ones (who can perform only one) becomes more important instead. For this purpose, it now becomes appropriate to differentiate workers in terms of their degree of versatility. For expositional simplicity, it will be convenient to assume that workers of type $i$ ($i$=1,2) can each be divided into two distinct groups: "versatile workers" who are capable of both tasks and "non-versatile workers" who are capable of only one.

The labor endowment of a type-1 versatile worker at task $i$ ($i$ = 1,2) is that described above: $e_i = s_i \cdot c_i,\ i = 1,2$.[11] The labor endowment of non-versatile type-1 workers is $e_1 = s_1(1) \cdot c_1(0)$.[12]

Let a fixed proportion $\alpha$ of the working population be able to perform task 1 and an identical proportion be able to perform task 2. Of the groups of workers able to perform one particular task, a fixed proportion $\beta$ is also able to perform the other task. Letting the working population be denoted by $L$, the aggregate supply of versatile type-1 workers ($A_1^v$) and versatile type-2 workers ($A_2^v$) is $A_1^v = A_2^v = \alpha\beta L$, and the aggregate supply of non-versatile type-1 ($A_1^s$) and non-versatile type-2 workers ($A_2^s$) is $A_1^s = A_2^s = \left(1-\alpha\cdot\beta\right)L$. We assume that holistic organizations require only versatile workers, whereas the Tayloristic ones are able to use both versatile and non-versatile ones.

We make the standard assumption that the wage and employment decisions are made in two stages: first the wage is set through bargaining between each firm and its employees, taking the employment repercussions into account; then the employment decisions are made, taking the wage as given. Since this paper does not seek to make a contribution to the wage bargaining literature, we will simply adopt a standard specification of a wage bargaining equation (yielded by a variety of union and other bargaining models, as well as various efficiency wage models). Specifically,

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[11] We continue to assume, for simplicity, that the versatile type-1 and type-2 workers have symmetric comparative advantages across tasks.

we suppose that the negotiated wage depends inversely on the unemployment rate and positively on the reservation wage: $w_j^o = w_j^o\left(u_j, r_j\right)$, $\frac{\partial w_j^o}{\partial u_j} < 0, \frac{\partial w_j^o}{\partial r_j} > 0$, where $u_j$ is the unemployment rate ($u_j \equiv 1 - \left(N_j^D / N_j^S\right), N_j^D$ is the aggregate demand, and $N_j^S$ is the aggregate supply), and $r_r$ is the reservation wage (at which workers are indifferent between employment unemployment), for any homogenous group $j$ of workers.[13] We assume that versatile workers have a higher reservation wage for Tayloristic jobs than for holistic ones. In particular each versatile worker's reservation wage at Tayloristic jobs is $r^+$ (a constant) and every other worker's reservation wage is $r^-$ (another constant), where $r^+ > r^-$.

Next, consider the equilibrium in the labor market, taking the number of Tayloristic organizations ($F_T$) and the number of holistic ones ($F_H$) as given. To capture some common differences between holistic and Tayloristic organizations in practice, we parameterize our model so that, in the labor market equilibrium,[14] employment per Tayloristic organization exceeds employment per holistic organization ($n_T^* > n_H^*$ and $N_T^* > N_H^*$), and the holistic wage exceeds the Tayloristic wage ($w_H^* > w_T^*$ and $W_H^* > W_T^*$).[15] Since the holistic wage is higher than the Tayloristic wage in the labor market equilibrium and since versatile workers have a preference

[12] Similarly for the type-2 worker. In words, a non-versatile worker has the endowment that a versatile worker would have if he performed only the first task.

[13] Holistic organizations, as noted, employ only the versatile workers. By symmetry, the type-1 and type-2 versatile workers have the same marginal product and the same reservation wage and thus receive the same wage. In Tayloristic organizations the marginal products of versatile and non-versatile type-1 workers are identical (and similarly for the type-2 workers), and we assume that these organizations pay the same wage to workers from both groups. (Allowing them to pay different wages to versatile and non-versatile workers would make no substantial difference to our conclusions.)

[14] The implications of dropping these assumption are described below.

[15] This requires that the fixed costs of production (described below) have the following properties: (i) the fixed cost $\phi_T$ of operating the Tayloristic organization must be sufficiently large relative to the fixed cost $\phi_H$ of operating the holistic organization or (ii) the number of versatile workers is sufficiently small relative to the number of non-versatile ones, or both. To see this, observe that (as we will show in the next section) the greater is the fixed cost $\phi_T$ relative to $\phi_H$, the smaller will be the equilibrium number of Tayloristic organizations relative to the number of holistic ones. Consequently, the larger will be the size of the Tayloristic organization in terms of employment relative to that of the holistic organization, and the lower will be the Tayloristic wage relative to the holistic wage. Moreover, the smaller is the holistic labor supply relative to the Tayloristic one, the greater will be the equilibrium holistic wage relative to the Tayloristic one.

for holistic over Tayloristic work, the aggregate supply of workers[16] available to the holistic firms is the aggregate supply of versatile workers of that type, $\alpha\beta L$.[17]

For expositional brevity, the aggregate labor market equilibrium is illustrated in Figure 2, and the algebraic description is relegated to Appendix B. On the horizontal axis, aggregate Tayloristic employment, $L_T^* = F_T \cdot \left(n_T^* + N_T^*\right)$ is measured from left to right, and aggregate holistic employment, $L_H^* = F_H \cdot \left(n_H^* + N_H^*\right)$, is measured from right to left. The aggregate Tayloristic and holistic labor demand curve are denoted by $L_T^D$ and $L_H^D$, respectively; and the associated wage setting curves[18] are denoted by $WS_T$ and $WS_H$. The total working age population (measured from left to right) is given by $L$.

The equilibrium wage and employment level in the Tayloristic (holistic) sector is given by the intersection between the aggregate Tayloristic (holistic) labor demand curve and the corresponding wage setting curve. The workers not employed in either the Tayloristic or holistic sectors are unemployed; the equilibrium unemployment level is denoted by $U^*$ in the figure.

This is our picture of a segmented labor market. Note that the segmentation does not follow the traditional lines that distinguish between skilled and unskilled workers, unionized and non-unionized workers, and so on, but rather the segmentation is related to the organization of work. On this basis, we will later examine how the process of reorganizing work can lead to a "resegmentation" of the labor market.

The above labor market equilibrium is derived for a given number of holistic and Tayloristic organizations. The next step in our analysis is to examine the market for these organizations.

## *5. Equilibrium in the Market for Organizations*

To model the restructuring process and determine the equilibrium number of holistic and Tayloristic organizations, we need to explain the conditions when

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[16]This is the supply of type-1 workers. Recall that the symmetry properties above permit us to focus just on type-1 workers.

[17] Under these circumstances, the labor market equilibrium can be derived recursively: the holistic equilibrium may be computed first, and this equilibrium then determines the supply of labor to the Tayloristic market, whose equilibrium may be derived next.

[18] Observe that the wage setting curve $WS_T$ has a discontinuity at $(1-\alpha\beta)L$, since the reservation wage associated with Tayloristic work is assumed to be higher for versatile workers than for non-versatile ones.

organizations of each type enter and exit from the economy and when organizations restructure. For this purpose, we distinguish between three sets of fixed costs:[19]

(i) the fixed costs expended by incumbent firms to remain in operation: $\phi_H$ for a holistic firm and $\phi_T$ for a Tayloristic one (where $\phi_T$ and $\phi_H$ are positive constants);[20]

(ii) the fixed costs of reorganization: $\rho_{TH}$ for a Tayloristic organization to restructure into a holistic one, and $\rho_{HT}$ for a holistic firm to become a Tayloristic one (where $\rho_{TH}$ and $\rho_{HT}$ are positive constants); and

(iii) the fixed costs of entry: $\theta_H$ to enter the holistic sector and $\theta_T$ to enter the Tayloristic one (where $\theta_H$ and $\theta_T$ are positive constants).

We assume, plausibly, that $\phi_H < \rho_{TH}$, $\theta_H$ and $\phi_T < \rho_{HT}$, $\theta_T$.

Entry into the holistic organization market proceeds until the profit of the entrant is reduced to zero:[21]

$$\Pi^*_{EH} = 0 \tag{6a}$$

The number of firms $F_H = \underline{F}_H$, which fulfills this condition may be called the "minimum sustainable number of holistic organizations", since any smaller number would induce the entry of new holistic organizations. Similarly, the entry condition for the Tayloristic organization market is

$$\Pi^*_{ET} = 0 \tag{6b}$$

The value $F_T = \underline{F}_T$ which fulfills this condition may be termed the "minimum sustainable number of Tayloristic organizations."

Reorganization of Tayloristic organizations into holistic ones proceeds until the profit from continuing to operate a Tayloristic organization is equal to that from transforming into a holistic one:

$$\Pi^*_T = \Pi^*_{TH} \tag{6c}$$

The value $F_T = \overline{F}_T$ which fulfills the reorganization condition may be called the "maximum sustainable number of Tayloristic organizations", since any greater number would induce Tayloristic organizations to transform into holistic ones. Similarly, the holistic reorganization condition is

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[19] These costs are represented $\phi_i$ by in the profit function (4), above.

[20] Since Tayloristic firms usually have greater returns to scale (*ceteris paribus*), we will assume that $\phi_H < \phi_F$.

[21] The algebraic expressions of the entry and restructuring conditions for the linearized labor demand and wage setting equations are given in Appendix B.

$$\Pi_H^* = \Pi_{HT}^* \tag{6d}$$

and $\overline{F}_H$ is the "maximum sustainable number of holistic organizations".

The market for organizations is in equilibrium whenever the number of holistic organizations lies between its maximum and minimum sustainable levels and similarly for the number of Tayloristic organizations:

$$\underline{F}_H \le F_H^* \le \overline{F}_H \quad \text{and} \quad \underline{F}_T \le F_T^* \le \overline{F}_T \tag{7}$$

If, on the other hand, this condition is not satisfied, then the number of organizations will change. (For example, if $F_H^* < \underline{F}_H$, then the number of holistic organizations increases.)

Figure 3 provides an illustrative example of a range of equilibria in the market for organizations. On the horizontal axis, the number of Tayloristic organizations is measured from left to right, and the number of holistic organizations is measured from right to left. $\Pi_T^*, \Pi_{HT}^*$, and $\Pi_{ET}^*$ are the profit curves of Tayloristic firms in operation, firms that have turned into Tayloristic firms, and Tayloristic firms that have just entered the economy, respectively. These curves are all downward sloping (measured from left to right). The reason is that, in Figure 2, if the number of holistic firms increases, the aggregate holistic labor demand curve $L_H^D$ shifts upwards, raising the equilibrium holistic wage $w_H^*$ and reducing profit $\pi_H^*$ of each holistic firm.[22] The figure presupposes that the costs of entry exceed the costs of restructuring from holistic to Tayloristic organization (thus $\theta_H > \rho_{TH}$ and $\theta_T > \rho_{HT}$). For this reason the $\Pi_H^*$ curve lies above the $\Pi_{TH}^*$ curve, which in turn lies above the $\Pi_{EH}^*$ curves.

Similarly, the profit curves $\Pi_H^*, \Pi_{TH}^*$, and $\Pi_{EH}^*$ for each holistic scenario also show an inverse relation between profit and the number of holistic firms. Once again, the figure assumes that the costs of entry exceed the costs of restructuring, now from Tayloristic to holistic organization.

In the figure, for example, every combination $(F_H^*, F_T^*)$ lying within the interval between $\overline{F}_T$ and $\overline{F}_H$ in the figure may be an organizational equilibrium.[23]

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[22] For simplicity, the profit curves are drawn for just one of the segments of the wage setting curve. Over both segments, clearly, the profit curves would have a kink.

[23] There is of course no reason why the $\underline{F}_H$ point should necessarily lie to the left of the $\overline{F}_T$ point, or why the $\overline{F}_H$ point should necessarily lie to the left of the $\underline{F}_T$ point.

Beginning from such an equilibrium, the next section investigates the forces inducing reorganization and entry into the holistic sector and explores the implications of these developments for the labor market.

## *6. The Restructuring Process and the Labor Market*

We now analyze how the major forces driving the restructuring process - advances in production and information technologies, and improvements in human capital - influence the labor market. Once again, for brevity, we illustrate our results in figures, leaving algebra to Appendix B.

We consider two types of sustained advances in production and information technologies: ones that increase the technological and informational task complementarities (as described in Section 2) and ones that reduce the holistic fixed cost $\phi_H$ (while the Tayloristic fixed cost $\phi_T$ remains unchanged).

How these changes affect the labor market depends on whether the restructuring condition (6c) or the entry condition (6a) is binding in the initial equilibrium.[24] Specifically, our analysis above has the following implications:

**Proposition 3:** *Consider technological advances that (a) increase the technological and information task complementarities, (b) reduce the fixed cost of operating holistic organizations, and (c) increase the number of versatilel workers. These advances have the following effects on the labor market above.*
*1. Suppose that the restructuring condition (6c) is binding in the initial equilibrium.*
*(a) Then the above technological advances lead first to a "restructuring phase", in which Tayloristic organizations are transformed into holistic ones: the high-wage holistic sector expands, the lower-wage Tayloristic sector contracts, and unemployment expands.*
*(b) This is followed by an "entry phase", in which new holistic organizations enter the economy: the high-wage holistic sector continues to expand, the lower-wage Tayloristic sector remains constant, and unemployment contracts.*
*2. Now suppose that the entry condition (6a) is binding in the initial equilibrium.*
*Then the above technological advances lead directly to the entry phase.*

To see this, observe that advances that increase the technological and informational task complementarities or that reduce the fixed cost of operating holistic organizations cause the profit curves $\Pi^*_{TH}$, and $\Pi^*_{EH}$ to rise through time, while the profit curve $\Pi^*_T$ remains unchanged, as shown in Figure 4. Furthermore, increases in the supply of versatile workers, induced through education and training, leads to a fall the holistic wage setting curve (by raising the supply of workers to holistic firms). Consequently, the profit curves $\Pi^*_{TH}$, and $\Pi^*_{EH}$ again rise. Under these circumstances, if the economy is initially in an organizational equilibrium, determined by condition (7), then it eventually will become worthwhile for Tayloristic organizations to be restructured into holistic ones and/or new holistic firms to enter.

Suppose that the restructuring condition (6c) is binding in the initial equilibrium, so that the technological changes above lead some Tayloristic firms to turn into holistic ones. In Figure 4, the profit curve $\Pi^*_{TH}$ of the restructured organizations rises to $\Pi'_{TH}$, while the profit curve $\Pi^*_T$ of incumbent Tayloristic organizations remains unchanged. As result, the intersection between these two curves shifts to the left, increasing the number of holistic organizations and reducing the number of Tayloristic ones.

The increase in the number of holistic organizations shifts the holistic labor demand curve upward in Figure 2. Consequently, the equilibrium holistic wage rises and the equilibrium level of aggregate holistic employment rises as well.

The fall in the number of Tayloristic organizations $F_T^*$, associated with the rise in the number of holistic organizations $F_H^*$, reduces the equilibrium aggregate Tayloristic employment and also reduces the equilibrium Tayloristic wage.[25] In terms of Figure 2, the Tayloristic labor demand curve shifts downward, and the Tayloristic labor supply curve shifts to the left. If the number of non-versatile workers is large, the Tayloristic equilibrium lies at the intersection of the labor demand curve and the lower segment of the wage setting curve, and then equilibrium employment and the wage in the Tayloristic sector both fall. If, on the other hand, the number of non-versatile workers is small, the Tayloristic equilibrium lies at the intersection of the labor demand curve and the upper segment of the wage setting curve, and then the Tayloristic wage setting curve will shift upwards in response to the rise in holistic

[24] As shown in Figure 3, a necessary condition for the restructuring condition to be binding is that the entry cost exceeds the restructuring cost. Furthermore, a sufficient condition for the entry condition to be binding is that the restructuring cost exceeds the entry cost.

[25] If the number of non-versatile workers is sufficiently large to satisfy the Tayloristic labor demand, then the fall in Tayloristic employment is driven solely by the fall in the number of Tayloristic organizations. Yet if the number of non-versatile workers is small enough to make it necessary for the Tayloristic organizations to hire some versatile workers, then the employment decline in the Tayloristic sector is also driven by the rise in the number of holistic organizations, which reduces the labor supply

employment. As result, Tayloristic employment will fall by more and the Tayloristic wage will fall by less than in the previous scenario.

Assuming that employment per Tayloristic organization exceeds the employment per holistic organization and that the unemployment rate among single-skill workers exceeds that among the versatile ones, the rise in aggregate holistic employment will be less than the corresponding fall in Tayloristic employment, and hence unemployment rises.

As technological progress shifts the profit curves $\Pi^*_{TH}$, and $\Pi^*_{EH}$ upwards by equal amounts while leaving the profit curve $\Pi^*_T$ unchanged, the restructuring of Tayloristic into holistic organizations will eventually be replaced by entry of new holistic organizations. In terms of our model, this means that the entry condition (6a) becomes binding, replacing the restructuring condition (6c).

It is easy to see why. Given the number of holistic and Tayloristic organizations, the technological progress above raises an organization's profit from entry into the holistic sector by the same amount as the profit from restructuring a Tayloristic organization into a holistic one, since the gross holistic profit ($\pi^*_H$) remains unchanged. But as the number of holistic organizations increases, an organization's profit from entry into the holistic sector falls at a slower rate than the profit from restructuring a Tayloristic organization into a holistic one. The reason is that, as the restructuring process reduces the number of Tayloristic organizations, the profit of each remaining incumbent Tayloristic organization rises (since the wage in the Tayloristic sector falls), and this provides a disincentive to restructure. There is no corresponding disincentive to enter the holistic sector.

This is illustrated in Figure 4. Here we consider an initial equilibrium at Point A, where the marginal organization entering the holistic sector makes zero profit, and the marginal Tayloristic organization that restructures into a holistic one makes zero profit as well. Then the technological change raises the profit curve $\Pi^*_{EH}$ by the same amount as the profit curve $\Pi^*_{TH}$. Thus, the magnitude of the upward shift from $\Pi^*_{EH}$ to $\Pi'_{EH}$ in the figure is equal to the magnitude of the upward shift of the profit curve from $\Pi^*_{TH}$ to $\Pi'_{TH}$.

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to the Tayloristic organizations and shifts the wage setting equation upwards (since the reservation wage rises).

The restructuring process moves the economy from Point A to B in the figure (i.e. the number of holistic organizations increases by AB and the number of Tayloristic organizations falls by an equal amount). But at Point B there are still positive profits to be made from entering the holistic sector. The reason is that the intersection of the profit curve $\Pi_{EH}$ with the horizontal axis shifts to the left by a larger amount (from Point A to C) than the intersection of the profit curve $\Pi_{TH}$ with the profit curve $\Pi_T$ (from Point A to Point B). Consequently, the number of holistic organizations increases by $\Delta F_H^*$ = BC in the figure. Since the aggregate number of organizations has increased by $\Delta F_H^*$, the left-hand vertical axis shifts leftwards by an equal amount, pulling the Tayloristic incumbent organization's profit curve leftwards by an equal amount as well (from $\Pi_T^*$ to $\Pi_T^{'}$ in the figure).

At Point C, however, the profit from restructuring a Tayloristic into a holistic organization (given by $\Pi_{TH}^{'}$) is less than the profit from remaining a Tayloristic organization (given by $\Pi_T^{'}$). Thus when the technological progress in the following period shifts the holistic profit curves upwards again, only entry into the holistic sector - but no restructuring - will take place.

On the other hand, if the entry condition is binding in the initial equilibrium, then – by the analysis above – the technological changes above will ensure that the entry condition remains binding. Then, as the holistic profit curves shift upwards, the number of holistic firms increases while the number of Tayloristic ones remains constant. As result unemployment declines.

## *7. Concluding Thoughts*

Our analysis attempts to provide a new perspective on the organization of work. The recent literature on the division of labor within firms (e.g. Becker and Murphy (1992), Bolton and Dewatripont (1994), and Yang and Borland (1991)) focuses primarily on the returns to specialization relative to the costs of co-ordination *across workers*. It shows, among other things, that as the costs of communication among workers decline, the returns to specialization rise relative to the co-ordination costs and consequently the division of labor within firms increases. Another branch of the literature (e.g. Baumgardner (1988), Kim (1989), and Stigler (1951)) shows that as the size of the market increases (due to, say, economic growth or the expansion of international trade), the greater is the division of labor that it supports. Yet another branch (e.g. Holmstrom and Milgrom (1991)) shows how the division of labor within firms depends on the degree to which performance on particular tasks is measurable and the degree to which wages affect task performance. These contributions do not, however, explain how educational achievements and recent technological advances - particularly, the application of improved information technologies and the introduction of flexible machine tools and programmable, multi-purpose equipment - may lead to a *reduced* division of labor within firms. Our analysis has done so by examining changes in the division of labor from the perspective of the *intra-personal* returns from multi-tasking, rather than the *inter-personal* returns from co-ordination of worker activities or the incentive effects of wages.

In particular, our analysis has focused on how complementarities among tasks can be exploited when individual workers use their experience at one task to improve their performance at another task. In practice, this phenomenon - versatility across tasks, the ability to combine different tasks in meeting a customer's needs, the ability to apply the knowledge gained at one task to improve productivity at another task - can take on a wide variety of forms. There are abundant examples of this: the use of customer information gained from sales activities to improve product design, the use of technological information gained from production activities to improve financial accounting practices, the use of employee information gained from training activities to improve work practices, work rotation on the shop floor among blue-collar workers, and so on. The literature on organizational restructuring (cited in Section 2) suggests that nowadays this phenomenon plays an increasingly important role in the restructuring of work. In this context the introduction of new computer technologies and versatile capital equipment can enhance inter-task complementarities and thereby lead to a decline in the division of labor within firms.

In this context, the paper has examined the implications of these changes in the market for organizations and the labor market. In effect, the above changes in the division of labor "resegment" the labor market, raising the earnings versatile workers relative to non-versatile ones. Our analysis indicates that when the restructuring constraint is binding, the developments above initially lead to a "restructuring phase," in which some Tayloristic organizations are transformed into holistic ones and unemployment expands. The result is rising labor market segmentation in the sense of greater inequality of employment opportunities. If the restructuring process is driven by increases in informational and technological task complementarities or by reductions in returns to scale, the wages of versatile workers rise relative to those of the non-versatile ones. But if the process is driven by improvements in human capital that increase the supply of versatile workers, the movement in relative wages in the holistic versus Tayloristic sectors depends on the degree to which the supply of versatile workers increases relative to the holistic labor demand.

Furthermore, our analysis shows that the restructuring phase is followed by an "entry phase," in which the holistic sector expands, the Tayloristic sector stops contracting, and unemployment falls. In contrast to the increasing labor market segmentation in the restructuring phase, the entry phase is characterized by less labor market segmentation, since the holistic sector no longer grows at the expense of the Tayloristic one. The analysis also shows that when the entry constraint is binding, the developments above lead directly to the entry phase, without intervening restructuring phase.

It is worth noting that the "general training" that leads to an increased supply of versatile workers, potentially useful to all firms, has an influence quite different in our model from that in the standard human capital theory. In the latter, general training raises wages in all firms since it raises workers' productivity all over the economy. In our theory, by contrast, general training increases the supply of labor to holistic organizations and thereby expands the holistic sector at the expense of the Tayloristic one and reduces holistic wages relative to Tayloristic ones.

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