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Work Effort and Alternative Methods of Remuneration

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The Incidence of Wage Payment Methods

It has become customary in economics to measure the input of labor services in production over a period of time by some combination of the number of workers employed and their hours of work adjusted in some fashion for variations in acquired skills. This has been a most useful procedure in assisting our understanding of a large class of behavior in the labor market. In this paper, however, another dimension of the input of labor services receives particular attention and emphasis, namely, the intensity and diligence of work effort manifested by each employee working individually and by all employees working together as a team. The neglect by economists of this aspect of the exchange of labor services is a relatively recent phenomenon. For instance, Alfred Marshall stressed how the effective supply of productive factors depends upon "...the willingness of those, in whose charge it is, to apply it in production" and he wrote, therefore, of the "supply of efficient work."[1/] He censured Böhm-Bawerk for believing that wages were determined by demand alone "for even if the number of [working] hours in the year were rigidly fixed, which it is not, the intensity of work would remain elastic."[2/] Yet analytical work in economics of a more recent vintage has tended to ignore the intensity of work effort and the subject has become the almost

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1/ Marshall [1920], pp. 437-39.

2/ Marshall [1920], p. 438, n. 1.

exclusive province of industrial relations researchers. As one such student has observed, "...while the economist thinks primarily of an increase in the number of workers when he speaks of a change in the supply of labor, managers in practice--especially in times of full employment--think in terms of increasing the supply of effort from their existing labor force."[1/] Much of this paper, therefore, is concerned with rehabilitating the notion of work effort into analytical economics.

The manner in which individual and team work effort is modelled below derives from considering aspects of the operation of alternative methods of remunerating employees. This is a natural context in which to examine work effort since essentially it is to elicit a response from this dimension of the input of labor services for which incentive methods of remuneration are designed. In this way, attention is directed to particular characteristics associated with the exchange of the services of labor and the resources consumed in effecting such transactions. An important class of these resources consists of the factors spent by management in converting a body of disparate and perhaps grudging individuals into an integrated and productive labor force. In such team work, each employee has the occasion of pursuing his own interests at the expense of all and this self-seeking will partly take the form of each worker consuming more leisure on the job. This shirking is detectable by management spending resources to monitor the behavior of employees so that the incidence of slovenly work behavior will be related to the properties of

[1/] Behrend [1957].

the function relating enforcement costs to the level of the firm's policing activities.[1/] Evidence that important costs are involved in monitoring workers is supplied by the fact that firms sometimes choose to hive off that activity and pay someone else to discharge that function. For instance, in many cases, labor contractors are paid not merely to recruit workers, but also to supervise them and to apportion rewards among them.[2/] Whether in the direct pay of the firm itself or the employees of an intermediary, the incomes of the supervisors are to be understood as the marginal return to the firm for their monitoring the work effort of the firm's labor force.[3/]

This policing activity includes "metering input productivity and metering rewards."[4/] If the price mechanism is to allocate resources efficiently, the rewards and penalties to different activities must accurately reflect their marginal productivities and marginal costs. This correspondence between market signals and demands and supplies is accomplished through devices that monitor and register claims on and contributions

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[1/] For a more thorough statement of this view of the firm, see Alchian and Demsetz [1972].

[2/] This is true of the contractors in the California harvest labor market some of whose functions have been taken over recently by officers of employee unions; of the Italian padrone at the turn of the century who not merely advanced credit to poorly-informed immigrants and occupied the role of the go-between for laborers and employers, but also sometimes acted as foreman and paymaster; and of the jamadar in India who enlists and supervises workers for firms in the construction industry. For more information on the work performed by labor contractors, consult Epstein and Monat [1973].

[3/] The nature of these net returns is discussed in Becker and Stigler [1974].

[4/] Alchian and Demsetz [1972], p. 778.

to output. One class of these devices consists of the various arrangements by which individual employees are renumerated for their work. Essentially, there are two such arrangements: remuneration may be distributed according to the input or inputs that each worker supplies to his job or according to the performance or output produced by a worker or group of workers. The first type of arrangement commonly takes the form of time payments--wage per hour, salary per month or per year, etc.--while the second encompasses pure piecework and a great variety of incentive payments schemes. Since many individuals classified as operating on incentive methods have some fraction of their total pay related to their working time, the menu of choices available to workers does not simply consist of receiving either all their earnings in the form of time payments or all as piecework. Instead, the market has generated a spectrum of wage payment methods in which the weight attached to working time in the metering system ranges from zero in the pure piece-rate system to unity for workers on time-rate methods.

The distinction between the use of time input, on the one hand, and output or performance, on the other hand, as a metering device is not always a clear one, however. For instance, a number of payment-by-results schemes measure performance by the difference between the time taken by a worker to complete a task and the "normal" time scheduled as gauged from work study methods. Here pay is related to work performance and the index of performance itself is linked to the input of time, namely, to the extent to which the time spent by the worker on an activity falls short of the rated time "allowed." The desire to combine the

advantages of each general class of payment mechanism has led to "mixed contracts" like measured daywork under which a worker (or group of workers) is paid a basic time rate and receives a bonus (or set of bonuses) providing a certain standard is met. This is a contract in which part of the payment is contingent upon the satisfaction of some condition. Moreover, this classification into time-related and output-related metering devices involves grouping a wide assortment of payment schemes into two sweeping categories. Thus, in what follows, the terms "incentive systems," "payment-by-results methods," and "piecework contracts" are used interchangeably and we do injustice to the rich variety of different types of incentive schemes that the market has generated. No doubt, there are occasions on which lack of discrimination among different types of time payments and incentive payments methods will hinder an understanding of a particular problem. Nevertheless, the main purpose of this paper is not to look for differences within the two payments system, but rather to identify some general principles that distinguish between the two.

Since the lines of demarcation between time payments and incentive payments methods are blurred and since this categorization has sometimes appeared as no more distinctive as that among different types of incentive schemes, the information available on the incidence of payment systems is sometimes difficult to interpret for changes over time or differences between countries. Consider the data on United States manufacturing in Table 1: the first column shows the percentage of factory workers on piecework as given in the Census of Population of 1890 and the second column shows the percentage of production workers on incentive pay in 1958.[1/]

[1/] See Lebergott [1972].

Table 1

Percentage of Production Workers on Piecework in 1890 and Incentive Pay in 1958 in United States Manufacturing Industry

	1890	1958
All manufacturing industry	17.9	27.0
Tobacco	64.1	30.9
Furniture	54.2	25.0
Apparel	51.3	59.3
Leather	44.0	63.2
Paper boxes	45.3	20.0
Printing	14.6	3.8
Textiles	13.4	39.7
Food	10.4	11.5
Chemicals	5.6	8.8
Lumber	4.1	6.3
Instruments	45.2	29.2
Toys, sporting goods	24.5	24.0
Nonelectrical machinery	21.2	25.9
Fabricated metals	18.6	23.1
Electrical machinery	15.6	40.3
Primary metals	10.1	46.4
Jewelry, silverware	10.0	35.0
Transport equipment	4.6	10.4
Stone, clay, and glass	8.4	25.1

From U. S. Bureau of the Census, Census of Population 1890: Manufactures, Part 1, Table 4

L. Earl Lewis, Monthly Labor Review, May 1960, pp. 460-63.

Table 2

Percentage of Production Workers Paid on an Incentive Basis, 1945-56 and 1958 in United States Manufacturing Industry

		1945-46	1958
1.	men's + boy's dress shirts and nightwear	74	71
2.	drugs + medicines	11	17
3.	industrial chemicals	3	5.5
4.	paints and varnishes	6	13
5.	aircraft engines + engine parts	20	4
6.	ferrous foundries	29	27
7.	nonferrous foundries	20	23
8.	iron and steel forgings	34	33
9.	cotton textiles	35	36
10.	rayon + silk textiles	35	29
11.	textile dyeing + finishing	22	14
12.	woolen and worsted textiles	34	29
13.	bakeries	< 0.5	5
14.	cigarettes	6	3
15.	cigars	73	66
16.	footwear (except slippers + rubber products)	69	70
17.	costume jewelry	22	17
18.	precious jewelry	14	35
19.	structural clay products	26	31
	all manufacturing industries studied	30	27

From Joseph M. Sherman, "Incentive Pay in American Industry, 1945-46," Monthly Labor Review, Nov. 1947, pp. 535-38.

L. Earl Lewis, "Extent of Incentive Pay in Manufacturing," Monthly Labor Review, May 1960, pp. 460-63.

Table 3

Percentage of Manual Workers on Payments-by-Results in British Industry for October 1938 and April 1961

		males aged 21 & over		females aged 18 & over		all workers	
		1938	1961	1938	1961	1938	1961
1.	minimg & quarrying (except coal)	27	23	--	43	27	23
2.	treatment of nonmetals	15	30	30	37	15	29
3.	bricks, pottery & glass	34	45	51	49	35	45
4.	chemicals, paints, & oils	5	21	24	20	9	21
5.	metal manufacture	50*	62	42*	44	49*	59
6.	shipbuilding & marine engineering	40*	67	20*	24	40*	65
7.	vehicles	53*	52	56*	54	52*	52
8.	other metals & engineering	44*	45	53*	53	45*	46
9.	textiles	29	39	64	61	45	51
10.	clothing	36	34	41	50	35	47
11.	leather, fur, etc.	34	39	23	30	27	33
12.	food, drink, & tobacco	8	14	27	28	14	20
13.	woodworking	13	27	26	34	15	26
14.	paper, printing, & stationery	5	17	29	25	12	19
15.	building & construction	0	15	--	7	1	14
16.	transport & communications (except rail)	3	7	3	2	2	7
17.	public utilities	1	2	1	0	1	2
	all industries surveyed	18	30	46	44	25	33

* ≡ data relate to April 1947 rather than to October 1938

From the Ministry of Labour Gazette for 1947 and for 1961

Table 4

Percent of Production Workers Paid on an Incentive Basis in American and British Manufacturing Industry

		U.S.A.(1958)	Britain(1961)
1.	Food and drink	11.2	18
2.	Tobacco	32.0	42
3.	Chemicals and allied industries	8.8	21
4.	Primary metals	46.5	59
5.	Electrical and nonelectrical machinery	28.9	47
6.	Shipbuilding and marine engineering	20.0	65
7.	Vehicles	9.5	52
8.	Other metal goods	23.1	41
9.	Textiles	39.8	51
10.	Leather and fur	36.8	33
11.	Clothing	58.3	45
12.	Footwear	70.0	56
13.	Bricks, pottery, glass + cement	24.5	40
14.	Timber and furniture	12.3	26
15.	Paper, printing and publishing	7.7	19
16.	Toys and sporting goods	24.0	57
	all manufacturing industry	27.0	42

Notes to Table 4

The American data pertain to those production and related workers eligible for incentive payments in May 1958. They appear in Earl Lewis, "Extent of Incentive Pay in Manufacturing," Monthly Labor Review, Vol. 83, No. 5, May 1960, pp. 460-63. The British data are defined as wage-earners paid partly or wholly under payment-by-results systems in April 1961 and are given in the Ministry of Labour Gazette, Vol. 69, No. 9, September 1961, pp. 369-73. From what can be gathered from the commentary accompanying these data, both surveys cover essentially the same sort of payment systems, namely, piecework arrangements, bonus schemes, and systems in which remuneration is related to the output of a group of workers.

Inspection of these numbers indicates contrasting experiences in different manufacturing industries, but overall the incidence of those employees working at payment-by-results methods appears to have increased by almost ten percentage points. Unfortunately, this inference may not be held with a great degree of confidence since the comparability of these two series is somewhat suspect. First, in the 1890 Census, the employer was requested to list operatives, officers or firm members, clerks, unskilled workers, and finally pieceworkers "not included in foregoing statement." This taxonomy may mean that some pieceworkers are classified among the other groups of workers and that the series in the first column of Table 1 is something of a residual category. Second, the 1890 data pertain to factory workers only; yet, in apparel and textile manufacturing in particular, a number of employees worked at home and all of these, of course, were remunerated at a piece-rate basis. For both of these reasons, the incidence of piecework in 1890 is probably under-stated by these figures.

Greater confidence may be placed in the comparability of the data in Table 2 which show the percentage of production workers on incentive pay in 1945-56 and in 1958: the use of incentive methods fell over this period in "aircraft engines and engine parts" and rose for "bakeries" and "precious jewelry," but there appears to be no general dominant trend. Similarly, the criteria used in classifying the British data in Table 3 have been pretty much the same over the period from 1938 to 1961. Here, the incidence of incentive pay appears to have been approximately constant for adult female workers, but has increased for adult male workers. The only comparable British study since 1961 was conducted by the National

Board for Prices and Incomes in December 1967 from which is concluded "...there is no clear evidence of any overall movement to, or away from, payment-by-results since the Ministry of Labour's 1961 enquiry."[1/]

The data given in Table 4 compare the incidence of incentive pay in manufacturing industry in the U.S. with that in Britain. Though these methods are more widely used in Britain than in the United States, typically in those industries where incentive systems are common in one country they are also frequent in the other country. (The simple correlation coefficient between the two series in Table 4 is 0.52.) In fact, there is considerable casual evidence suggesting that the United States is among those countries that make least use of payment-by-results methods for remunerating manual workers in industry. For instance, in the late 1940's, it was estimated that the percentage of total hours worked by manual workers at some form of piecework was 37 in West Germany, 40 in Denmark, 52 in Norway, 58 in Sweden, and 70 in Hungary.[2/] As of August 1965, some 63 percent of production workers in the Soviet Union were paid by some form of piecework with almost one-quarter working at straight piecework methods.[3/] In the 1950's, up to 42 percent of China's industrial force were on piecework, but it is thought that the use of these methods subsequently declined and premium payments with bonuses paid for exceptional group or individual performance were substituted in their stead in the 1960's.[4/]

[1/] National Board for Prices and Incomes, [May 1968].

[2/] See International Labour Office, [1951], Ch. 3.

[3/] See Kirsch, [1972], Ch. 2. Piecework systems (particularly of the "progressive" form in which the piece-rate increases with rising output) were, of course, extensively applied in the Soviet Union under Joseph Stalin. Such economies in which the state figures so prominently tend also to make considerable use of exhortative techniques to stumulate work effort: the most famous of these was the Stakhanovist movement in the 1930's in the U.S.S.R., named after a coal-face worker who was said to have yielded 102 tons of coal in one shift, fourteen times above the norm!

[4/] See Howe, [1973], pp. 118-27.

The Employer's Choice Among Wage Payment Systems

At any given moment of time, each employee's contribution to the firm's output and sales is incompletely known to management. In addition, the employer is not fully cognizant of the labor services which will be forthcoming at different levels of remuneration that he may offer. Put differently, since information is a scarce resource, management has the problem of disseminating rewards among and of posing incentives for its employees. A firm's response to these two interdependent problems takes the form of adopting a particular wage payment system. Consider the manner in which each of these two problems is treated by various wage payment methods.

In assessing each employee's contribution to production and thus in allocating wage payments among workers, the method of time payments distributes remuneration according to some measure of working time while incentive pay systems involve constructing some index of work performance and relating pay to this index. The costs of precisely metering the output of an individual (or a group) compared with identifying his working hours (or days) may lead to the total absence of piecework from certain types of jobs. Presumably this is why piecework is less common among white-collar employees. The exceptions are provided either by those employees whose remuneration is based in part upon the value (or increases in the value) of their sales (e.g., retail salesmen of durable goods, insurance, and security) or by those for whom "tips" constitute an important fraction of their income (e.g., taxi cab drivers, restaurant waiters,

hotel page boys). In the first case, something readily measurable is available; the second category of workers have their performance evaluated directly by the consumer. There are, in fact, few jobs where some index of performance could not be constructed and used in remunerating workers though it may not be desirable to do so.[1/] Teaching was once invoked as the standard example of a profession in which a payment-by-results method could not work profitably, but the debate over the operation of educational performance contracting under which a teacher's earnings are linked to increases in the measured scholastic aptitudes of their students has rendered the once classic example a little less convincing. Even where the output is measurable with little cost, the resources used up in policing an incentive payments system would be considerable if careful, time-consuming, checking of the output is required in order that performance does not fall below a quality constraint. This illustrates the point that under incentive schemes shirking takes the form of a tendency for the quality of the product to fall, while workers on time-rates shirk simply by putting as little effort into their work as goes undetected. Hence supervisory personnel are used to reduce shirking

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[1/] The payments scheme introduced for a short while by the British National Health Service to reward dentists provides a vivid illustration of the customer bearing (presumably) heavy costs. Dentists' pay was related to the number of cavities filled with the predictable result that the incidence of tooth decay identified by the dentist took a suspiciously dramatic leap upwards and the speed with which cavities were filled increased painfully from eighteen to six minutes per filling! Subsequently, more thorough devices were introduced to monitor the performance of dentists.

by workers on time-rates while with payment-by-results systems more resources are devoted to inspect the quality of output, to ascertain in the case of contingent contracts like measured daywork whether the conditions have been satisfied under which a bonus is to be paid, and to prevent employees from maltreating physical capital owned by the firm. (Thus under incentive schemes the employer will be less inclined to "loan" capital equipment to the worker.) Hence the function of supervisory personnel tends to differ under the two payment systems: in each case, they serve as agents communicating information between upper management and production workers; but with time payments their concern is directed towards monitoring the pace at which individuals work while with payment-by-results it is the care and assiduousness exhibited by the workers that is particularly subject to deterioration and thus which requires the supervisors' attention. Clearly the supply prices of these different monitoring functions will affect the choice of payment systems to adopt for rewarding production workers.[1/]

The second important class of problems to which the wage payment method is addressed arises from the fact that, at any given moment of time, knowledge of market clearing prices is not freely available to market participants. As a consequence of opportunities and preferences continually changing, information concerning the terms at which goods and services are being offered for sale is not costless to obtain. In the context of the labor market, employers are not certain what quantity

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[1/] In their examination of wage payment methods, the British National Board for Prices and Incomes "...came across a strong minority opinion [among managements] that payment-by-results systems were primarily concerned, not to raise productivity, but to deal with the problem of work supervision," National Board for Prices and Incomes, [May 1968], p. 25.

of labor services will be forthcoming at different offered prices and workers do not have complete information of all wage offers. Though the employer's ignorance of the labor supply schedule facing him obtains whether it is a set of piece-rates or of time-rates that is being determined, different elements of the problem are associated with the two payment systems. Thus, payment-by-results has the advantage that, once piece-rates have been settled for a given class of workers, the more able and more industrious individuals will naturally receive higher earnings as the simple consequence of the system's operation. Put differently, incentive systems tend to circumvent some of the employer's problem of accurately screening his employees. So, given a cost to detecting each employee's work performance, the use of piece-rate methods is prompted by a wide dispersion of productivities among different workers. Under time-payments, such differential rewards for diligence and hard work are more difficult to determine since such characteristics of workers are incompletely known both prior to and after being hired. So under incentive schemes, employers may permit the wage payment mechanism itself to discriminate among workers of different productivity. On the other hand, there is a good deal of evidence to the effect that the determination of the piece-rate is particularly difficult (costly). Individuals schooled in the techniques of scientific management and industrial engineering try to determine that piece-rate which will yield the flow of output from workers that the employer is seeking and their procedures normally take the form of ascertaining what an "average" employee will produce over a "normal" period of working time. If the piece-rate is set "too" low, the required number of workers will not be forthcoming to replace those who

have quit unless the employer engages in costly methods of recruitment; if it is set "too" high, the fear of "rate-cutting" induces workers to form formal or informal cartels to prevent some individuals from working as hard as they would like.[1/] If the production technology and individuals' preferences and opportunities were constant over time, by trial and error the employer will grope towards the optimal piece-rate but such a stationary environment is not, of course, the one in which the employer operates. In particular, rapid technical change involves especially frequent piece-rate revisions with all the attendant costs so that we should expect incentive methods to affect and to be affected by the pace of technological change: where keen competition obliges firms to be innovators or swift initators in production technology, there will be a tendency for a firm to make use of time-rate methods that do not necessitate a revision of wage rate schedules each time a production process is reorganized; alternatively, piece-rate methods throughcut an industry add a cost to and thereby discourage the development of new technologies in that industry.[2/] Where the firm employs workers of various skills, a change in the piece-rate necessarily involves questions of the relative remuneration of workers of different skill classes. These problems

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[1/] Such cartels go by the name of "restrictions of output," These are discussed below.

[2/] There is, indeed, evidence to this effect: "An incentive plan is also helped by stable technology. The manufacturing industries where the value of incentive plans is most frequently questioned appear to have had continuous and significant technological change. Those industries where incentive payment is taken for granted appear to have had relatively stable technology," Sumner H. Slichter, James J. Healy, and E. Robert Livernash, [1960], p. 519.

of determining the relative wage structure also obtain when workers are employed at time-rates[1] though the tendency for earnings differentials to display marked anomalies over time under an incentive system bears witness to the problem not only of determining the piece-rate for a given group of workers, but also of establishing skill differentials that do not create feelings of inequity or injustice that affect work performance.[2] The nonpecuniary aspects of alternative employments that derive from the fact that (in Marshall's words) "the seller of labour must deliver himself" include, inter alia, the fairness and justice with which each worker sees himself as being accorded by the management. Arbitrary or, sometimes, inequitable treatment of employees on the part of management is often

[1] Rees [1970] has put the general point in the following succinct manner: "...every change in wages tends to raise questions of internal equity that can be very troublesome to solve. Even if it is decided to raise all wage uniformly, it must be decided whether this is to be by a uniform percentage or by a uniform amount, and whether the increase is to extend all the way up the structure of wages and salaries or only part way. The problems are not unlike those faced by the United States Congress in separating problems of the level of the income tax from issues of tax reform,".

[2] Cf. "We have in short found considerable disenchantment among workers with the constant time-consuming process of shop floor haggling, inequity, falsification of work records, inversion of customary skill differentials and lack of security, which are so often associated with conventional payment-by-results systems...workers are as concerned with the equity and stability of earnings as they are with their absolute amount, and are therefore likely to be willing to 'trade-off' those features which permit a rapid and uncontrolled rise in earnings in exchange for alternative advantages," National Board for Prices and Incomes, [May 1968], p. 29.

followed by uncooperative and unaccommodating work behavior. Not only do incentive methods lead to disparities in earnings that sometimes induce discontent among employees, but the fewer supervisory personnel with which payment-by-results systems typically operate also implies that the costs of managing these wage payment methods are particularly sensitive to the prevailing climate of management-employee relations.[1/]

The Supply of Working Hours and Work Effort

Consider now the supply of labor services under different wage payment systems and, for this purpose, suppose the output or performance of an individual employed over any given period of time (say, a week) on an incentive payments scheme may be indexed by Z. For this present analysis, all variables that might affect the level of Z are excluded save two: the numbers of hours worked at piecework (H_p) and the amount of effort expended at that work (E). The relationship between these variables describes an individual's on-the-job production function (assumed to be strictly concave): $Z = Z(H_p, E)$.

Consider first the association between working hours and output. Most of the research that has been undertaken on this relationship has been conducted not by observing an individual's performance, but the work performance of a group of employees at a plant or factory. A convenient summary of this research is provided by Brown [1965] from whose paper the data

[1/] There is a large amount of evidence from the industrial relations literature of how incentive systems tend to generate substantial or anomalous interskill earnings differentials which contribute to considerable management-employee discord. These are described by the National Board for Prices and Incomes as "decayed" systems while Slichter, Healy, and Livernash talk of "demoralized" plans noting that "Serious demoralization typically involves not only poor union-management relations and a high rate of grievances but continuous use of wildcats and slowdowns," p. 498.

Table 5: A Summary of the Studies Investigating the Association between Hours of Work and Output

length of workweek*	no. of case studies	% of cases in which hours and output are positively associated	% of cases in which hours and output are unrelated or negatively related
more than 60 hours	238	53	47
52-60 hours	894	66	34
less than 52 hours	91	82	18

*Length of workweek is measured at original hours in situations when hours were reduced and at the new hours when hours were increased.

in Table 5 are taken. A dominant positive association between output and hours is only apparent when the workweek enters the range of sixty hours or less. One suspects that, when the workweek is very long, changes in hours of work are associated with opposite changes in work effort and that, if in some way work effort could have been held constant, the positive relationship between working hours and output would have been equally apparent at long working hours as it clearly is at shorter hours. It appears that the most recurring question this research tries to resolve is not the direction of the effect of hours on output, but of hours upon output per hour, an issue that turns on whether the marginal product of hours is more than or less than the average product.

Presumably one should also expect $\partial Z/\partial E > 0$. There is a long history of highly respectable research into work fatigue and, while some commentators seem to think that with the shorter working hours (per day or per week) of today fatigue is a thing of the past, there remains an awareness of the fact that boredom and the monotony of the job affect work performance. It is variations in the amount of effort expended by workers

that is invoked to account for the shape of the "work curve", as it is commonly called in the literature, the time path of workers' output during the day or week. This curve reveals interesting differences from case study to case study and clearly a careful analysis of this variety would require examination of a number of explanatory factors. However, if a typical curve can be said to exist, then it has the characteristics first of rising during the course of continuous work and then of falling off, sometimes quite steeply, towards the end of the working period.[1/] This decline in the rate of output that appears to set in after a period of continuous labor is generally attributed to the growing disinterest and fatigue of workers. It was relationships such as these that led earlier writers to reserve a particular role for effort in the supply of labor services.[2/]

[1/] An excellent discussion of "work curves" is contained in P. Sargant Florence [1924] who writes, "This curve cannot be attributed to any physiological fluctuation that would occur even if no work were done, since such fluctuations as have been measured seem to be diurnal in span, i.e., from a curve spread over the whole day and not over particular hours corresponding with the spell of work in the factory. Further, this curve can be spoken of as typical; it is not a mere compromise between two or more divergent curves but tends to be the curve most frequently shown. Deviations therefore shown by particular workers and particular days seem distributed around it as might be expected from chance errors. Nor, as far as my evidence goes, do the less productive individuals have the more precipitous curves", p. 234.

[2/] And the treatment at that time of this dimension of labor services corresponds to some suggestions that the deceleration of output per man from the 1890's in certain trades in British industry is attributable "...to a certain slackening in the men's individual labour effort," E. J. Hobsbawm, [1964], p. 351. Or, to illustrate with another instance earlier in that century which also draws attention to the adjustment of work effort to rewards, consider this description of English navvies (railway construction laborers) working in France in 1843: "The navvies worked this way for six weeks and earned fifteen francs a day each. Then the French engineers began to see that the Englishmen were making them pay an enormous sum for the work and reduced the price. The navvies, having no other work to go to, had to take it. When the next pay day came round there was another reduction, this time to five francs a day. Then the Englishmen muttered that they would do not more than five francs worth of work, and they thereupon slackened off and took things easy," Coleman, [1968], pp. 208-209.

The employee's production function will, of course, contain other arguments. For instance, the vital role of work experience in accounting for variations in labor incomes across individuals suggests a "learning-by-doing" effect in the function Z. Such learning effects have been recorded not only for individual work performance, but also for group performance.[1/] There are also characteristics of the individual's working environment that will affect his output--the machinery with which he works, the organization of the work processes, social interactions among employees, the climate of management-employee relations, and so on. However, for our present purposes, the presence of two variables, working hours and work effort, in the individual's production function is sufficiently general to highlight the substitution that may take place in the supply of labor services for individuals working on payment-by-results schemes.

Consider now the implications for the standard utility analysis of the supply of labor services when the individual's work-leisure choice includes an option to be remunerated by incentive methods at work rather than by time-rate methods.[2/] His (well-behaved) utility function (U) takes the form:

$$U = U(H_t, H_p, E, Q) \qquad (1)$$

where H_t measures hours of work in the time-rate sector, H_p hours of work in the piece-rate sector, E the amount of effort spent at piece-work, and Q the consumption of commodities. Increases in Q are assumed to yield greater utility in the individual (i.e., $\partial U/\partial Q > 0$) while small increases

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[1/] See, for instance, the study by Blackburn, [1936].

[2/] For expositional convenience, the individual is taken to be the decision-maker. The extension to the context of the household is straightforward.

in working hours and work effort are presumed to be associated with more disutility (i.e., $\partial U/\partial H_t$, $\partial U/\partial H_p$, $\partial U/\partial E < 0$). The assumption of $\partial U/\partial E < 0$ may well not be the case over certain ranges of effort: when the individual is bored, greater work effort may reduce his feeling of ennui and yield him greater satisfaction. Under such circumstances, greater effort will be expended at work until the marginal utility of work effort turns negative. The budget constraint may be written as follows:

$$I + wH_t + \pi Z(H_p,E) = pQ \qquad (2)$$

where I measures nonlabor income, p the price of consumer goods, w the wage per hour worked in the time-rate sector, and π the piece-rate for work performed in the payment-by-results sector. In the spirit in which this analysis is normally conducted, all prices (including the piece-rate) are taken as parametric to the individual. The total hours (H^o) available to an individual over a given period of time (say, a week) are assumed to be divided entirely between household activities or "leisure" (H_ℓ), work paid at time-rates (H_t), and work in the piece-rate sector (H_p). The individual's behavior may now be described by the maximization of his utility, equation (1), subject to the budget constraint given in equation (2), to the form of his on-the-job production function, and to the implicit constraint on hours ($H^o = H_\ell + H_t + H_p$).

The form in which effort is modelled here is only one of a number of possible characterizations and it describes a particular dimension of the expenditure of effort. Here, effort is spent at piece-work, but not at work in the time-rate sector nor in the process of consuming "leisure" off

the job. Of course, effort is spent at time work but variations in this expenditure of effort are not immediately and automatically reflected in variations in a worker's earnings. Instead, an employee on time payments who consistently and permanently works diligently and whose effort is detected by supervisors will tend to be promoted to a higher wage rate class more rapidly than other workers. Under time rates, therefore, habitual work effort is rewarded through promotion and the appropriate incentives involve steeper earnings-experience profiles than will be the case for piece-rate workers. Work effort that is transitory and volatile tends not to be rewarded in time rate schemes but is compensated with piece-rate methods through the mechanical workings of the payment system. Formally, the level of habitual work effort has the properties of an investment decision: an expenditure of a resource (effort) is made prior to the payment of the rewards. It is the expenditure of transitory work effort that is described by the relationships in equation (2).

As far as the use of effort at nonmarket activities is concerned, an alternative characterization might recognize that an energy or effort constraint obliges the individual to allocate his energies between that expended on the job and that used in household or leisure activities and the appropriate formulation would involve not merely the consumption, but also the production of energy during non-labor market time. In this way, the model links up with the economics of health. This would lead us away from the main purpose of this essay which is to examine labor supply behavior under different forms of the wage payment contract, but it seems

a natural and perhaps useful development.[1/]

The first-order conditions for a maximum involve the constraint shown as equation (2) plus

$$(\frac{\partial U}{\partial H_t} + \lambda w)H_t = 0, \quad (\frac{\partial U}{\partial H_p} + \lambda \pi \frac{\partial Z}{\partial H_p})H_p = 0, \quad (\frac{\partial U}{\partial E} + \lambda \pi \frac{\partial Z}{\partial E})E = 0,$$

where λ is a Lagrange multiplier to be interpreted as the marginal utility of consumption (that is, $\lambda p = \partial U/\partial Q$). If the individual works entirely in the time-rate sector, then $H_p = E = 0$, $H_t > 0$, and there is the familiar $\partial U/\partial H_t = -\lambda w$ condition; alternatively, for the worker specializing in the piece-rate sector, $H_t = 0$, $H_p > 0$ and $E > 0$ and the marginal rate of substitution of work effort for working hours in his utility function equals the marginal rate of substitution of effort for hours in his on-the-job production function:

$$\frac{\partial U/\partial E}{\partial U/\partial H_p} = \frac{\partial Z/\partial E}{\partial Z/\partial H_p} \quad . \tag{3}$$

The absence of the piece-rate from this condition arises from the postulated form of the incentive payment system under which neither working hours nor work effort are rewarded directly, but rather only as they contribute to work performance (Z).

[1/] The budget constraint also abstracts from factors like the existence of a premium rate for overtime and from the fact that very many workers in the piece-rate sector do not receive all their remuneration on a payment-by-results basis, but are also paid in part on a time-rate basis. These modifications in the wage payment system may be grafted on to the basic model with little difficulty.

Totally differentiating the first-order conditions and then solving for the individual's decision variables yields equations for the supply of working hours (H_t and H_p) and effort (E). As usual, the effects of a change in the wage rate upon hours worked and of a change in the piece-rate upon hours and upon effort expended at work may be decomposed into income effects and utility-constant substitution effects. In the case of hours worked in the time-rate sector, the substitution effect $(\partial H_t/\partial w)^*$ is ambiguously positive, the standard result. (The asterisk here and below denotes the income compensation that enables the individual to remain on the same indifference surface.) However, the unusual implication of this model is that, within the piece-rate sector, the sign of each of the substitution effects is ambiguous. If changes in work effort did not affect the individual's production (i.e., if $\partial Z/\partial E = 0$), then, in the case of the H_p equation, the substitution effect would be unambiguously positive, as is the standard result. Correspondingly, in the E equation, if the individual were not free to vary his hours of work (i.e., if $\partial Z/\partial H_p = 0$), alterations in work effort would be positively associated with income-compensated changes in the piece-rate. But once a substitution between hours of work and work effort is permitted in the piece-rate sector, we can no longer be certain of the signs of these utility-constant substitution effects. The economic rationale for these results is straightforward: at piece-work, effort and hours are rewarded only insofar as they contribute to an individual's output (Z); an income-compensated increase in the piece-rate affects simultaneously the return from hours of work and from work effort and so may encourage the substitution of effort for hours of work depending upon the nature of the production function

and of the utility function, both functions containing hours of work of and work effort as arguments. A necessary condition for these abnormal substitution effects is that hours at piecework and work effort are strong substitutes in the individual's utility function: that is, if an individual elects to work more hours, then he will tend to reduce his fatigue (effort) from working.

Although the signs of the substitution effects $(\partial H_p/\partial \pi)^*$ and $(\partial E/\partial \pi)^*$ are indeterminate, we can be sure that the income-compensated increase in π will induce an increase in net labor input and, therefore, given the marginal products of these inputs, an increase in output Z. The reason for this is that, since a small change in π leaves the relative return on work effort and working hours unchanged within the piece-rate sector, we may invoke Hicks' composite commodity theorem, treat effort and hours "as a single commodity", and derive the result that the income-compensated effect of an increase in π on the individual's output or performance (Z) is unambiguously positive. In short, in payment-by-results work, the familiar conditions on substitution effects apply to changes in a worker's output (Z), not to changes in his working hours, as a function of changes in the piece-rate (π).

Careful empirical research needs to be undertaken into the structure of the individual worker's on-the-job production function since, inter alia, this structure will affect his labor supply behavior. The research that involves estimating cross-section wage equations may well be useful in this regard though their interpretation needs to proceed with caution. For instance, annual or weekly earnings equations for workers on incentive payments systems will only shed light on the on-the-job production function

if the determinants of the piece-rate (π) can be separately identified and held constant, otherwise the right-hand variables in such equations will tend to compound the factors that affect π with the arguments of the production function. This problem also exists for equations in which the dependent variable is defined as average hourly earnings (or, more frequently, it natural logarithm). Concerning the inferences that may be drawn on the individual's on-the-job production function, this procedure of dividing earnings by hours worked is, of course, unexceptional where, under payment-by-results schemes, the elasticity (in the case of the logarithmic specification) of an individual's output with respect to hours worked is unity (i.e., $\partial \ln Z / \partial \ln H_p = 1$). But presumably, this should not always be treated as a maintained hypothesis.

Many incentive payments schemes reward various dimensions of a worker's output at different rates. The door-to-door salesman with a suitcase of products selling at various prices is an obvious illustration. There are other cases: slaughtermen in Britain are paid different rates according to the type and the size of animal they slaughter;[1/] a chemical firm investigated by the National Board for Prices and Incomes [Dec. 1969] awarded points for workshop cleanliness and linked pay to the number of points collected while a synthetic fibres plant related one element of earnings to the quality of output by reducing pay as the number of defective items produced increased; and, in educational performance contracting, the contractor's (including the teacher's) payment often depends upon increases in pupil's recorded mathematical abilities, gains

[1/] Consult the interesting study by Greenwood, [1969].

in their verbal test scores, and other particular attributes that the pupils have acquired (like a higher attendance rate).[1/] In each of these illustrations, several dimensions of output are distinguished and each is rewarded at a different rate. The individual then has to allocate his time not simply between piece-work, work on time rates, and leisure, but also among the various types of piece-work activities, each activity corresponding to a different dimension of output. If i indexes the different work activities and leisure, then the supply equations for H_i and E_i to each activity will contain as arguments the incentive rates, π_i in all the activities and we arrive at a general system of economic incentives that determines the allocation of an individual's time and effort among many activities.

Once it is granted that an employer values a number of different attributes of an employee's work performance, this case of a multi-dimensional output may be regarded as the typical one. And if for analytical convenience the situation is characterized as one in which the employee applies his time and his effort to merely two work activities (say, Z_a and Z_b), the two-sector model of general equilibrium that was originally devised to handle problems in international trade suggests itself as an appropriate representation.[2/] Suppose that a worker's supply of hours and of effort is made in a two-stage process such that, at the first stage, the division of hours and effort between market work and nonmarket activity is determined and, at the second stage, this given quantum of working hours and effort is then allocated among the two different work activities. This separability allows us to treat the endowment

[1/] See the summary of eight performance contracting programs in Hall [1972].

[2/] Alternatively, if effort were expended in nonmarket as well as in market activities, again a two-sector (market versus nonmarket) model of the allocation of time and effort is involved.

of working hours and of work effort as fixed for a given individual although, of course, these endowments will normally vary between employees according to variations in individual preferences. These input endowments are specific to an individual and cannot be transferred between their use as inputs in producing Z_a and Z_b (providing specialization in either Z_a or Z_b is ruled out). Consider two employees with the same on-the-job production functions (linear and homogeneous) yet different relative endowments of working hours and working effort to apply in the production of both Z_a and Z_b. Though the per unit returns to Z_a and Z_b are likely to differ (i.e., $\pi_a \neq \pi_b$) both individuals face the same piece-rate in a given activity. One final and crucial condition is that, for all relative input shadow prices, Z_a and Z_b have different and invariant input intensities, say, Z_a being hours-intensive and Z_b effort-intensive (i.e., $H_a/E_a > H_b/E_b$). Under these postulates, the following "factor price equalization" theorem may be asserted: the two individuals have the identical shadow price of time at work in the two activities and have the same shadow price of work effort. This does not mean, of course, that they receive the same earnings (or hourly earnings) since, although their per unit valuation of working hours and effort is the same, they bring to work different endowments of these inputs.[1/] The usefulness of this result is that, if two individuals are observed working the same number of hours, then in certain circumstances differences in their earnings may be attributed to differences in the amount of effort they apply to their work and not to differences in their respective valuations of effort and time that would

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[1/] On the assumptions stated, an individual's labor earnings (Y) over a period of time is equal to the sum of his earnings in producing Z_a and Z_b (i.e., $Y = \pi_a Z_a + \pi_b Z_b$) and this in turn is divided into that attributable to hours and that to effort [i.e., $Y = u(H_a + H_b) + v(E_a + E_b)$ where u and v are the shadow prices of hours and effort respectively].

derive from dissimilar input marginal productivities (production functions).

This sort of model can also be employed to yield implications concerning the effects of technological change. It is frequently asserted that with modern factory processes the employee becomes little more than a machine tender and his output is unresponsive to changes in factors under his particular control. Put differently, it is argued that changes in the technical organization of production have tended to raise the marginal product of hours relative to the marginal product of effort, an effort-saving technological change. Suppose a quantity and a quality dimension to the output of each individual are identified, the index of quantity being given by Z_a and the measure of the quality of work performance by Z_b.[1/] Also, as before, suppose that Z_b is relatively intensive in effort and Z_a in hours (i.e., $H_a/E_a > H_b/E_b$): in other words, the quality of work performance requires comparatively greater effort. Under these conditions, an effort-saving (hours-using) technical change in the performance of the effort-intensive output, Z_b, leads to hours being substituted for effort in both Z_a and Z_b and, of course, the shadow price of effort rises and that of hours falls. The output of the effort-intensive commodity, Z_b, will rise and that of Z_a will fall: the quality of work performance will increase. Conversely, an effort-saving technological change in the production of Z_a, the hours-intensive quantity of output, induces a substitution of effort for hours in Z_b though not necessarily in the quantity of output, Z_a. In this case, the effects on the outputs Z_a and Z_b are indeterminate.

[1/] In the example of the synthetic fibres plant above, Z_b was measured by the (inverse of the) number of defective items produced.

Restriction of Output

One of the most consistent and well-researched findings of industrial relations specialists examining the operation of incentive payments schemes is that production workers in a number of plants operate under another constraint that, in this literature, goes by the name of "restrictions of output".[1/] The role of unions in operating "make work" or "featherbedding" arrangements is familiar to economists, but the extent of such practices among nonunion employees is not typically appreciated. Starting with Mathewson's classic work in 1931 on the Restriction of Output among Unorganized Workers, researchers have discovered that social pressure and custom may operate as effectively as formal union rules to limit the production of employees.[2/] Though such restrictions of output exist where pay is related solely to the input of time, they seem particularly prevalent under incentive payment systems where a fear is that a great expenditure of effort leading to a bulging pay packet will induce management

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[1/] Synonyms include rattening, soldiering, striking on the job, goldbricking, government work, scamping, skulking, and Ca'Canny.

[2/] Thus, as Leiserson observed in a chapter of Mathewson's book: "...nonunionists are far from helpless in limiting the amount of work they will turn out. They have developed methods of collective action as effective as trade-union practices...Trade-union restriction is ordinarily enforced by agreements with employers which usually come to the public notice. In fear of the condemnation of public opinion, responsible leaders of labor organizations use their influence to reduce the restrictive practices of their members. Non-union workers have no such restraining influence, except as the management is on the watch; but this is offset by an amazing amount of encouragement of restriction by the workers' immediate foremen and supervisors," Mathewson, [1931], pp. 162-63. And Leiserson footnotes J.H. Willits who is quoted as writing, "In short I don't think you can do anything but say that restriction occurs also abundantly among non-unionists and that the causes, therefore, must be considered as deeper than the trade-union organization." This behavior is sometimes manifested not in a restriction in output of a given quality, but a fall in the quality of a given output so that the inspection procedure results in rejecting a higher fraction of output as faulty or defective.

to respond by cutting the piece-rate. The workers' cartel may thus be interpreted as a device for redistributing income among workers in one period as an insurance against rate-cutting in the future. There are, naturally, other explanations--to stabilize earnings over vagaries in output, to reduce interpersonal frictions by narrowing the dispersion in individual earnings, to assert an independence from management-initiated administrative schemes, and so on--though the possibility of rate-cutting appears to be the most frequently cited reason for the existence of these restrictions on output. Moreover, there are many historical precedents for rate-cutting so the employees' fears are by no means groundless. Once the cartel has been formed it may well be directed not merely at narrowing the dispersion of earnings at each point in time, but also at raising the average. This may be achieved either by affecting the setting of the piece-rate or by altering the indices (the Z's) to which the piece-rate is linked. In these latter activities, whatever else the employees' cartel may be doing, it is both supplying information to management about work processes and employee work performance and also auditing management so that management's commitments in the labor contract are being fulfilled.

Insofar as the restriction of output is concerned, the fraction of workers (unionised and nonunionised) in American and in British industry for whom such a constraint on their earnings is operative is not known, but the industrial relations literature referred to suggests that it is by no means peculiar. Presumably, the existence of this constraint (if known) will be an element in the individual's job choice and workers who

do not wish to be bound by such a constraint will tend to congregate in employments where it is not operative. Over a longer period of time, therefore, this constraint loses much of its force. On the other hand, in the short run, such customs and traditions should be incorporated into our economic models, as are the constraints of the legal system, if they operate meaningfully to affect behavior. In fact, the effect of these restrictions of output on hours worked and effort spent is fully tractable by conventional economic analysis. For suppose that the piece-rate (π) is given to the individual so that a restriction on the output (Z) he may produce is equivalent to a constraint on his piecework earnings. Let $(\pi Z)^{o}$ be the earnings limitation imposed by social pressure or union rules so that for any worker employed wholly on an incentive basis, in addition to the standard budget constraint, he is subject to the constraint that $\pi Z \leq (\pi Z)^{o}$; this is his earnings allotment in the cartel.[1/] The Lagrangean thus takes the following form:

$$\Omega = U(H_t, H_p, E, Q) + \lambda[I + wH_t + \pi Z(H_p, E) - pQ] + \mu[(\pi Z)^{o} - \pi Z(H_p, E)]$$

[1/] This characterization of the problem is adopted because it is simple and permits us (as shown below) to draw upon the literature on the behavior of the consumer under rationing. Nonetheless, it is a little misleading since breaking the constraint is a feasible option. Akin to the effect of a law on behavior, the individual worker's decision whether or not to act in accordance with the community-imposed limitation on his output will be affected by the penalties that would follow from his noncompliance. These normally take the form of verbal antagonism from his fellow employees, the imposition of fines, social ostracism, and "binging" (striking on the upper arm!--see Roethlisberger and Dickson, [1939], pp. 421-23).

where $\mu < 0$ is a multiplier to be interpreted as the increase in the individual's utility (other things equal) from small decreases in working hours and/or work effort that accompany changes in the community-imposed piece-work earnings constraint. If, in fact, the individual elects to earn less than the constraint $(\pi Z)^{\circ}$, then $\mu = 0$ and the analysis in the previous section of this paper requires no amendment. If, on the other hand, the constraint is binding ($\mu < 0$), the analysis becomes formally identical to multiple constraint problems like the consumer's choice under rationing.[1/] There will be some reallocation of labor as those individuals formerly near the margin of indifference between working in the piece-rate sector and working in the time-rate sector now evade the piece-work earnings constraint by working at time payments. For those individuals remaining at piece-work, their hours of work (or work effort) is determined at that point at which its marginal disutility equals a weighted average of the piece-rate times the marginal product of working hours (or work effort), the weights being the Lagrangean multipliers: $\partial U/\partial H_p = \pi(\partial Z/\partial H_p)(\mu - \lambda)$; and $\partial U/\partial E = \pi(\partial Z/\partial E)(\mu - \lambda)$. Dividing the one equation by the

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[1/] In fact, treating the constraint as an equality rather than an inequality also seems descriptively accurate in those cases in which social pressure is levied on those whose output (or earnings) falls substantially short of the prescribed level. Thus consider the following description of one workshop's customs: "To work too quickly was to be labelled a 'teararse' and to be at least partly shut out from the friendly give and take of the shop and from the spontaneously formed 'scrounging groups' which, in defiance of management rulings, assembled in secluded corners of the shop for unofficial tea breaks and discussions...If to be a "teararse' was to court exclusion from the social life of the workshop, it was also regarded as a breach of workshop custom to be too much of a 'scrounger'. The man who persistently dodged work and whose output fell below what was generally considered 'decent' became an object of ridicule...Many of the customs of the workshop effectively regulated the output of the shop in respect to both quality and quantity, and it was known to be management's opinion that the output of the shop could easily be increased," Lupton, [1963], p. 2.

other yields equation (3): at the optimum, an output constraint notwithstanding, the marginal rate of substitution of work effort for piece-work hours in the utility function equals the marginal rate of technical substitution of effort for hours in the on-the-job production function, as in the non-output constrained case. The irrelevance of the output constraint as far as this relationship is concerned makes clear the fact that the appropriate analogy is not with single commodity rationing, but with "points rationing" in which a weighted sum of various commodities is subject to a limit, the weights designated as the "points prices." Thus, in our case, hours or effort are not separately rationed: instead, their joint product (earnings) is rationed with the points prices of each of the inputs being equal to the value of their marginal products. Where both an earnings constraint and an hours constraint obtain at piecework then, of course, equation (3) does not hold. If both of these constraints are binding, then all the adjustment is upon work effort and loafing, sleeping, and, in general, consuming leisure during working hours will be observed.

By comparison, the marginal rate of substitution of piecework hours (or of work effort) for goods in the utility function will be different from that in the non-earnings constrained case. In particular,

$$\frac{\partial U/\partial H_p}{\partial U/\partial Q} = \frac{\pi}{p}\frac{\partial Z}{\partial H_p}\left(\frac{\mu}{\lambda} - 1\right)$$

where the presence of the Lagrangean multipliers distinguish it from the situation in which there is no restriction of output.

The labor supply functions (supply of work effort and of working hours) for workers subject to this community-imposed output constraint will contain $(\pi X)^{\circ}$ as an argument. It can also be shown, making use of Le Chatelier's principle, that the consequences of introducing this earnings constraint is for the utility-constant effect of a change in the piece-rate (π) upon output (Z) to be smaller for such workers as compared with those for whom no such constraint is operative. Or, stated more loosely, labor supply curves will tend to be more inelastic with respect to the piece-rate for those workers affected by restrictions on output.

The Relative Earnings of Timeworkers and Pieceworkers

The previous sections outlined the determinants of both the employer's choice and a representative employee's choice among wage payment methods. Thus, at given factor prices, the firm's employment of pieceworkers and timeworkers depends upon the relative productivity of the two activities and from these decisions on the part of firms is derived the relative market demand for pieceworkers vis-a-vis timeworkers. If the marginal rate of substitution of pieceworkers for timeworkers in production is the same for all firms in a particular market, then the market's relative demand curve will be infinitely elastic at the given relative marginal products. On the other hand, some dispersion in the ratio of the marginal products of the two groups of workers among firms would impart a negative elasticity to the market's relative demand curve. Analogously, a relative market supply curve may be constructed that shows the supply of pieceworkers to timeworkers at different relative returns. Together, the relative market

demand and relative market supply curves determine the relative pay and employment at the two payment methods. At the market equilibrium, the marginal worker is indifferent between working at time-rates and working at piece-rates which, from the analysis above, will obtain when

$$\frac{\partial U/\partial H_p + \partial U/\partial E}{\partial U/\partial H_t} = \frac{\pi}{w}\left(\frac{\partial Z}{\partial H_p} + \frac{\partial Z}{\partial E}\right).$$

To focus attention on the price and production parameters, suppose the marginal disutilities of work in the two sectors are equal in which case an individual will work in the time-rate sector when $w > \pi(\partial Z/\partial H_p + \partial Z/\partial E)$ and in the piece-rate sector when the inequality is reversed.[1/] Where π and w are given to each individual, a postively-inclined relative market supply curve would be generated if physical and intellectual aptitudes cause $\partial Z/\partial H_p$ and $\partial Z/\partial E$ to vary across individuals. Clearly, the greater the similarities in these marginal products among individuals in a given market, the greater the elasticity of the relative supply curve. Differences in the position of the relative supply function across, say, occupations will be related to differences in the frequency distribution of the marginal productivities over individuals in each occupation: where the distribution of marginal products in one market lies to the right of that in another market, so the relative supply curve in the former market will lie to the right of the relative supply curve in the latter market.

[1/] Note that the inequality may switch for a given individual as his marginal productivities alter with increasing inputs of time and effort. An absence of total specialization of work on the two wage payment systems may be manifested in "moonlighting" or in individuals seeking out jobs in which remuneration is partly on a time-rate and partly on a piece-rate basis.

This section uses this framework for an empirical analysis of the relative pay and employment of the two classes of workers. Of course, since returns to workers in the piece-rate sector are measured in terms of dollars per unit of output (π) and in the time-rate sector in terms of dollars per unit of time (w), there is little purpose in comparing π with w alone. The pay differentials analyzed in this section are the hourly earnings of these workers. Thus, if V_t denotes the weekly earnings of timeworkers and since the data are adjusted to omit overtime work, the hourly earnings of these workers measure $V_t/H_t = w$. On the other hand, for pieceworkers producing a weekly output indexed by Z and ignoring the minimum time payments guaranteed, their hourly earnings are given by $V_p/H_p = (\pi Z)/H_p$. By way of illustration, when Z is Cobb-Douglas in hours and effort, the logarithm of the hourly earnings of these workers is given by

$$\ln\left(\frac{V_p}{H_p}\right) = \text{constant} + \ln \pi + (a-1)\ln H_p + b\ln E$$

where a and b are the elasticities of output with respect to hours worked and effort respectively. All workers from the Chicago labor market study discussed below were observed at the same number of working hours so H_p is a constant. Of course, E is unobserved though will be higher in the payment-by-results sector since transitory changes in work effort are unrewarded at time-payments.

It is well known that the average hourly earnings of incentive payments workers typically exceed those for timeworkers within particular skill-industry categories. To examine whether the relatively higher

earnings of employees on incentive pay may be attributed to identifiable personal or plant characteristics requires a body of data that contain information on variables in addition to the earnings of the two types of workers. Such information was collected for one semi-skilled occupation, namely, punch press operators, by Albert Rees and George Shultz [1970] as part of their Chicago labor market study.[1/] Of the 183 male operators in 12 establishments, 84 work on time-rates and 99 on incentive methods; only one of these 12 establishments employed both male time- and piece-workers together. Of the 120 female operators in 8 establishments, 51 worked on time-rates and 69 on incentive pay; no establishment employed the two types of female workers together. A summary of characteristics of these workers is given in Table 6. As far as the male employees are concerned, there is the typical situation of the (unadjusted) hourly earnings of workers on incentive pay being higher on average and having a greater dispersion across individuals than time-workers. The frequency distribution of hourly earnings approximates a lognormal for each class of workers though the dispersion is greater for those on piece-rates: both the highest paid and the lowest paid workers were on incentive schemes. Of the other characteristics of these male employees, workers

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[1/] I am most indebted to Mary Hamilton for going to considerable trouble to provide me with these data. "A punch press operator sets up and operates a machine that forms or shapes metal or plastic parts by punching them out of a sheet or strip of stock. The work pace is usually under the control of the operator. Punch presses differ greatly in size and in the heaviness of the stock used," [1970], p. 57. This last characteristic, the variations in the type of machine, means one cannot assume the piece-rate is the same even among pieceworkers in a single establishment. Thus, with these data, the factors that affect each pieceworker's output are not distinguishable from those that determine his piece-rate.

on incentive methods tend to have longer job tenure, are more likely to be black or have a Spanish surname and to be covered by union-negotiated collective bargaining agreements, and are working in plants characterized by high turnover rates for all workers in the plant.[1/] These characteristics of time and incentive workers also hold true for the female employees save for the relatively lower earnings and smaller dispersion of pieceworkers. This aberration from the normal situation of relatively higher earnings for piece-workers raises the question of whether this sample of female workers is, indeed, representative of the population of female employees on the two wage payment systems to which an assured answer cannot be given with our present state of knowledge. The use of piece-rate methods as a self-screeing device where a wide dispersion of productivities is thought to obtain will account for the higher incidence of black and female employees at work on payment-by-results.

Are the hourly earnings of workers on incentive pay significantly higher than those on time payments after adjusting for other identifiable differences between the two groups of employees? To answer this question requires, of course, the use of some maintained hypothesis concerning the causes of earnings differentials. For this purpose, we turned to the recent

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[1/] The turnover variable (X_6) measures the percent of all workers in the establishment who have been hired in the previous three years and the private agency variable (X_7) measures the percent of all workers hired through advertisements or private agencies. Of the variables in this table, all measure characteristics of the individual employees except for these variables X_6 and X_7. The latter two variables measure characteristics of the establishments in which each employee works : and each individual is given the values of X_6 and X_7 that correspond to the plant in which he or she works.

Table 6

Characteristics of Time-Rate and Piece-Rate Workers:
Punch Press Operators in Chicago

	male workers		female workers	
	time-rate	piece-rate	time-rate	piece-rate
number of individuals	84	99	51	69
Y, hourly earnings ($s): mean	2.35	2.55	2.43	2.25
standard deviation	0.26	0.50	0.30	0.23
X_1, years of schooling	9.71	9.16	9.22	9.57
X_2, years on present job	6.08	10.74	9.17	11.33
X_3 = 1 if occupational experience prior to present job	0.49	0.49	0.27	0.49
X_4 = 1 if black or Spanish surname	.08	.25	.16	.33
X_5 = 1 if occupation unionized	.06	.53	.65	1.00
X_6, percent turnover in establishment	7.72	27.50	7.27	16.13
X_7, percent hired through private agency or advertisement	25.35	11.99	52.67	22.41

literature on human capital and labor earnings which has provided evidence that variations in investments in schooling and in on-the-job training remove a large fraction of earnings differentials across individual workers. The particular regression equation which was fitted to the observations on these male workers takes the following form:

$$\ln Y = \text{constant} + \alpha_1 X_1 + \alpha_2 X_1^2 + \alpha_3 X_2 + \alpha_4 X_2^2 + \alpha_5 X_1 X_2 + \alpha_6 X_3 + \alpha_7 X_1 X_3 + \alpha_8 X_2 X_3 + \beta_1 X_4 + \beta_2 X_5 + \beta_3 X_6 + \beta_4 X_7 + \gamma P + \delta G P + \varepsilon, \quad (4)$$

where ln Y measures the (natural) logarithm of the hourly earnings of each worker before any overtime, P is a dichotomous variable taking the value of unity if the worker was paid on incentive methods and of zero on time-rates, G is a dichotomous variable to be explained below, ε stands for a stochastic disturbance term, and where the other variables are indicated in Table 6.[1/] The variables X_1, X_2, X_3 are interpreted as measuring human capital investments and have been entered into the equation in a most general form, namely, as if the function relating these variables to the services of the human capital stock may be approximated by a second-order Taylor series expansion. This specification has been used before in accounting for earnings differentials[2/] and for this sample it involved a substantial improvement over the narrower

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[1/] All these individuals, in effect, are working the same number of weekly hours. More precise definitions of these variables and information on the sample design and survey are contained in Rees and Shultz, [1970].

[2/] See Mincer, [1974].

form that involves a quadratic term in experience but not in schooling and no interaction terms between schooling and postschooling investments. The turnover and use of private agencies variables (X_6 and X_7) respectively) are included to capture the effects of management's policies on wages whenever labor supply curves to the firm are less than completely elastic. Thus each management may economize on the costs of labor turnover and of searching for productive employees by paying relatively high (conspicuous) wages so that our hypotheses are that both β_3 and β_4 possess negative signs.[1/]

As noted above, only one of the twelve establishments employing the male punch press operators (and none of the eight establishments employing the female workers) operated both time-rate and piece-rate methods. This non-specialized establishment supplies ten observations to the sample of 183 male workers of whom five are paid at time rates and 5 at piece-rates. The estimating equation has been specified to discover the particular relative hourly earnings differential between piece and time workers in this singular establishment. Thus, G is a dichotomous variable taking the value of unity if a worker is employed in this establishment that operates both time-rate and piece-rate methods and taking the value of zero for workers in all other establishments. An estimate of the proportionate earnings differential in this establishment is given by the estimates of γ plus δ.

[1/] On the employer's wage-turnover strategy, see Pencavel [1972] and on the employer's wage-search strategy, see Stigler, [1962].

Before turning to the results from estimating this equation with our sample of 183 male punch press operators, recall that previous studies into the earnings of individuals with different employers have made use of sample sizes many times larger than what is available to us here. For instance, Jacob Mincer's earnings functions were fitted to a sample of over 28,000 individuals and George Johnson and Frank Stafford's study of the earnings of academic economists make use of over 3,000 observations.[1] Our sample of 183 male employees in 12 different establishments looks pretty meagre by comparison and we should not expect the same sort of precision in our estimates of the regression coefficients as has been obtained by other researchers using equations similar to that above.

The consequences of estimating the above equation by the method of ordinary least-squares[2] are shown in the column headed equation (1) in Table 7. Almost three-quarters of the variance in the logarithm of hourly earnings is removed by this linear combination of variables and our sign hypotheses on the regression coefficients are borne out by the estimates. The absence of a strong positive effect of unionism (X_5) on wages may be attributed to the threat effect in an area with a strong union movement: that is, in setting the wage in his own plant, an

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[1] See Mincer, [1972] and Johnson and Stafford [1974].

[2] The appropriateness of this estimating procedure can, of course, be challenged. For example, an argument involving the simultaneous determination of wages and one or two of the right-hand variables is not difficult to construct. Treating the presence of piecework systems (the variable P) as simultaneously determined with ln Y and applying the method of instrumental variables yields an estimate γ that is practically identical to that given in Table 7.

Table 7

Estimated Regression Equations with the Logarithm of Hourly Earnings for Male Workers as the Dependent Variable

		equation (1)	equation (2)	equation (3)
Mean of dependent variable		.888	.850	.919
Standard deviation of dependent variable		.159	.107	.108
Number of observations		183	84	99
Estimates of...				
constant		.714	.854	1.005
		(.093)	(.099)	(.183)
X_1	schooling	.0422	.0155	.0427
		(.0169)	(.0166)	(.0258)
X_1^2	(schooling)^2	-.0021	-.0009	-.0024
		(.0009)	(.0007)	(.0015)
X_2	experience	.0099	.0138	.0077
		(.0052)	(.0069)	(.0075)
X_2^2	(experience)^2	-.000001	-.00013	.00003
		(.00009)	(.00031)	(.00013)
X_1X_2	(schooling × experience)	-.00028	-.00041	-.00004
		(.00034)	(.00044)	(.00050)
X_3	previous experience	.0379	.0711	.0460
		(.0557)	(.0516)	(.0931)
X_1X_3	(schooling × previous experience)	-.0089	-.0048	-.0038
		(.0052)	(.0045)	(.0089)
X_2X_3	(experience × previous experience)	.0035	-.0023	.0033
		(.0013)	(.0026)	(.0025)
X_4	Black or Spanish surname	-.0104	.00002	.00001
		(.0081)	(.01540)	(.02656)
X_5	unionism	-.0140	-.0487	-.2227
		(.0288)	(.0496)	(.1240)
X_6	turnover	-.0031	-.0008	-.0087
		(.0009)	(.0037)	(.0034)
X_7	private agency or ad.	-.0030	-.0063	.0019
		(.0006)	(.0011)	(.0021)
P	incentive pay	.0684		
		(.0399)		
PG	(incentive pay × non-specialized establishment)	-.0642		-.0967
		(.0414)		(.0523)
	R^2	.743	.910	.735
	SEE	.084	.035	.104

(Standard errors are given in parentheses beneath estimated coefficients. SEE is the standard error of estimate of the regression equation.)

employer of nonunion labor will be induced by the threat of union-organizing activity to prevent the appearance of a large gap between the wage rates he pays and those received by comparable union labor; such a gap normally implies that his workers would be extremely receptive to a union membership drive.[1/] A test of the null hypothesis that the variables measuring the human capital investments of these workers have no effect on their earnings (i.e., a joint test on the α coefficients) is decisively rejected: $\hat{F} = 8.14 > F_{0.05}(8,168) = 1.99$.[2/] The estimated coefficient on P suggests that, holding other factors constant, the proportional difference between the hourly earnings of incentive payments workers and those paid at time-rates is approximately 7 percent. This is, in fact, not significantly different from the figure we would arrive at by a comparison of the unadjusted wage differential of these workers (namely, 8.8 percent).[3/] This positive coefficient on P may be interpreted as the value of the self-screening service provided to the employer by the operation of the piece-work system. It reflects the fact

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[1/] For further details of this in the Chicago labor market, see Rees and Shultz, [1970], pp. 44-6, 181-84, and 220. Perhaps it should be added here that the estimated coefficients on other variables (such as distance to work and location) used by Rees and Shultz to account for the earnings differentials of these workers never approached conventional levels of significance and, more important, did not alter any of the qualitative conclusions from our estimates.

[2/] Since X_2 measures the years spent by each individual on his present job and X_3 indicates whether or not he had any occupational experience prior to starting his current job, the reader may wish to interpret the coefficients attached to these variables as isolating the effects of (post-schooling) specific training and of (post-schooling) general training, respectively, on earnings. The marginal rates of return to schooling are approximated by $\partial \ln Y/\partial X_1$ where an interpretation in terms of gross investment and depreciation would seem to be appropriate.

[3/] The mean hourly earnings of timeworkers and of pieceworkers not employed in the establishment that operates both payment methods are $2.37 and $2.57, respectively.

that incentive payments workers are rewarded for transitory variations in their work effort, a variable that is omitted from this regression. One check on this explanation takes the form of estimating this regression equation for the 84 time-workers and for the 99 payment-by-results workers separately: since the earnings of workers on time-rates are independent of transitory variations in their effort, we would be omitting an effective constant from this regression equation for time-workers; on the other hand, since transitory variations in work effort are rewarded under an incentive payments scheme and since we should expect individuals to respond in different ways to this incentive system, a regression equation describing the earnings of payment-by-results workers would, indeed, be omitting an important determining variable. Equation (2) in Table 7 describes the earnings of workers on time-rates[1/] and equation (3) of workers on incentive pay. The standard error of estimate (SEE) of regression equation (2) is about one-third of the standard deviation of the logarithm of earnings of time-workers while the ratio of the SEE to the standard deviation of the dependent variable in equation (3) is almost twice that number. Alternatively, the independent variables included in the regression equation will normally predict the earnings of time-workers with much more precision than they will the earnings of workers paid on incentive schemes. This is consistent with the conjecture

[1/] The only unionized timeworkers are employed in the establishment that operates both time-rates and piece-rates. Hence the timeworker regression equation founders on collinearity between X_5 and G. This is why equation (2) in Table 7 omits the G variable.

that an important explanatory variable (namely, work effort) has been omitted from equation (2).[1/]

As was pointed out above, the reward for diligent work effort performed under time payments is provided by steeper earnings-experience profiles than operates for payment-by-results workers. This is evident from the regression equations (2) and (3) in Table 7. Compare the (logarithm of) earnings-experience profiles for the two classes of workers at the approximate mean values of schooling and previous occupational experience (namely, $X_1 = 10$ and $X_3 = 0.50$ for both groups). For the time-rate workers, the slope of the logarithm of earnings-experience relationship is given by

$$\frac{\partial \ln Y}{\partial X_2} = .01675 - .00026\ X_2$$

while for payment-by-results workers it is

$$\frac{\partial \ln Y}{\partial X_2} = .00895 + .00006\ X_2.$$

The proportionate rise of earnings with on-the-job experience is, indeed, greater for time-rate workers than for piece-rate workers: the incentives to habitual work effort for employees on time payments involve greater rewards to on-the-job learning. The slight concavity (from below) in the logarithm of earnings-experience relationship for time-rate workers and the even more imperceptible convexity in the relationship for piece-rate

[1/] A test of the null hypothesis that the regression coefficients in equation (2) are no different from those in equation (3) may be rejected:

$$\hat{F} = 1.92 > F_{0.05}(6,353) = 1.75 .$$

workers implies that, after a number of years on the job, the proportionate return to experience becomes the same for the two classes of workers. For these employees, this obtains at 24 years of uninterrupted experience on the job. However, from these data not too much should be made of this convergence in the profiles: only some 13 of all 183 male workers were observed with at least 24 years of experience so, at this range of values, inferences are being drawn from a very small sample of observations.

The hourly earnings differential between these two groups of workers in the establishment that manages both wage payment methods is given by the sum of the estimates of γ and δ, namely, .068 - .064 = .004 which, to all intents and purposes, is zero. Hence, an earnings differential between piece and time workers only obtains between workers employed on the two payment systems in different establishments; in the only establishment that employs the two groups of workers alongside one another, there is no such pay differential. Since according to equation (3) of Table 7 pieceworkers in this establishment earn almost ten percent less than the other male incentive workers in this sample, the absence of a piece-time pay differential in this establishment may be attributed simply to less work effort on the part of these pieceworkers.[1/] Alternatively, the management of this plant may believe that a small interpersonal

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[1/] Of course, δ may be picking up other effects on earnings peculiar to this establishment that have little to do with the workings of the wage payment systems. An alternative procedure is to estimate an equation omitting the establishment variables (X_5, X_6, and X_7) and replacing them with separate dichotomous variables for each of the twelve establishments. The general drift of the results from this estimating equation does not conflict with those in Table 7 though the latter are typically estimated with greater statistical precision.

dispersion of earnings encourages harmonious and productive work effort. Note also that this is a unionized plant and the union itself may be operating effectively to narrow the pay differential of timeworkers and pieceworkers.[1/]

Trade Unions and Wage Payment Systems

This raises the general issue of the role of trade unions in the operation of different wage payment systems. In the popular mind in the United States, labor unions are associated with strong opposition to incentive payments schemes. No doubt, this is attributable to the conspicuous stand against piecework methods on the part of some unions, the United Automobile Workers in particular. Thus Walter Reuther of the U.A.W. spoke in 1947 of the opposition to payment-by-results as "...the cornerstone of our basic union policy" and continually bargained for the application of an hourly wage rate plan. Although some observers have questioned whether union opposition provides a sufficient explanation for the move away from incentive pay in the automobile industry since the early 1930's, the importance of the U.A.W. policy as a contributory cause is unchallenged.[2/] However, there is abundant evidence of other unions being not merely sympathetic to, but actually encouraging of the use of incentive methods.[3/] In many cases, presumably, the existence of the

[1/] Equations similar to those in Table 7 were estimated for the female time and piece-workers. A 2½ per cent hourly earnings differential was measured in favor of piece-workers though this was not estimated with great precision. Not too much should be made of these results given our inability with these data to take account of the discontinuous market experience of these female workers prior to their starting on the present job.

[2/] See the measured discussion in Macdonald, [1963], pp. 112-31.

[3/] For instance, read the discussion of the Steelworkers Union and of the unions in the garment trades as described by Slichter, Healy, and Livernash, [1960], pp. 514-16 and 523-25.

union introduces no element into the choice and operation of the wage payment system that would not also be present if the workers were unorganized: the union does no more than register, though perhaps in a better publicized fashion, the attitudes of its members. There may well be other cases, however, in which the methods of wage payment afford different opportunities for unions to negotiate pay levels that are above competitive rates. For instance, it has been well documented that the costs of operating incentive payments methods are particularly sensitive to the climate of management-employee relations. Insofar as organized workers can threaten to be more effective in dislocating production than unorganized workers, the employer may have to offer a higher price to purchase union cooperation in the administration of the incentive pay scheme. This suggests the hypothesis that the impact of the union on wages is greater for workers on payment-by-results than for timeworkers.

On the other hand, mention was made in the previous section of circumstances in which each individual employee may be working under a community-imposed output constraint: typically, these restrictions on output operate where workers fear that high earnings will induce employers to cut piece-rates. If union and non-union plants are equally effective in restricting output in this way, then, as far as this factor is concerned, there will be no union-related pay differential between timeworkers and pieceworkers. On the other hand, if the apparatus of union organization permits a more effective enforcement of output restrictions in union establishments, then, when all other variables are held constant, the average hourly earnings of pieceworkers will tend to be lower in union

plants than in nonunion plants:[1] put differently, unions are more effective in eliminating observations in the upper tail of the frequency distribution of pieceworkers' hourly earnings. This argues for the earnings differential between pieceworkers and timeworkers being lower in unionized establishments.

Consider the data in Table 8 on the proportionate difference in the hourly earnings of pieceworkers and timeworkers in union establishments and in nonunion establishments. If Y_p and Y_t denote the hourly earnings of pieceworkers and of timeworkers respectively, then the third column in Table 8 lists r where r is defined as

$$r \equiv \frac{(Y_p/Y_t)_u - (Y_p/Y_t)_n}{(Y_p/Y_t)_n}$$

where the subscript u indicates unionized establishments and n nonunion plants. These data do not indicate a persistent tendency for the pieceworkers-timeworkers earnings differential to be either higher or lower in union as compared with nonunion establishments though unionism clearly

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[1] Some illustrations of the policing arrangements of the union are given in Van Dusen Kennedy, [1945]. Kennedy writes, "In some cases the union imposes penalties for serious infractions, in the form of a brief suspension from work or a money fine. An interesting arrangement is the "kitty" system encountered in a few cases. A limit on production or earnings by the hour or by the day is agreed upon and workers forfeit any amount earned over the limit into a common fund or kitty. This fund is expended periodically for a group function or celebration. That less formal and more direct methods of enforcement are sometimes used is indicated by the statement of a committeeman at one plant that if a worker persisted in exceeding the limit established some of the boys would "take him out in the alley and beat hell out of him," p. 118.

Table 8

Average Hourly Earnings of Incentive and Time Workers in American Machinery Manufacturing Industries in 1942

occupation	proportionate hourly earnings difference in union plants	nonunion plants	r
male assemblers, bench, class A	-.007	.163	-.146
male assemblers, bench, class B	.137	.209	-.060
male assemblers, bench, class C	.142	.307	-.126
female assemblers, bench, class C	.296	.091	.187
male boring-mill operators, class A	.086	.390	-.219
male boring-mill operators, class B	.162	.300	-.106
male buffers and polishers	.221	.411	-.135
male casting cleaners	.192	.402	-.150
male craters, class B	.169	.315	-.110
male drill-press operators, class A	.081	.265	-.145
male drill-press operators, class B	.163	.130	.029
male drill-press operators, class C	.182	.037	.140
male heat treaters, class A	.163	.516	-.232
male lathe operators, engine, class A	.012	.251	-.191
male lathe operators, engine, class B	.179	.062	.110
male lathe operators, turret, class A	.023	.278	-.200
male lathe operators, turret, class B	.187	.122	.058
male metal-saw operators	.189	.207	-.015
male milling-machine operators, class A	.016	.332	-.237
male milling-machine operators, class B	.197	.324	-.096
male packers	.341	.175	.141
female packers	.118	-.018	.139
male spray painters	.238	.106	.119
male planer operators	.063	.022	.040
male power-shear operators	.120	.045	.072
male screw-machine operators, class A	.072	.264	-.152
male screw-machine operators, class B	.128	.119	.008
male screw-machine operators, class C	.180	.158	.018

Table 8 continued

occupation	union plants	nonunion plants	r
female testers, class C	.276	.075	.187
male welders, hand, class A	.163	.232	-.056
male welders, hand, class B	.376	.127	.221
male machine welders	.290	.380	-.065
female winders, class C	.228	.130	.086

unweighted arithmetic mean r = -.027

	number of occupations in union plants	number of occupations in nonunion plants
incentive earnings<time-work earnings	1	1
incentive earnings>time-work earnings		
by 0- 4.9%	3	3
5.0- 9.9%	4	3
10.0-14.9%	5	6
15.0-19.9%	12	3
20.0-24.9%	3	3
25.0-29.9%	3	4
30.0-34.9%	1	5
35.0-39.9%	1	2
40% and over	0	3
total number of occupations	33	33

From Effect of Incentive Payments on Hourly Earnings, BLS Bulletin No. 724, 1943.

narrows the inter-plant dispersion in $(Y_p - Y_t)/Y_t$. Alternatively, using the Rees-Shultz data on male punch press operators, when an interactive term X_5P (unionism dummy variable times the incentive pay dummy variable) is added to the regression equation (4) above, the resulting coefficient estimate is positive (.093), but with a standard error larger than the estimated coefficient. Though different conclusions may well be extracted from other bodies of data, there is little in these results to suggest that trade unions matter as far as the relative pay of pieceworkers and timeworkers is concerned.

Conclusions

The questions focused upon in this paper have been concerned with the problem of eliciting effort from employees. This problem arises because of the conflict of interest between the owners of capital (or their representatives) and the hired labor and because malingering is costly to detect and prevent. This gives rise to the issue of providing the appropriate set of incentives and penalties and the different wage payment mechanisms are directed to that end. In particular, piece-rate methods tend to be preferred when the employer's problem of accurately screening his workers assumes especial importance. The seven per cent pay differential between male pieceworkers and timeworkers that has been estimated above measures the value of the signalling function provided to the employer by the operation of the piece-worker system. Further work on this theme should move beyond the simple piece-rate/time-rate dichotomy of payment methods that has been followed in this paper and instead examine the nature of different sorts of payment mechanisms.

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