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THE TERMS OF AUTHORITY

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Many exchanges involve only a partial transfer of ownership rights. The employment relation is the standard example — an employer purchases the authority to use the worker's time in the most profitable way, within specified limits. This paper develops a model of the forces which determine the terms of authority.

1. Introduction

The exchange of commodities is a transferral of ownership rights pertaining to two bundles of goods. There are many ways in which economists have modelled the contractual form of such exchange. First, much of received microeconomic theory assumes that the contract stipulates that complete ownership rights to a quantity of a good is exchanged for a quantity of the unit of account (money) equal to the product of the unit price and the quantity of good. For example, when we purchase groceries at a supermarket, the checkout person computes a bill of sale which evaluates in money terms the value of our market basket. When we pay for the goods, we assume that we may use the groceries in any fashion we desire (within prescribed legal or social limits). Second, in the modern version of exchange individuals make payments now for the complete ownership rights to a quantity of a good contingent on the occurrence of some random event [see Arrow (1971a) or Debreu (1959)]. If the event does not occur the individual has no ownership rights over the goods in question. Third, in the literature on sequential markets [Grandmont (1977), Radner (1972)] some contracts are designed but never made formally binding until the event is actually realized some time in the future. Fourth, Simon (1957) has investigated contractual modes which he calls 'employment contracts' in which a payment is made now for the right to select the quantities of some commodities after the uncertain events have unfolded. The employment contract specifies limits on the quantities permitted. This does not exhaust the list of contractual modes; see also Williamson, Wachter and Harris (1975), Stiglitz (1975), Cheung (1968) and Mirrlees (1976).

In this paper, it will be assumed that labor services are the traded commodities and that all exchanges are made with (Simon) employment contracts which permit the buyer to determine, within prescribed limits, the laborer's activities in an authoritarian manner. It is important to notice that the authority relationship is not forced on the worker by the employer. Authority is a mutually advantageous arrangement for allocating resources, as Simon has pointed out. It is also important to remember that authority is limited. In a normal setting the worker can always refuse to follow the dictates of the employer and the worst sanction that can be imposed is to terminate the employment (although the government, as opposed to private employers, may put you in jail if you refuse to submit to authority).

A worker is a potential source of many types of labor [see Lancaster (1966) for a more general model]. When a worker takes a job (that is, agrees to an employment relation), a composite commodity is being exchanged for monetary units. Labor services, like any commodity, can be distinguished by physical characteristics, location in space, date in time and state of nature. It might be possible to write a contract for a worker that specifies in detail how much of each type of labor service is provided, where, when and in what circumstances. This type of contract is not used for several reasons spelled out by Simon (1957) and Williamson (1975). A traditional explanation is that transaction costs would be too large — construction and enforcement of such a complicated contract would be difficult. In this paper, the most appropriate rationalization would have to do with uncertainty and informational differences. Radner (1968) has demonstrated that contingent commodities will only be traded which are based on the common information of both parties.

For example, suppose that the employer of construction workers only has the capability to determine whether the temperature is above or below 80°F, while construction workers can only distinguish temperatures as being above or below 90°F. Even when the workers and employers have strong reasons for varying the salary with the temperature of the work site, their differing abilities to verify the temperature force them to pay a uniform salary. If the wage differed at 75° from that at 85°, the workers would be susceptible to a dishonest employer's misrepresentation of the temperature and would therefore reject such a wage schedule. Similarly, a wage schedule with different wages at 85° and 95° would be rejected by the employer. The only mutually acceptable contract is one with a uniform wage for all temperatures.

With Simon's employment contract, a mutually advantageous resolution of the difficulties of informational differences may be found. For example, a secretary may contract to type, file reports, take shorthand dictation, answer telephones or perform many other tasks, all at the discretion of the boss. The employer pays for the partial ownership right to allocate the secretary's time between tasks as uncertainties facing the employer resolve themselves. The freedom enjoyed by the employer to change the labor allocation after information is obtained may be very valuable to the employer. The employer may, therefore, be willing to pay salary premiums to the workers for the authority to unilaterally adjust work tasks as his personal information is acquired. Workers may find these premiums attractive enough so that they accept some uncertainty about the exact job conditions.

The employment contract must describe the job in some fashion. Simon assumed that the description was simply to state the set of possible tasks that might be asked of the worker. In this paper, a slightly more general formulation of job description will be used. The employment contract will specify the frequency which the employer expects the tasks to occur. For example, the agreement between boss and secretary might specify that the secretary is required to brew coffee for the boss only in very unlikely circumstances (or in the limit, as Simon might require, never). A job will be characterized by a probability distribution defined on the set of possible time allocations between various types of tasks.

This paper presents models of job selection and the determination of work conditions in an uncertain world. A major distinction between these models and the traditional labor supply models is the assumption made here of full-time employment. Workers either give an employer all their labor time or they do not work for him at all. This assumption is based on the mode of contractual exchange. When authority is granted to the employer by the worker, this means that the worker is on-call to perform any task asked of him within the agreed to limits. Even if nature turns out to be such that the worker is performing the task of 'wait but do nothing', he cannot use this freetime to moonlight at another job. He is paid a salary premium to assure the employer that he is available for any task assignment. The worker cannot make such an agreement with two employers.

The aim of this paper is to develop a model of labor market equilibrium which captures two realistic institutional features — indivisible, full-time work and an authority relationship between employer and employee. The economic rationale for authority is developed in section 2. The full-time nature of the employment contract may lead to difficulties in matching workers and jobs. This is analyzed in section 3. The terms of authority are determined by the tastes and the technology of employees and employers. In section 4, the equilibrium terms of employment contracts are studied as a function of the authority aversion of workers and the riskiness of the employer's technology.

2. Authority in employment relationships

Work consists of a finite number of tasks indexed by $i=1,2,\ldots,n$. Tasks may be distinguished by physical characteristics, time and location but not by random events. The time that a worker devotes to a task i is denoted t_i

and work is the vector of times $t=(t_1,\ldots,t_n)$. The quantity of work in each task might include other dimensions such as effort, quality and pace, but here it is assumed that these are included in the specification of the tasks. For example, task i might be 'typing leisurely' and task $i+1$ might be 'typing swiftly'. Time will be considered as the sole measure of the service provided.

It will be assumed for simplicity that each worker is capable of doing the same work, although there may be differences in tastes about the type of work. The unique set of time allocations which are possible is denoted $T \subseteq R^n$. If $t \in T$ then any worker can perform the task i for t_i time units, $i=1,\ldots,n$. Workers are not identical with respect to tastes. Let us assume that there are m workers indexed by $w=1,2,\ldots,m$. A worker w has preferences for combinations of certain income I (a proxy for the commodities which income buys) and work t which are represented by a von Neumann–Morgenstern utility function (defined up to affine transformations),

$$U(I,t,w). \tag{1}$$

The dependence on w indicates that different workers may have different preferences.

Let us first assume that there are exactly as many employers as there are workers. This will be weakened subsequently. Index the employers by $e=1,2,\ldots,m$. Assume that each employer has need for at most one worker. This, too, will be weakened later. Each employer e knows that if his employee performs work t when nature is in the state $\theta \in \Theta$ that the worker's contribution to revenue will be

$$R(t,\theta,e). \tag{2}$$

The dependence on e indicates that different employers face different technological or market environments. The state of nature, θ, is not known with certainty ex ante, although the employers' beliefs about the likelihoods can be expressed in a subjective probability density, $\gamma(\theta,e)$, defined on the state space Θ, where

$$\gamma(\theta,e) \geqq 0, \quad \theta \in \Theta \quad \text{and} \quad \int_{\Theta} \gamma(\theta,e)\,\mathrm{d}\theta = 1. \tag{3}$$

The dependence on e indicates that employers may have different beliefs about nature.

The employer derives utility from income and is unaffected by the tasks his employee performs. His tastes are given by the von Neumann–Morgenstern utility function

$$G(I,e). \tag{4}$$

The only thing which needs to be specified about the economic environment is the information systems of the employers and workers. It will be assumed that the employer can observe the true state of nature, θ, before the production activities are selected. The employer can also observe the revenue, R, derived from the productive enterprise and can costlessly monitor the actions, t, of his employee. The worker, on the other hand, is assumed to learn nothing about the state of nature or the revenue of his employer. All he can observe are the tasks he performs.

As a result of these informational assumptions the payment of the worker cannot depend directly on the revenue or the state of nature. In particular, the worker cannot be paid by giving him a share in the resulting revenue. [When sharing is possible the employment relationship takes on characteristics of the principal–agent relationship discussed by Ross (1973, 1974), Harris and Raviv (1978), Shavell (1979) and Holmstrom (1979).] If payment was based upon R or θ, the worker would not be able to enforce the contract.

It would seem that similar reasoning would imply that the task selected by the employer cannot depend on the state of nature. If it did the worker would be unable to enforce the contingent features of the employment contract. However, there are opportunities lost when the task is not the most propitious activity for the true state of nature. The remainder of the section provides a rationale for an employment contract with a fixed wage but with state contingent work selected unilaterally by the employer.

Suppose that the worker has alternative uses of his time which provide a level of utility,

$$\bar{U}(w). \tag{5}$$

If the employer does not adjust tasks when he observes the state of nature, the best he can do is to select a task, t, and a salary, S, to maximize his own expected utility

$$\int G(R(t,\theta,e)-S,e)\gamma(\theta,e)\,\mathrm{d}\theta, \tag{6}$$

subject to the employee's requirement that

$$U(S,t,w) \geqq \bar{U}(w). \tag{7}$$

Denote the solution of this problem (t^1, S^1). The solution depends upon which particular employer e we are looking at but this will be suppressed for notational simplicity. If the employee allows the task to be selected by the employer after he observes θ, he is taking a chance of having an undetectable breach of contract. However, if the contract does allow t to vary with θ, the employer will select a decision rule $t(\theta)$ and salary S to maximize

$$\int G(R(t(\theta),\theta,e)-S,e)\gamma(\theta,e)\mathrm{d}\theta, \tag{8}$$

subject to

$$\int U(S,t(\theta),w)\gamma(\theta,e)\mathrm{d}\theta \geqq \bar{U}(w). \tag{9}$$

Denote the solution of this problem $(t^2(\theta), S^2)$. Since (t^1,S^1) satisfy (7) it is clear that they also satisfy (9). The optimality of $(t^2(\theta),S^2)$ implies that

$$\int G(R(t^2(\theta),\theta,e)-S^2,e)\gamma(\theta,e)\mathrm{d}\theta \geqq \int G(R(t^1,\theta,e)-S^1,e)\gamma(\theta,e)\mathrm{d}\theta. \tag{10}$$

The employer should be able to share these benefits with his worker by paying a salary premium above S^2.

It should be noted that if the worker can observe t, there is no reason that the salary should be independent of the task in general. However, if the employer is risk neutral, the worker risk averse with respect to income and the marginal utility of income is unaffected by changes in tasks, the optimal salary should not depend on the actual task. The intuitive explanation is this; if the worker is risk averse he would give up some expected salary to eliminate uncertainty about the salary and since the employer is risk neutral, he is better off when paying a lower expected salary and having a riskier net revenue. To be more precise, suppose that $(t^3(\theta),S^3(t))$ maximizes the employer's expected income

$$\int [(R(t(\theta),\theta,e)-S(t(\theta))]\gamma(\theta,e)\mathrm{d}\theta, \tag{11}$$

subject to

$$\int U(S(t(\theta)),t(\theta),w)\gamma(\theta,e)\mathrm{d}\theta \geqq \bar{U}(w). \tag{12}$$

Let us assume that the worker's utility is separable so that changes in income do not affect the relative desirability of tasks. The first-order condition for the salary rule is

$$U_I(S^3(t^3(\theta)),t^3(\theta),w)=\frac{1}{\lambda} \quad \text{for all } \theta, \tag{13}$$

where λ is the Lagrange multiplier of (12). Holding θ constant, differentiating (13) with respect to t_i gives

$$U_{II}\frac{\partial S^3}{\partial t_i}+U_{It_i}=0. \tag{14}$$

Solve for $\partial S^3/\partial t_i$ to get

$$\partial S^3/\partial t_i = -U_{It_i}/U_{II}. \tag{15}$$

The assumption that utility is separable in income and work implies that

$$\partial S^3/\partial t_i = 0, \qquad i = 1, 2, \ldots, n, \tag{16}$$

or

$$S^3(t) = \text{constant}. \tag{17}$$

Since it is reasonable to assume that the employer is risk neutral [see Bailey (1974)], in the remainder of the paper it will be assumed that employers are interested in maximizing their expected income. This will be achieved by employment contracts which make a fixed salary payment to the workers and which permit the employer to adjust the assignment of tasks. Although workers cannot observe θ to check if the task asked of them corresponds to the authorized task, $t(\theta)$, the salary is large enough to compensate. If the worker and employer have a recurring contractual relationship, the employee may be able to detect misuses of authority when the empirical frequency with which tasks are performed differ from the contractual frequency implied by $t(\theta)$ and $\gamma(\theta, e)$.

3. Job–worker matching with full-time employment

Workers are hired by employers to perform work tasks. Salaries are paid the workers unconditionally and employers are granted the right to select work tasks *after* nature has determined its state, θ. The employer is assumed to select the work $t \in T$ to maximize the revenue generated by a worker conditional upon the state of nature. Without specifying marginal conditions, let us denote the optimal choice of work by employer e in state s by

$$t(\theta, e). \tag{18}$$

Given this decision rule and the subjective probability of θ, the employer determines the frequency with which his worker may be called upon to perform each possible task combination. Denote the resulting probability density of work t with employer e by $\mu(t, e)$, where

$$\mu(t, e) \geqq 0, \quad t \in T \quad \text{and} \quad \int_T \mu(t, e)\,\mathrm{d}t = 1. \tag{19}$$

Given these ex post work decisions the employer must decide if a worker should be hired. The expected optimal revenue associated with the worker of employer e is

$$R(e)=\int_{\Theta} R(t(\theta,e),\theta,e)\gamma(\theta,e)\,\mathrm{d}\theta. \tag{20}$$

The employer e can afford to hire a worker if the salary he pays, $S(e)$, does not exceed the expected optimal revenue of the worker, $R(e)$. If salary exceeds $R(e)$ then the employer hires no worker.

The employer makes a *job offer* to all workers consisting of a *job description*, $\mu(t,e)$, and a *salary*, $S(e)$. Workers who accept such a contract will be paid a known salary but will not know with certainty the actual task involved. For example, a secretary might be hired for a fixed weekly salary and told only that there is an equal probability that the week will be spent typing or taking shorthand dictation.

Workers are free to choose any job offer which has been made. They observe the entire spectrum of potential job contracts

$$\langle S(e),\mu(t,e)\rangle_{e=1}^{m}. \tag{21}$$

The wth worker can calculate for each e the expected utility derived from the announced salary income and job description,

$$V(S(e),e,w)=\int_{T} U(S(e),t,w)\mu(t,e)\,\mathrm{d}t. \tag{22}$$

The worker is not concerned with the manner that the probability distribution is derived from the work assignment rule (18) and the state probability density (3). Workers select the employer which makes the most attractive job offer. This choice of employer may be formulated as the following linear integer programming problem: maximize by choice of $a_{w0},a_{w1},\dots,a_{wm}$

$$\sum_{e=1}^{m} e_{we}V(S(e),e,w)+a_{w0}U(0,0,w), \tag{23}$$

subject to

$$\sum_{e=0}^{m} a_{we}=1, \tag{24}$$

and

$$a_{we}\in\{0,1\}. \tag{25}$$

The choice variables $\{a_{we}\}$ are integer assignment variables with the following interpretation: $a_{w0}=1$ when non-employment is optimal and $a_{we}=1$

if employer e has the most attractive job available. The constraints specify that each worker w must choose one and only one employer for whom to work. The job consists of the full-time submission to the authority of the employer.

A job offer spectrum like (21) would lead to equilibrium in the job markets if the optimal assignment vectors from the above problem, $A=\{a_{we}\}$, also satisfy the condition

$$\sum_{w=1}^{m} a_{we}=1 \quad \text{if} \quad S(e)\leq R(e), \qquad e=1,2,\ldots,M, \tag{26}$$

$$\sum_{w=1}^{m} a_{we}=0 \quad \text{if} \quad S(e)>R(e), \qquad e=1,2,\ldots,M. \tag{27}$$

Condition (26) states that each employer receives only one acceptance of his job offer and condition (27) implies that the job offers are profitable to the employers.

In this simple model where employers hire only one worker, the job description, $\mu(t,e)$, is fixed by the technology [the revenue function $R(t,\theta,e)$ and the beliefs $\gamma(\theta,e)$]. Only the salary is adjustable. The market is assumed to increase salaries of jobs which are not selected by any worker and to decrease the salaries of jobs which are desired by more than one worker.

Equilibrium can be illustrated as in fig. 1.

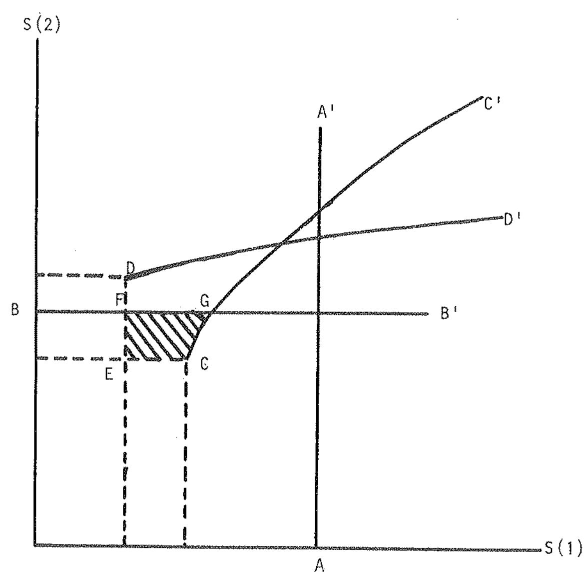

Fig. 1

There are two employers and two workers. Line AA' in the salary space represents the dividing line between profit and loss for employer $e=1$. To the left of AA', the salary $S(1)$ is low enough that employer 1 can profit from an employee, to the right a worker would not cover his salary with the revenues he generates. Similarly, BB' divides the salary space according to the profitability of a worker for employer $e=2$. Curve CC' divides the salary space according to the preferences of worker $w=1$. Below and to the left of point C both salaries are so low that worker 1 rejects employment. Salaries below the curve CC' lead the worker 1 to choose employer $e=1$ since his salary is significantly larger than that of employer 2. Curve DD' is the analogous curve for worker $w=1$. When salaries are in the shaded region, $CEFG$, the workers and employers have reached an equilibrium where worker $w=1$ accepts the offer of employee $e=2$ and worker $w=2$ accepts the offer of employer $e=1$.

It should be pointed out that equilibrium may result in one or more pairs of workers and employers deciding that there is no mutually beneficial employment. In fig. 2 the equilibrium salaries must lay in region $ECGF$. In this region the worker $w=1$ decides to be self-employed and employer $e=2$ decides not to employ a worker. Worker $w=2$ and employer $e=1$ strike an employment bargain. One should not view this as a situation of unemployment. The remainder of the paper will presume that all workers find work with the employers and are not self-employed.

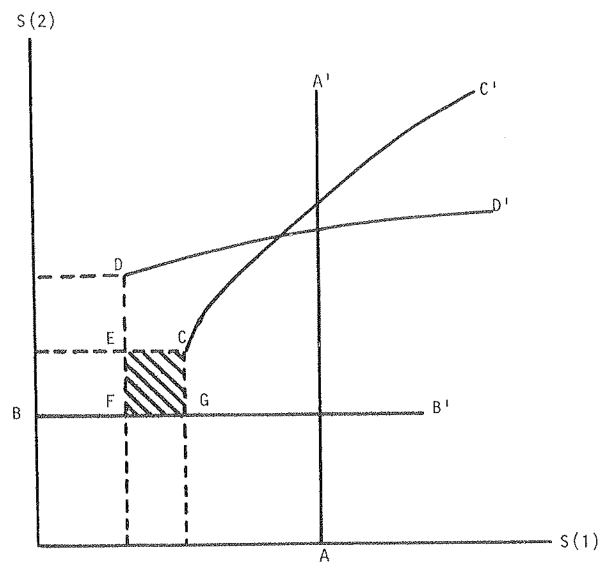

Fig. 2

In the above simple model the job conditions are determined only on the supply side: the function relating optimal work and state of nature, $t(\theta, e)$, and the subjective beliefs about nature, $\gamma(\theta, e)$, together determine the job description, $\mu(t, e)$. This is completely independent of labor market conditions. The next task is to show how the job description may be endogenously determined, in part by the preferences of workers.

The only change to be made in the above model is to permit employers the option of hiring several workers. (There is no longer a need to assume that the number of employers equals the number of workers.) Let x be the number of workers employed by the employer and denote the total contribution of those workers toward revenue by

$$R(x, t, \theta, e). \tag{28}$$

The employer e with work force x observes the state of nature θ and selects the task assignments for the typical worker,

$$t(x, \theta, e), \tag{29}$$

to maximize revenue. By the nature of the employment relation, the work selection is done after workers are hired and nature is observed.

Prior to hiring workers the employer calculates that the expected net revenue associated with x workers is

$$\int_{\Theta} R(x, t(x, \theta, e), \theta, e)\gamma(\theta, e)\,\mathrm{d}\theta - S(e)x, \tag{30}$$

where $S(e)x$ is the cost of hiring x full-time employees. The employer selects the work force to maximize the expected net revenue. Denote the optimal number of workers by

$$x(e, S(e)). \tag{31}$$

When this has been done the employer can calculate the job conditions (a probability density of T) from the composite function $t(x(e, S(e)), \theta, e)$ and the subjective beliefs, $\gamma(\theta, e)$. Denote the calculated job description by $\mu(t, e, S(e))$, where

$$\mu(t, e, S(e)) \geqq 0, \quad t \in T \quad \text{and} \quad \int_{T} \mu(t, e, S(e))\,\mathrm{d}t = 1. \tag{32}$$

Unlike the previous model the job conditions are endogenously determined. As salary adjusts, so do the optimal work force sizes and hence so do the optimal work tasks.

Workers observe the spectrum of job offers

$$\langle S(e), \mu(t, e, S(e))\rangle_{e=1}^{k}, \tag{33}$$

and select the employer whose offer maximizes their expected utility, exactly as before. More than one worker may find employer e's offer the most attractive. If $A=(a_{we})$ is the array of workers' assignment variables, equilibrium will occur when

$$\sum_{w=1}^{m} a_{we}=x(e, S(e)), \quad \text{for all } e. \tag{34}$$

If revenue is zero when the number of workers is zero ($R(0,t,s,e)\equiv 0$), then equilibrium may occur with some employers hiring no workers. The choice of optimal work force removes the requirement that $S(e)\leqq R(e)$ as in eq. (27) above.

3. Equilibrium analysis: An example

In this section a market for workers who operate or repair machines is analyzed focusing on the market impacts of employer's changing riskiness of technology. The example is specified numerically as an expository aid. More general specifications will be left for other studies. The example illustrates the strengths and weaknesses of the general model of the previous section.

Workers are hired in this example because they can operate machinery or repair machinery when it malfunctions. For a particular employer, e, let θ_e be the number of worker-days needed to repair machines. This is a random variable. Let L_0 denote the total worker-days of labor used in operating machines and let L_r denote the total worker-days used for repair work. Labor can be transformed into revenue by the eth employer according to the relation

$$R=a(e)L_0-\tfrac{1}{2}L_0^2-\tfrac{1}{2}(L_r-\theta_e)^2. \tag{35}$$

The first two terms are the total revenue product of machine operating labor and the last term is the loss in revenue which occurs if there is a deviation from the required number of repairmen. The coefficient $a(e)$ varies with employer, reflecting perhaps the size of the employer's capital stock.

Labor is hired as in the previous section. If the employer has x workers and each worker's time is allocated between operating and repairing according to $t=(t_0, t_r)$ then total labor is

$$L_0=xt_0 \quad \text{and} \quad L_r=xt_r. \tag{36}$$

It is assumed that each worker supplies one worker-day of labor, so

$$T=\{t \mid t_0+t_r=1\}. \tag{37}$$

Non-negativity constraints will be ignored.

Suppose the employer believes that the number of worker-days needed to repair machines has a mean η_e and a standard deviation δ_e. To assure that non-negativity constraints are not violated it might also be assumed that η_e is large compared to δ_e and that the probability density has a compact support. The employer maximizes the expectation of (35) subject to (36) and (37). The optimal time spent operating machines will be

$$t_0(x,\theta_e,e)=1/2+(a(e)-\theta_e)/2x, \tag{38}$$

and the optimal size work force will be

$$x(e,S(e))=\eta_e+a(e)-2S(e). \tag{39}$$

The workers hired by the employer e grant the employer the authority to select operation time t_0 with a frequency given by a probability distribution with mean

$$E\{t_0\}=1/2+(a(e)-\eta_e)/2(\eta_e+a(e)-2S(e)), \tag{40}$$

and standard deviation

$$\sigma(e)=\sqrt{E\{(t_0-E\{t_0\})^2\}}=\delta_e/2(\eta_e+a(e)-2S(e)). \tag{41}$$

To simplify the analysis assume that all employers believe that the expected number of worker-days needed for repair work equals the coefficient of productivity of the machines, $\eta_e=a(e)$. Because of this when the salary increases the job description changes only by an increase in the authority required, $\sigma(e)$, and there is no change in the expected time spent operating and repairing machines. See fig. 3. For employers with less predictable machines the authority curve in fig. 3 will be uniformly higher and steeper.

Assume that workers have utility functions of the separable form

$$U(I,t,w)=V(I,w)-D(t,w). \tag{42}$$

V is the value of income and D is the disutility of labor. Separability implies that the marginal utility of income is not influenced by the job conditions. Let us make a Taylor series approximation of expected utility around

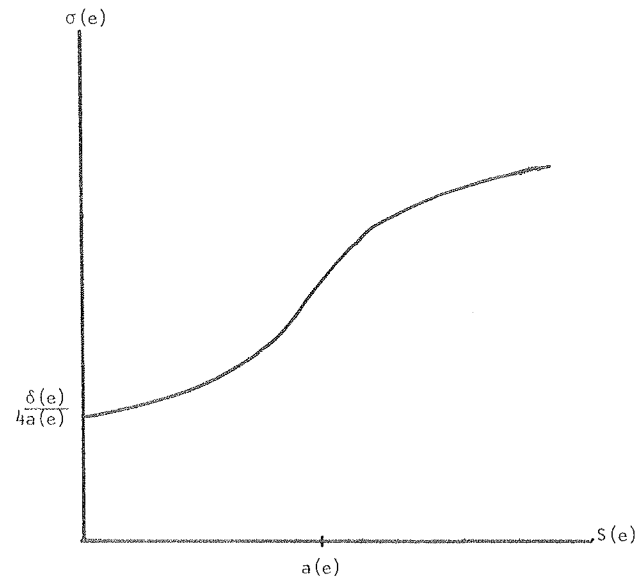

Fig. 3

$t=(1/2,\ 1/2)$ keeping only terms of degree two or less:

$$E\{U(S(e),t,w)\}=V(S(e),w)-1/2A(w)\sigma(e)^2-\bar{D}, \tag{43}$$

where

$$A(w)=D_{t_1t_1}-2D_{t_1t_2}+D_{t_2t_2}, \tag{44}$$

and

$$\bar{D}=D(1/2,1/2,w). \tag{45}$$

$A(w)$ is evaluated at $t=(1/2,1/2)$. The worker w would pay an amount approximately equal to

$$1/2\sigma(e)^2A(w)/V_I(S(e),w) \tag{46}$$

to eliminate the authority which employer e asks for. $A(w)$ will be treated as a measure of the worker's aversion to authority. When the worker views the tasks as perfect substitutes,

$$D(t_0,t_r,w)=D(t_0+t_r,w), \tag{47}$$

the worker does not care how much authority the employer wants so long as the total supply of labor time is the same. In this case the value of $A(w)$ will be zero and the worker will not pay to reduce the authority of the employer. This brings into relief the assumption made here that the amount authority is measured by the spread of the distribution of the random variables $t_0(x, \theta_e, e)$ and $t_r(x, \theta_e, e)$. The tastes of a worker can be described by a family of indifference curves as in fig. 4. [Arrow (1971b) and Pratt (1964) use a similar analysis.]

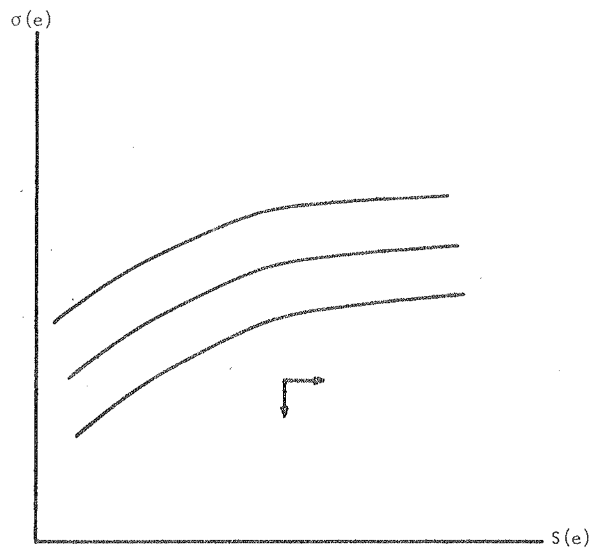

Fig. 4

Workers with greater aversion to authority will have flatter indifference curves.

Suppose there are two employers where $\delta(1) > \delta(2)$. The first employer has less predicable machines and must have greater authority to adjust the repair/operating task assignment. Also suppose there are two types of workers where $A(1) < A(2)$. Workers of type 1 are less averse to working under authority. If there are X_w workers of type w, the salaries that would induce the employer $e = w$ to hire all the workers of that type is $S(e) = a(e) - 1/2X_w$. Equilibrium will be achieved if these salaries lead to workers of type w accepting employer $e = w$'s offer as in fig. 5.

Since the indifference curves of $w = 1$ are so much steeper than $w = 2$, type 1 workers accept the offer J and type 2 workers accept the offer I. There is no tendency for salaries or job authority to adjust from these values.

Only dramatic shifts in workers' attitudes towards authority will influence salaries and authority. If $A(1)$ increases slightly, the indifference curves of $w = 1$ will rotate clockwise slightly. The workers of type 1 will be less satisfied with

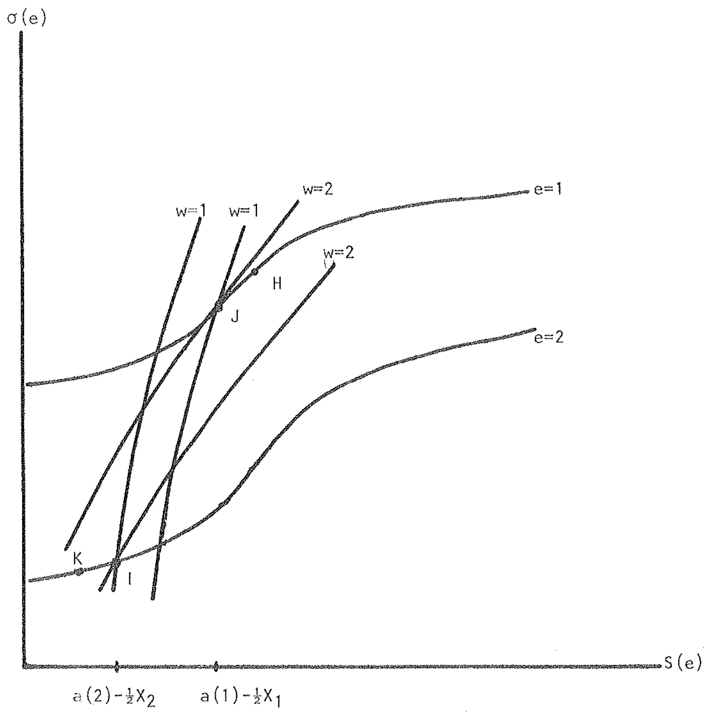

Fig. 5

the offer J than before but will still choose the authoritarian employer's offer. J will not change.

If one member of type 1 workers was to change aversion to authority and become a type 2 worker, equilibrium salaries and job descriptions must adjust. The salary offered by employer 2 will fall along the authority curve from I to K; K is 1/2 units less salary. Simultaneously the employer 1 will find his salary rising by 1/2 to reduce his excess demand for workers. The employer 2 reduces the authority he requires from his workers while employer 1 increases his authority.

If the productivity of operating labor increases at the same time that the expected time required for machine repair increases [$a(e)=\eta_e$ goes up] the employer e will increase the salary he offers. If the numbers of workers remains constant the salary increase will be just sufficient so that job authority is unchanged. There is a shift in the authority curve as well as a movement along it. The workers of the employer will be better off than before.

If the predictability of machines decreases the salary of workers is unaffected but the required authority necessary to justify that salary and work force will rise. The worker's expected utility will fall.

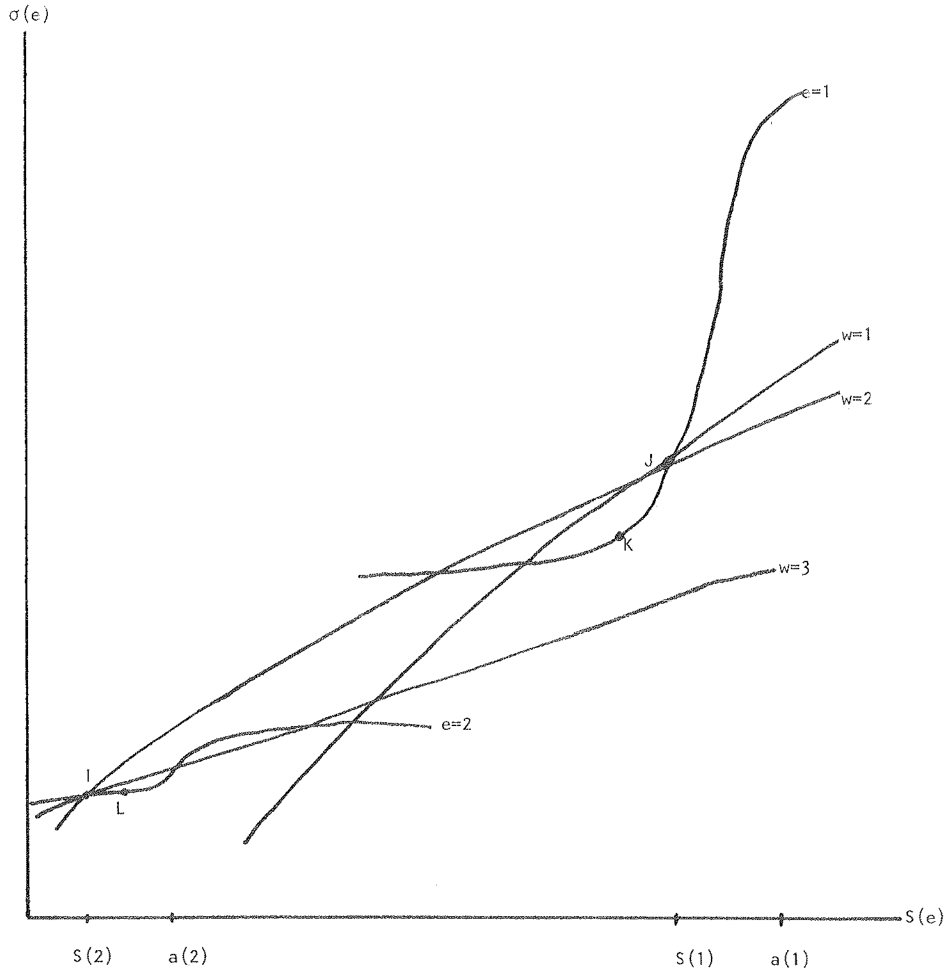

Fig. 6

Equilibrium in job markets like these may not produce an efficient allocation of resources. Consider an economy with two employers and three types of workers as in fig. 6. Only one indifference curve is drawn for each worker type. Workers of type 1 are the least averse to authority and workers of type 3 are the most averse to authority. The preferences are chosen such that workers of type 1 would accept offer J rather than offer I; workers of type 3 would accept I rather than J. The single worker of type 2 is indifferent between the two offers but assume that he has selected offer I. If the salary of employer 1 were to fall by 1/2 units he would want to hire one additional worker; if the salary of employer 2 were to rise by 1/2 units he would want to fire one worker. By construction of the indifference curves all workers would be better off if this salary adjustment were made. Worker 1 is better off at K than at J and would still prefer the more authoritarian employer. Worker 3 would be better off at L than at I and would still prefer to work in the less authoritarian situation. Since the authority curve of $e=1$ intersects worker 2's indifference curve with a steeper slope than employer 2's, the worker 2 will want to switch employers and accept offer K.

Are the employers better off by this salary adjustment? Substitution of the optimal work force and task assignment back into the revenue function allows us to calculate the expected profit of the employer as a function of his salary:

$$E\{R\}-S(e)x(e,S(e))=-1/2(a(e)+\delta_e^2)+(S(e)-a(e))^2. \tag{48}$$

The closer $S(e)$ is to $a(e)$ the flatter the expected profit relationship. By construction $S(2)$ is closer to $a(2)$ than $S(1)$ is to $a(1)$. From this we conclude that a rise in $S(2)$ by 1/2 units and a fall in $S(1)$ by 1/2 units will increase the total expected profits of the employers 1 and 2.

In summary, fig. 6 illustrates an economy with multiple equilibria. Not all equilibria are efficient since equilibrium $I-J$ is dominated by $L-K$. All parties would be better off if worker 2 worked for employer 1. However, there is no tendency for $I-J$ to change since salaries are determined by the labor market, not by fiat.

4. Summary

This paper is a tentative step toward a general model of the equilibrium terms of authority. The contractual mode studied here permits the employer to authoritatively select the tasks performed by workers. The motivation for such an investigation is simple. Authoritarian allocation of resources is a prevalent technique for distributing scarce resources, not only in centralized economies but also in economies with strong property rights. Most of us voluntarily work for a boss who tells us how to use a large proportion of our time. Not only should economists investigate conditions which result in such widespread use of authority, but they should also investigate the limits and terms of such authority.

In the previous sections a model of the equilibrium of a system of job markets was developed; authority was a primary ingredient. Employers desired authority because of the uncertainties they faced and workers were willing to submit to authority because their income was supplemented by such submissive behavior. The matching of workers to jobs was carried out by a market mechanism, which also determined the equilibrium terms of authority. By postulating specific changes in workers' attitudes toward

authority or changes in employers' beliefs about uncertainties, the model was able to predict changes in salary levels as well as levels of authority.

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