A THEORY OF THE FIRM ON LAYOFF BEHAVIOR

by

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CHAPTER I

INTRODUCTION

Layoff is firm originated separations of workers. Both firm and workers suffer from layoff. For a firm, layoff evidently disturbs the teamwork of production activity, lowers worker morale and causes partial loss of trained workers. It also costs the firm directly and indirectly.[1] For workers, it causes a total or partial (if compensated by unemployment insurance) loss of income. They may lose their specific skill for which they financed. Therefore both firm and workers want to avoid layoff when they face a reduction of aggregate demand.

Most firms, however, have to meet this sort of situation in their business activities, however painful the process and result of layoff may be. The question which arises from this is how can a firm handle the problem of layoff, or more generally how can a firm maintain optimum level and quality of employment?

In the short run, the change in aggregate demand (nominal income) is divided into the changes in price and output (real income). Given a desired output, the desired flow of input services such as manhours or machine-hours can be made up by various combinations depending on input supply conditions and the different input utilization rates. In other words, substitution among stocks of inputs, and among inputs and utilization rates will occur. Up to this point the usual assumption of homogeneity of each input is sufficient. Most economic studies on the

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[1] See II-2-3) for layoff-related administrative and retraining costs.

equilibrium conditions and adjustment processes of demand change have been done at this level of abstraction. But as to the question of how a certain number of employees can be reduced, the assumption of homogeneity of workers is no longer sufficient.[1]

First of all, the reduction of the numbers can not be done at random. Every worker may have a different value from the firm's point of view. A firm, therefore, has to take quality of workers into consideration. Second, even if the firm reaches a decision about the desired level of the work force, the necessary reduction of workers does not necessarily mean the same number of layoffs. For layoff is only one aspect of the multi-sided phenomenon of labor turnover. For example, as will be shown later, the number of layoffs is inversely related to the number of quits, and the manipulation of quit rate by the firm may lead to a change in layoff rate. If the firm finds the outside labor market highly favorable, it may lay off more workers, which will result in more hiring in the current or immediately follwing periods for replacement. The point is that we can not read the number of layoffs directly from the desired reduction of output or the desired reduction of the work force. This point will be dealt with in detail in Chapter II.

Traditionally, the layoff problem has been treated as a part of the problem of labor turnover or labor mobility. Costs of hiring, training, and terminating, or disturbances of teamwork in production due to the abrupt discontinuities have long been recognized. In the early decades of

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[1]Note that the question raised here is one step beyond the familiar question of optimum demand for labor.

this century, much effort was directed toward study of the prevention of turnover. Among the many suggestions made were more accurate screening, a probation period, transfer within a plant, proper grievance procedures, and even ownership of the house.[1] Later on these problems were partly taken up under the heading of labor mobility. Different mobility aspects of labor among different industries, regions, ages, sexes, races, skills or duration of services were studied.

In recent years, the contributions of economists to the analysis of factors which affect layoff (or labor turnover in general) in one way or another have become increasingly specific. Becker (1962,1964) suggested that human capital, particulary firm specific human capital, had retarding effects on labor turnover. Oi (1962) demonstrated that labor was a quasi-fixed factor due to the hiring and training costs and that consequently this raised the critical value of labor cutoff in a recession. Parsons (1970, 1972 and 1973), following Becker's implication, developed and empirically tested the hypothesis that the level of specific human capital and its division into firm-financed and worker-financed portions had systematic effects on labor turnover. Pencavel (1972) also examined labor turnover within similar human capital framework. There are other studies such as Phelps et al.(1970) or McCall[2] which deal with labor turnover from the employee standpoint, but they are less relavant to this study.

Change in the utilization rate (hours of work) of labor input as a substitute for change in the number of workers has long been observed and more explicitly treated in recent studies (Fair (1969), Nadiri and Rosen (1973)), indicating a positive relationship with layoff. Holt and others

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[1]Eberle, G.J. "Labor Turnover," American Economic Review, (March, 1919).

[2]McCall, J.J. "Economics of Information and Job Search," Quarterly Journal of Economics, (February, 1970).

(1960) also showed that the inventory of a firm was a substitute for output, implying that inventory and layoff are inversely related.

All these studies, however, are but partial explanations of the question raised, there are no systematic explanations for the interrelationship of factors affecting layoff. What we need to know is in what kind of general framework the turnover policy variables are fabricated and how they operate.

There are two broad aims in this study. One is to develop a model which analyzes a firm's layoff behavior and related problem by probing into the interrelationship of labor turnover policy variables, with specific emphasis on labor quality. The other is to test empirically the testable hypotheses of the model. Quality of workers or maintenance of the best qualified work force is assumed to be a major concern throughout the study when a firm decides layoff. In the model, the quality of each employee is evaluated and this is used as a basis of comparison by the firm. Quality of workers in the firm, i.e., in the internal labor market, is also compared to that of workers who are actual or potential applicants outside the firm, i.e., in the external labor market. Of course the quality of workers in the external market must be discounted sufficiently by a certain measurement because of turnover costs and quality uncertainty. Variables in the model affect either the quality of the workers in both labor markets, or affect layoffs directly.

The model is empirically estimated using time series and cross section data. Especially in the cross section analysis, some of the specific human capital hypotheses are tested. The results are compared with other studies and explanations are sought for the various predictions and findings. It is also possible by the model to test related labor issues such as the

effect of change in attitude toward worksharing[1] on layoff, rehire vs. new hire decisions, and male-female layoff differentials. The test of the change in layoff due to the changes in attitude toward worksharing is especially interesting because the layoff behavior of a firm is closely related to the unemployment level and structure. It has been alleged that the development of trade unions, unemployment compensation, and supplementary unemployment benefit plan are factors which have caused a firm to use worksharing less often and to do more laying off. This would obviously lead to more unemployment. In the empirical study, an attempt is made to test this change over time. If the test supports the assertion, then such a change can be one of the widening factors of skill wage differentials.[2,3]

Since a firm's successive adjustments to the change in aggregate demand, i.e., price, output, utilization rates, and inputs, is an important economic problem, the analysis of firm layoff behavior as the last portion of the adjustment chain is an extension of the conventional theory of the firm, and it must contribute to the theory.

It is noted that the question raised here is the aggregate number of layoffs to be made for a certain discrete production period and not how to select a worker who will be laid off at a certain moment of time. It is assumed that the firm makes the overall labor turnover policy first and, atomic decisions later. In this study I focus on the former.

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[1]Worksharing is a reduced work schedule which can be adopted when a firm faces a contraction of business activity.

[2]Skill wage differential is defined by the ratio of the wage rates of skilled to unskilled workers.

[3]It is a well known fact that skill wage differentials are widening

In Chapter II, the layoff policies and practices of the firm are discussed extensively. The problem of why layoff occurs is briefly mentioned and individual factors or policy variables relating layoff are analyzed. The relationship between discharge and layoff are also discussed. The quantitative model and the implications of the model are presented in Chapter III. The empirical specifications of the model and the empirical results are given in Chapters IV and V. The basic estimations of the model using time series and cross section data are presented in Chapter IV. The empirical analyses of the effect of change in worksharing practices on layoff, a firm's strategy on rehires (recalls) vs. new hires,and male-female differentials in layoffs are given in Chapter V. The summary and conclusions are given in Chapter VI.

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during recessions and are narrowing during expansions. More layoffs due to the less worksharing practices imply relatively more layoffs of unskilled workers to that of the skilled. Therefore, if every firm behaves similarily, then this must lead to the widening of the skill wage differentials.

CHAPTER II

LAYOFF POLICIES AND PRACTICES OF THE FIRM

1 The Reasons Why Layoff Occurs

Before the investigation of firm layoff behavior begins, a brief consideration of the reasons why layoff occurs is in order. It is not impossible to proceed with the analysis of how a firm handles the layoff problem without the theory of why layoff occurs, but better understanding of the reasons for layoff should help the question of how.

The traditional and most widespread hypothesis is the Keynesian postulate that presumes short run rigidity of the money wage rate. Downward rigidity of the money wage rate when the aggregate demand decreases is said to be responsible for layoff. This rigidity comes mainly from the workers' side in the Keynesian framework.[1]

Similar to this theory is the "Social Minimum" hypothesis advanced by Reder. According to Reder, SM (for social minimum) is the minimum (straight-time) hourly wage rate at which a business firm or government —— as distinguished from a household or family farm —— can hire an hour of labor. SM may be set by statute (e.g., a minimum wage law), by social custom and/or by trade union policy.[2] The social minimum hypothesis is slightly different from the Keynesian one. In the former hypothesis, the source of wage rigidity is initiated not only by the workers, but also by the employers.

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[1] See Leijonhufvud, Axel. On Keynesian Economics and the Economics of Keynes, A Study in Monetary Theory. N.Y. Oxford University Press, 1968, pp. 91-98.

[2] Reder, Melvin. "The Theory of Occupational Wage Differentials," American Economic Review, (December, 1955), p 839.

Another hypothesis is quasi-contract theory[1] which is based on tenured or non-tenured employment practices like quasi-contracts. This does not require the rigidity of money wage rate in explaining layoffs. This theory emphasizes two phenomena. One is an upward-sloping short run labor supply curve for non-tenured employees. The other is the distinction between tenured and non-tenured employees or different degrees of tenureships which enable a firm to treat different classes of workers differently with respect to job security and wage rates. Therefore "the layoffs occur because after the drop in demand it would require a very substantial, not a trivial drop in wages to make it worthwhile to hire (retain; author) any of the non-tenured employees. And this is because the marginal revenue product of the tenured employees,..., is not an epsilon but far below the previous wage of non-tenured employees."[2] The quasi-contract model postulates different risk-sharing quasi-contracts with different workers as well. Therefore this can be interpreted to mean that the model implicitly assumes different qualities among different workers, with additional criteria of the worker's quality evaluation which are tenureship and risk-sharing quasi-contract.[3] Given this interpretation, the current study and the quasi-contract model share common ground which is quality differentiation among workers.

In addition to the theories described above, I add one more proposition for the possibility of layoffs, strictly speaking, the possibility of

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[1]Gordon, Donald F. "A Neoclassical Theory of Keynesian Unemployment," Economic Inquiry,(December, 1974).

[2]Gordon, Donald F. op. cit.

[3]See II-2-1) for the assumed procedure of the quality evaluation.

additional layoffs. This requires somewhat extended explanation.

When a firm hires a worker or a group of workers at a certain wage rate the firm is only sure that the worker accepts the wage rate but, is not quite certain about the worker's quality other than the information given to the firms such as formal education or years of experience, etc. The firm may try to screen intensively at the point of hiring. The problem with this procedure is that screening (gathering information or testing) is costly and secondly, not all aspects of a worker's performance are revealed until he has been employed for some time.[1]

The cost, the unrevealed work performance, and the average high quit rates at early stages of employment[2] discourage a firm from putting too much effort into screening. Of course the employer can judge an applicant's expected quality or expected quit-proneness in some degree by statistical information on an applicant such as years of schooling, age, sex, race, etc. The employer, however, expects a hiring to be the start of an

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[1]For the economics of a probationary period Eberle argued that "let the theoretical mental and physical tests be ever so perfect they never will and never can replace selection by actual application. Experience here, as in many other matters, is by far the best and most conclusive test. Not until the person has worked in the position or on the job will he or some one more competent, know whether he is properly placed." Eberle, George J. op. cit., p. 79. Phelps also noted that "it is quite impossible to become informed as to the exact abilities and reliabilities of a worker without actually trying him out. It is even rather costly to acquire personal data from the individual from which some predictions of the worker's ability can be made," Phelps, Edmund S. Inflation Policy and Unemployment Theory, New York, W.W. Norton, 1972, p. 24.

[2]Reynolds notes that "young people quit jobs more frequently than older people, and black workers more often than whites. For young people, this can be interpreted as fumbling one's way toward a satisfactory job through a trial-and-error process." Reynolds, Lloyd G. Labor Economics and Labor Relations, 6th ed. Englewood Cliffs, Prentice-Hall, 1974,p. 136.

engagement for years to come, and he is assumed to require more information about a worker's performance in order to properly evaluate a worker's value to the firm. This is the reason why there is the widespread practices of a probationary period.[1] Same holds true from the worker's point of view, i.e., a trial of a job to get proper information. So once workers are hired, the firm and the workers both start their employment engagements surrounded with uncertainties about the qualities of workers (for the firm) and the jobs (for the workers).

Another important point is that there are substantially high possibilities of disappointment for either or both parties after initial (or probationary) experiments in the employments.[2] Since there are uncertainties on both sides when the employment contract is made, there are four possible outcomes of the initial trial: (1) both satisfied, (2) both disappointed, (3) firm disappointed, and (4) worker disappointed. This point is analogous to the one that Akerlof made, about the difficulty of making a buying decision for a commodity when quality is uncertain.[3] Although the possibility of disappointment will be heavily concentrated

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[1]For the probation period, Chamberlin reports that in steel industry in 1948 "the contracts generally specify that new employees will be regarded as probationary for the first 260 hours of actual work" which is about one and half a month periods. Neil Chamberlin, The Union Challenge to Management Control, New York, Harper & Brothers, 1948, p. 290. And a case shown in Stessin's book, one month probation period was cited. L. Stessin, The Practice of Personnel and Industrial Relations, New York, Pitman Publishing Corp., 1964.

[2]I am implicity assuming that both employer and employees can get complete information about the workers' qualities and the jobs after the initial trial.

[3]Akerlof, G.A., "the Market for 'Lemons': Quality Uncertainty and the Market Mechanism," Quarterly Journal of Economics, (September, 1970).

during or after the initial period, we do not exclude disappointment in subsequent periods due to the discrepancy between the quality improvement of a worker and the compensations by the firm.

As a natural consequence of the trial with uncertainty and the substantially high chance of disappointment, the firm must be able to dispose of the less desirable employees, equivalent to quit behaviors by the workers. Discharges play this role in all phases of a business cycle. Layoffs, however, fulfil the same functions in a limited sense.[1] In other words, layoff can be used as another way of getting rid of undesirable workers. This may be especially relevant for the rapid contraction period after a rapid expansion of enterprise.[2]

This argument can be supported by two observations on firm behavior. One is so called "the fundamental management's right to manage or to discipline". Alchian and Demsetz wrote that "to discipline team members and reduce shirking, the residual claimant (the employer in usual term: author) must have power to revise the contract terms and incentives of

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[1]The relationship between discharge and layoff is described in detail in II-2-6).

[2]This was observed even half a century ago. Brissenden and Frankel worte; "It is obvious that when an establishment is rapidly increasing its work force in a tight labor market it cannot usually make a very careful examination of the fitness of a particular applicant for the job. During such time it is also possible that people are taken on who in normal times would not be hired at all. After these people actually begin to work in an establishment, however, a good many of them will be found to be unfit or undesirable and after longer or shorter period of service are let go. This selective process is, of course, greatly intensified in times of unusual industrial activity, when there is a scarcity of labor. All this involves an increase in the number of both accessions and separations far above the ordinary number, which is already unnecessarily large." Brissenden, Paul F. and Frankel, Mil, Labor Turnover in Industry: A statistical Analysis, New York, The MaCmillan Co., 1922, p. 35.

individual members without having to terminate or alter every other input's contract. Hence, team members who seek to increase their productivity will assign to the monitor not only the residual claimant right but also the right to alter individual membership and performance on the team. Each team member, of course, can terminate his own membership (i.e., quit the team), but only the monitor may unilaterally terminate the membership of any of the other members (i.e., layoff or discharge: author) without necessarily terminating the team itself or his association with the team; and he alone can expand or reduce membership,..."[1] A very similar argument of the intrinsic necessity of management and discipline for the group interest was stated by Selig Perlman[2] in 1928.

The other argument is the frequent practices of layoff as a substitute for discipline or discharge. These practices are often expressed as "cleaning house"[3] or "taking it out".[4] For example, Slichter and others report that "surprisingly often supervision uses a layoff to 'get rid of a guy' who is considered an inferior employee". After citing one case of layoff they go on: "the company explained to the union that the quality of this man's work was inferior. It went so far as

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[1]Alchian, Armen A. and Demsetz, Harold, "Production, Information Costs, and Economic Organization," American Economic Review, (December, 1972), pp. 782-783.

[2]Perlman, Selig, A Theory of the Labor Movement. New York, August M. Kelly, 1928, P. 242.

[3]Lester, Richard A., Layoff Policies and Practices: Recent Experience under Collective Bargaining, Industrial Relations Section, Research Report Series No. 82, Princeton University, 1950, p. 48.

[4]Reynolds, Lloyd, G., op.cit., p. 512.

to say that it had no intention of recalling him no matter how business improved in the future. In effect, the company was discharging the employee under the guise of applying layoff criteria."[1,2]

So far I have argued that a firm tended to use layoff as a way of disposal of undesirable workers. Even though it is true, there must be some restrictions on this proposition. For example, I indicated earlier that there were substantially high chances of disappointment to the employer and the workers for the initial trials. Not all the disappointment will lead to the separations though. Concentrating on the firm side, many of the disappointing (less qualified) workers may be kept in the firm depending on the labor demand and the labor market conditions. This delayed separations may seriously change the desirabilities of those workers. Because, as Alchian and Demsetz pointed out, "efficient production with heterogeneous resources is a result not of having <u>better</u> resources but in <u>knowing more accurately</u> the relative productive performances of those resources."[3] This implies that with different speeds and lengths of expansion of the work force, there can be different discharge and layoff rates, ceteris paribus, when the labor demand declines.

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[1]Slichter, Summer H., Herly, James J. and Livernash, E. Robert, <u>The Impact of Collective Bargaining on Management</u>. Washington, D.C. The Brookings Institution, 1960, p. 175.

[2]Dealing with unionized firm the same authors give another example: "Suppose Maintenance wants to eliminate 15 men because of a drop in volume. They decide to reduce 2 Electricians, 1 Millwright, and so on. They then say, 'Who's the next Millwright? Oh boy, it's the guy we wanted to get rid of. Let's layoff more Millwrights.' " Slichter et al., <u>op. cit.</u>, p. 175.

[3]Alchian, Armen A., and Demsetz, Harold, <u>op. cit.</u>, p. 793 Italics as original text.

2. Layoff Policies and Practices of the Firm

1) The Basic Structure of Layoff Decision Making

The present study is based, in the first place, on the assumption that there is neither monopoly (or monopsony) nor the trade union. In order to obviate the complexity stemming from different skills and diverse wage groups in a firm, this analysis focuses primarily on one specific wage group of workers yet having different qualities. The analysis, however, can easily be extended and any predictions drawn from the model with one wage group can be made valid to the multi-wage groups if, as is assumed below, the firm knows the qualities of workers. Other than that, the firm is an ordianry profit maximizing institution.

Two basic assumptions underlying this study: Assumption I is that the employer can subjectively evaluate the qualities of workers in the firm, i.e., in the internal labor market,[1] and in the closely related labor pool, i.e., in the external labor market.[2]

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[1]The internal labor market is an administrative unit, such as a manufacturing plant, within which the pricing and allocation of labor is governed by a set of administrative rules and procedures. See Dunlop, John T. "Job Vacancy Measures and Economic Analysis" in NBER, The Measurement and Interpretation of Job Vacancies, New York, Columbia University Press for National Bureau of Economic Research, 1966. See also Doeringer and Piore (1971).

[2]The external labor market in this study is defined as a labor market outside the firm, but it is the labor market where actual or potential applicants most likely search for their jobs. It is also within the reach of the firm's influence especially in terms of its recruitment policy. The need to narrowly define market in this case arises from the fact that a firm's new hiring or rehiring policies are limited by the closely associated labor market, but not by the overall outside labor market.

But this assumption does not mean that the employer knows them perfectly regardless of the internal or external labor market. It is assumed that he knows fully well the qualities of workers in the internal market except those of the employees on the probationary period. Since the qualities of the workers on probationary period are not fully known to the firm, and since a firm tends to evaluate highly the resources on which it has more accurate information, the workers on probationary period can be classified as the lowest group in the internal labor market. The labor qualities in the external market are uncertain and even more uncertain than those of the employees on probationary period. Therefore, labor qualities must be discounted properly by some measurement of uncertainty, in addition to hiring and training costs.

The way a firm evaluates the qualities of workers can be outlined in the following manner; One can imagine that workers are different in their labor characteristics in many ways. Suppose, for simplicity, the firm evaluates workers by their formal educations (E), and specific human capitals (K). Then, the workers under discussion will be evaluated differently by the different combinations of E and K, and by the weights the firm gives to two characteristics. This evaluation of quality is analogous to a utility function although the quality in this study must be known in terms of cardinal unit.[1]

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[1]This restriction is not unrealistic though because actual evaluations occur by the separate units, like production department or welding section in the real world. It would not be too difficult for the department or section chief to subjectively evaluate the qualities of their subordinates. I benefited from the discussion with Professor Galatin about the cardinality of workers' quality.

If Y stands for quality and

(2·1) $$Y = Y (K,E)$$

then, quality indifference curves can be drawn on the K-E space. The combination of K and E along a quality indifference curve will differ. Now, if the firm evaluates quality with three labor characterisitcs; K, E and α, then Y will be

(2·2) $$Y = Y (K , E,\alpha)$$

where α stands for say reliability. Then there will be quality indifference surface. Two workers with the same E and K may now be evaluated differently by the firm. Since there are enough labor characteristics to be considered, the case of indetermination will be very rare.

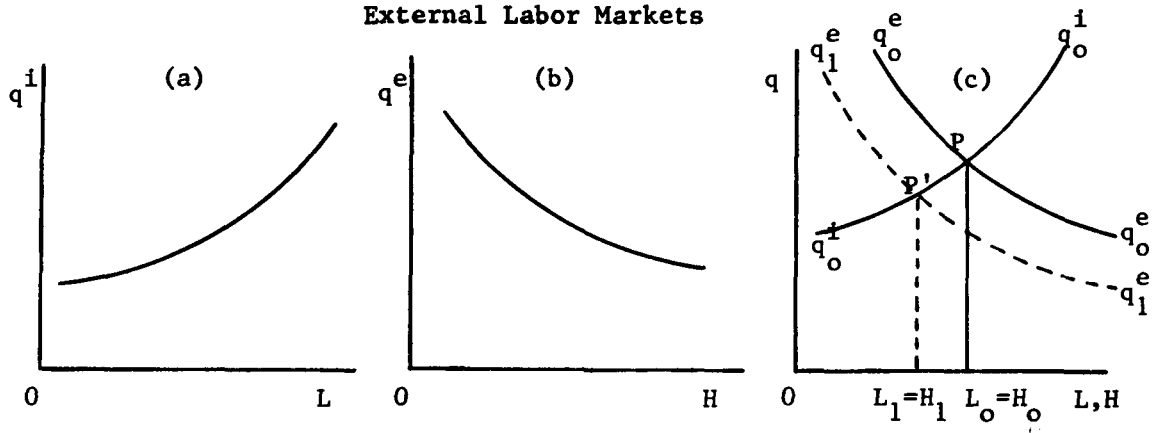
The labor quality by which the firm evaluates the labor is not necessarily the labors' marketable skill or productivity. Therefore, the question such as why the highly-evaluated workers do not move to other firms is irrelevant.

Assumption II is that a firm always tries to maintain the best qualified employees. This suggests the workers in the internal labor market can be replaced by the external market labor with qualities of the latter discounted by all the relevant discount factors.

With these two assumptions the basic structure of the layoff management can be described. Suppose the firm lays off workers from the least qualified worker first, then the relationship between the quality index of workers and layoffs in the internal labor market can be shown as in Figure 1 (a). The vertical axis shows quality index of the workers and the horizontal axis represents the number of layoffs. The quality index of the workers rises as the number of layoffs increases.

In the external labor market, however, the quality of the workers

Figure 1. Workers' Quality, Layoffs and Hires in Internal and External Labor Markets



who are ready for hire decreases as the number of hires increases, assuming the firm hires the best qualified worker first from this market. This is shown in Figure 1(b)[1].

When two diagrams are merged, there appears the most extreme case of labor turnover relationship (Figure 1 (c)). Suppose there is no hiring or firing costs and no training cost, then the firm will attempt to replace its employees by firing OL_o and by simultaneously hiring OH_o, according to Assumption II.[2] This can hardly be true in the real world. There are many factors which prevent the firm from doing this. However, the important point is that this may well be the underlying momentum for the profit maximization and "the right of management" of the firm. If the inherent nature of labor input and/or institutional barriers had not interfered with the firm making it behave differently, this basic structure might

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[1] In extreme case, the curve can be almost horizontal up to a certain point on H.

[2] It is always possible for a firm to have less qualified workers in its internal labor market, because first, the firm can make mistake when it hires due to uncertainty and second, as time goes on, the quality of workers in the external market can rise independently of the internal market situation.

have applied to the turnover of labor.

Now let me assume that there are costs for hiring, layoff and training. These costs in their importance are beyond the comparison with the usual transaction costs for other inputs. The costs will cause either the curve $q_o^e\ q_o^e$ to move downward to $q_1^e\ q_1^e$ as shown in (c), or to move the other curve ($q_o^i\ q_o^i$) upward. This is analogous to giving more discount for the quality of workers in the external labor market, and to allowing for premium for that of workers in the internal labor market. This also means less layoffs and less replacement ($OL_1 < OL_o$), ceteris paribus. Note, however, that this discount is an additional one to the discount needed to compensate the uncertainty of the workers' qualities in the external labor market.

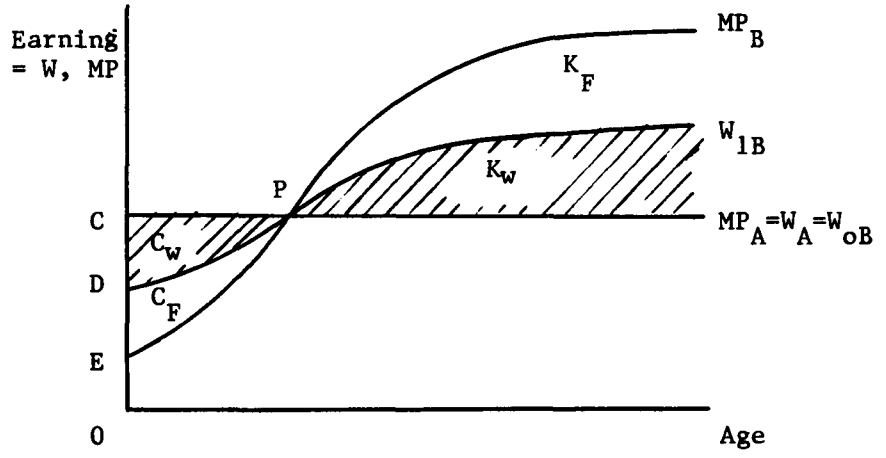
2) Specific Human Capital and Layoffs: Investment Decision for Specific Human Capital

Training, especially firm specific training, affects the internal labor market situation considerably. Because training creates detering characteristics both for the firm and the employees. According to Becker, training can be divided into general market training and firm-specific training. General training applies not only to one firm, but also to firm in general. But firm-specific training is applicable to one specific firm. Under the usual circumstances a firm does not pay general training cost, because it does not matter much for the firm whether it hires a generally trained worker or whether it gives general training to a worker at his own expenses. The firm can not keep the worker even if it pays the cost for general training. Therefore, pure general training does not alter the firm behavior on layoff.

If the training is a firm-specific one, however, this changes firm

behavior systematically. The more a worker has a firm-specific training, holding the division of cost between a worker and a firm constant, the more valuable he is for the firm, and consequently the less chance he stands for being laid off. And the more the firm spent in training costs, the more valuable he would be and also less chance he stands for being fired.[1] This can be easily shown by a diagram.

Figure 2. Age-Earning Profile with Firm-Specific Human Capital



Ignoring DW_{1B} curve for the moment, this age-earning profile shows the relationship between the investment in specific training and the return of the investment after the last training point of time P. Line CMP_A is an age- earning profile of worker A who has no specific training. If the firm finances all the training costs, its foregone income due to the investment will be the area CPE and it will recoup the investment in the future along the PMP_B curve. The difference between PMP_B and PMP_A (area $K_F + K_w$) will be the return for the firm. The specifically trained worker B will receive the same wage as untrained worker ($W_{oB} = W_A$). Therefore

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[1] See Parsons Donald O., "Specific Human Capital: Layoffs and Quits," unpublished Ph.D. dissertation, The University of Chicago, 1970.

the bigger the investment in specific training (the bigger the area CPE), the bigger the difference between PMP_B and PMP_A and the more valuable the worker B is for the firm.

When the firm shares the investment cost with the worker B, the worker's foregone earning will then be the shaded area CPD (C_w) and he will recoup the investment along the curve PW_{1B}. The difference between PW_{1B} and PW_A (the shaded area: K_w) will be the increased earning. This sort of cost sharing scheme is said to be profitable for both parties because the investment in firm-specific training by a worker tends to reduce quit rate and that investment by a firm tends to lower layoff rate. In other words, the portion of a worker's investment deters the quit propensity and that of a firm lowers the layoff propensity. Note, however, that given firm-financed specific training, there is higher chance of being laid off for a worker who invested more specific training by his expense because he will be more likely to be retained in the unemployment pool (See the relevant discussion in IV-2-2)-(2).

Speaking in terms of the internal and external labor market, firm-specific training obviously affects the firm in favor of the internal labor market. There will be less layoffs if the level of the training and the share of the firm for the cost of training become higher. Therefore firm-specific training should be considered as an important factor in making layoff decision. If this investment decision is considered by the firm as a layoff policy option over periods, then the firm may weigh the cost and benefit of it.

Since a firm is usually aware of business fluctuations in the near future and is well aware of the effects of specific training on labor turnover, it would be safe to assume that specific human capital investment

decision works partly as a turnover policy variable, constraining an employer's turnover behavior over time. For example, suppose an employer faces demand decline. If the employer had had the expectation of the employment change, his decision on the investment in training in the previous periods might have been different. He could have avoided over-investment in the specific training and the resulting costs which are now in part would turn out to be wasteful. In this study, the investment in specific training is chosen as a labor trunover variable.

3) Quits and Layoffs: Wage Rate Decision

Quit decisions belong basically to workers. Average quit rate in a firm, however, is not totally unforeseeable in the firm. If the firm rasies its wage rate, then the workers will quit less given workers' contributions. If the firm gives more firm-specific training to the workers, then they will quit less too. It is assumed in this study that quit rate is a function of wage rate and that the function is known to the firm. Other reasons for quitting were ignored.

In usual circumstances a firm, of course, wants to experience less quits. Abrupt discontinuities in employment by workers disturb the smooth production process. It also imposes extra turnover costs such as hiring and training costs. But if the firm faces or anticipates the downturn of its business, then it may not be eager to hold quit rate down or it may even prefer to have a little higher quit rate. Because it knows very well about how painful the layoff processes are for both management and employees.

It is this downward phase of a business cycle which is relevant in explanation of the relationship between quit and layoff. Let me limit the observation in this phase. The firm is now less likely to fill the

vacancies created by quits. So it is less likely to pay hiring or training costs, and having quits is less painful for the firm than that in usual cases. Therefore the firm may prefer to have more quits, i.e., more voluntary separations.

To infer this kind of proposition, two points may need to be clarified.

The first point is that the firm would rather have its qualified workers quit than to undergo the pain of layoff procedure. Considering Assumption II, which postulates that a firm tries to maintain the best qualified workers, the firm would want to reduce the work force by layoff rather than to have the workers quit in the strict quality sense because quits are arbitrarily determined by any quality levels of workers, whereas workers to be laid off are selected by the firm.

But layoff may well be more painful and costly to the firm than the loss of qualified workers in certain cases. In actual layoff management, if a firm takes the seniority of workers into account, for example, then there may be many transfers, many "bumpings"[1] and consequently much of administrative and training costs. Lester reported that more than half of the companies in his study stressed the burdens that transfers in lieu of layoff placed on management during the course of reducing operations. He also showed the cases that in a firm layoff of some 900 employees involved "at least as many transfers" and for another large company, an average ratio of two moves was made for every employee laid

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[1] "the process of readjusting work forces through displacement of workers during a layoff is often referred to as 'bumping'". Lester, Richard A., op.cit., p. 17

off (11,000 employees were permanently laid off and there were 23,000 movements).[1] Therefore it would be fair to assume that a firm in a certain situation may choose quit as a substitute for layoff.

The second point is that quit rate is relatively low during business downswing when layoff rate is high. It is low simply because workers find outside labor market unfavorable. This relatively low quit rate will certainly force relatively high layoff rate. Therefore, if a firm decides to manipulate quit rate upward by changing wage rate, for example, the decision will not involve extraordinary loss of the qualified workers.

By this decision I do not suggest drastic wage cut. A very conservative action may be enough. Delaying or lowering expected annual wage raise may cause some workers to leave. If the firm uses quit as a partial substitute for layoff at all, it is likely that those who determine to leave are the least committed workers to the firm. This compensates the loss caused by the quit partially because less committed workers are less desirable to the firm's point of view.

In the light of these two points that a firm may use quit as a partial substitute for layoff, and that quit rate is low during downswing, wage rate decision will certainly work as layoff policy variables for the firm.

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[1] Lester, Richard A., op. cit., p. 22

4) The Conditions of the External Labor Market and Layoffs: "Search" Decision

In Assumption I, I postulated that the firm evaluated the qualities of workers in two labor market, i.e., internal and external. If the external labor market happens to be highly favorable to the firm, the firm is likely to layoff more workers, firm is less vulnerable to the loss of workers laid off, and is easier to find replacement workers for current or the immediately following periods, if it so desires. Therefore without making any specific effort on the part of the firm, one can see that the external labor market condition is clearly a factor which must be taken into consideration for the layoff decision.

Now, suppose the firm pays some costs to get better applicants in the external labor market. A typical firm may not do this when it lays off workers. Considering various job categories and different occupations, however, this may happen even when a firm lays off employees in certain jobs. The more the firm tries, such as job advertising or granting of moving expenses, the better the quality of the workers in the external labor market and the more layoffs the firm tends to have. Of course, this will be possible under the mild phase of a business cycle and within the diversified jobs in a firm.

Surprisingly enough, mild layoffs have occurred almost every month in SIC 4-digit industries in the United States for long time. Layoff rates in such industries have been fairly stable over time except during the salient upswings and downswings. Therefore, the routine job advertisement or any other recruitment efforts must have affected layoff behavior of a firm in one way or another. The point is that such firm activity in an external labor market which one may call "search" activity is clearly

a policy variable affecting layoff decision. The word "search" may be too strong, but I believe that there is a systematic relationship between this "search" and layoff decision. A firm may well be better off by doing "search" if the search cost is very low and the marginal efficiency of the search activity is very high, resulting in higher quality of workers in the external labor market and relatively more layoffs.

5) Utilization Rate and Layoffs

The demand for labor input in a ultimate form is in terms of a flow service of manhour. Generally, for all inputs, it will be the stock of input times the rate of utilization per unit of stock. An appropriate measure for the utilization rate in the case of labor input will be hours of work per day or per week and hours of positive or negative overtime work. A conventional term like worksharing which is reduced working hour (negative overtime) will also be one of the proper measures.

For given amount of manhour, the longer the hours of work per man is, the less the stock of labor is. Therefore, during a business contraction, the shorter the hour of work is, the less the layoffs tend to be. Both hours of work and number of layoffs are positively related as a matter of simple arithmetic.

Historically interesting thing, however, is an assertion that the attitudes of workers and managements toward worksharing has changed in the U.S. industries in the recent years.

By two most valuable and extensive studies on layoff practices,[1] both workers and managements preferred to have worksharing schemes until

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[1]Lester, Richard A., op.cit., and Slichter, S. et al., op. cit.

the end of 1950 or the beginning of 1960. But workers as organized unions began to dislike the schemes thereafter. Lester observed that "the trend ... is towards a restricted use of reduced workweeks...."[1] Slichter et al. also reported marked evidence of a growing desire on the part of unions to restrict management's freedom to reduce the workweek or to adopt a rotational system of worksharing. They went on; "whereas twenty years ago a substantial number of unions insisted on reasonable worksharing before layoffs could be made, today the trend of union preference is more and more toward the restriction of worksharing arrangements."[2]

There can be various reasons for this change in the attitude. The most important among them may be the result of the aging of trade union members and the development of unemployment compensation or supplement unemployment benefit plan. Old workers who accumulated high seniority rights are rarely affected by layoff and, if they control union, then the union as a bargaining unit may well insist against worksharing. The development of unemployment compensation or supplement unemployment benefit plan seems to accelerate this trend. Since workers work in many cases 32 hours a week under worksharing, this provides little more remuneration than state unemployment compensation plus negotiated supplementary benefits during a layoff. This shift in the attitudes of workers on worksharing over time must have an impact on the layoff behavior of a firm and consequently on the level and structure of unemployment.[3]

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[1]Lester, Richard A., op. cit., p. 37.

[2]Slichter, S. et al., op. cit., p. 152.

[3]Reynolds, after analyzing different layoff rates in different age, sex, race, notes that "there is a widespread impression that the unemployment picture has worsened over the past decade or so; that is, the level of unemployment corresponding to a given level of labor demand (and job vacancies) is higher than it used to be." Reynolds, L.G., op. cit., pp. 137- 138.

This assertion has not been tested against empirical data. If there has been any change in layoff behavior due to the shift in worksharing scheme, I believe it must be detected sooner or later during the 1960's according probably to the degree of union power. In V-1, I test empirically this effect of the change in attitude toward worksharing practice on layoff.

6) Discharges and Layoffs

Discharge is a firm-initiated separation of employment for "just cause." For example, Brissenden and Frankel reported that the causes of discharges of 1,439 employees in 6 metal trade establishments were as following;[1]

TABLE 1 Causes of Discharges

Causes of Discharges	Number	Per cent
Incompetent	478	33.2
Unreliable	422	29.3
Lazy	148	10.3
Careless	66	4.6
Insubordination	93	6.5
Misconduct	54	3.7
Trouble Breeder	105	7.3
Liquor	73	5.1
Total	1,439	100.0

[1] Brissenden, Paul F. and Frankel, Emi., op. cit., p. 96.

Formally a discharge is treated quite differently from a layoff by a firm. But there are some similarities together with dissimilarities between them and the relationship between them has yet to be clarified.

As was mentioned in the previous discussion, layoff may be used by a firm as a way of disposal of less desirable workers. In this respect, both layoff and discharge are common in the separation of employment and in the manifestation of less desirability from the part of the firm. Note that a firm never choose a laidoff worker randomly.[1] The difference between them may be a matter of degree in disappointment on the part of the firm. Furthermore, if we take account of the facts that a firm is willing to lower its criteria of discharge under a tight labor market and, that the length of layoffs is sometimes so long that some laidoff workers are forced to find other jobs, assuming that the firm recalls the most desirable laidoff workers first,[2] one can see the distinction between these two categories is not so clear as appeared in the first place.[3] The reason for this similarity may lie in the quality consideration on workers by the firm. In other words, they are similar in the sense that workers in both categories are selected on the basis of their less desirabilities.

Nonetheless, one important point is that this similarity does not directly lead the firm to behave similary in both categories, regardless

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[1]By the definition of the Bureau of Labor Statistics, layoffs are separations "initiated by the employer without prejudice to the worker." It seems that there may not be moral prejudice, but that does not necessarily mean layoffs are selected randomly either. Allowing modifications I tend to argue that the basic principle in layoff will be "the least qualified worker goes first."

[2]See p.57 for the unionization effect on the layoff and recall policy of a firm.

[3]According to "the laidoff manager's handy checklist," most check items are concerned about the ways of providing help to find other jobs forthe laid off workers. Industry Week, (April 12, 1971).

of phases of a business cycle. Many other factors prevent the firm doing that. Factors such as labor demand, labor market conditions, attitudes of workers as well as phases of a business cycle may well force the firm behave qiute differently.

One observes more discharges in business expansions and less in business contractions, whereas obviously we expect less layoffs in the former and more in the latter. The number discharged during a boom increases because, first, there are more hires and second, the urgent need of workers makes careful selection more difficult. By the same token, the number discharged during depressions decreases because first, there are fewer hires and second, workers take more care not to risk discharge. Therefore, if one limits one's observation on the relationship between discharge and layoff rates to the years or months of rapid expansion and contractions, he may conclude that these two rates are inversely related with each other.

There is a counteracting force to these cyclical tendencies too, namely, adjustment of the criteria of discharge. As I stated earlier, a firm is willing to lower its criteria of discharge under a tight labor market. This contributes to the positive relationship between discharge and layoff. One can envisage this relationship, as Slichter indicated, by computing discharge rate as a percentage of the number of hires instead of as a percentage of the average force.[1] Table 2 illustrates this. The years 1960 and 1969 are the years of expansions and 1958, 1961 and 1970 are the years of contractions.

In Table 2, discharge rates as percentages of the average work force

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[1]Slichter, S. et al., op. cit., p. 103.

TABLE 2

Discharge Rates in Boom and Recession Years

SIC	BOOM YEARS				RECESSION YEARS					
	1960		1969		1958		1961		1970	
	A	B	A	B	A	B	A	B	A	B
2011	.5	(.36)	.7	(.27)	.4	(.50)	.4	(.31)	.8	(.29)
2051	.6	(.24)	.7	(.15)	.5	(.23)	.6	(.27)	.7	(.18)
221	.5	(.31)	1.1	(.26)	.4	(.28)	.4	(.25)	1.1	(.27)
225	.5	(.17)	.7	(.17)	.3	(.14)	.6	(.21)	.8	(.23)
228	.6	(.02)	1.0	(.17)	.5	(.27)	.2	(.07)	1.2	(.23)
2321	.4	(.12)	.7	(.16)	.4	(.19)	.5	(.17)	.9	(.22)
2341	.6	(.18)	.8	(.19)	.4	(.14)	.6	(.18)	.7	(.18)
2511	.7	(.24)	1.2	(.21)	.5	(.22)	.5	(.18)	1.0	(.25)
261,2	.3	(.27)	.6	(.30)	.2	(.20)	.4	(.40)	.6	(.42)
2653	.7	(.31)	1.3	(.25)	1.5	(.75)	.6	(2.60)	.9	(.28)
2823	.2	(.33)	.6	(.43)	.2	(.40)	.3	(.38)	.4	(.57)
2834	.4	(.22)	.5	(.20)	.4	(.28)	.4	(.25)	.5	(.25)
291	.4	(.66)	.6	(.40)	.5	(1.25)	.5	(.83)	.6	(.42)
301	.4	(1.00)	.8	(.42)	.3	(.75)	.5	(1.25)	.8	(.66)
314	.7	(.25)	1.1	(.26)	.4	(.20)	.8	(.30)	1.1	(.27)
3221	.8	(.40)	1.0	(.25)	.4	(.26)	.8	(.47)	1.0	(.27)
3312	.5	(1.66)	1.1	(.50)	.4	(1.33)	.6	(1.50)	1.0	(.71)
3321	.5	(.41)	1.4	(.28)	.4	(.33)	.7	(.50)	1.2	(.41)
3443	.5	(.22)	.9	(.27)	.4	(.29)	.5	(.28)	1.0	(.39)
346	.6	(.35)	1.1	(.31)	.6	(.46)	.7	(.43)	1.0	(.45)
3531	.6	(.66)	1.0	(.38)	.3	(.33)	.6	(.66)	1.0	(.62)
3585	.7	(.29)	1.5	(.33)	.5	(.26)	.7	(.43)	1.1	(.39)
3621	.7	(.58)	.8	(.26)	.4	(.44)	.7	(.63)	.8	(.44)
3662	.8	(.42)	.8	(.26)	1.4	(.93)	.8	(.42)	.6	(.40)
3711	.8	(.73)	1.1	(.48)	.8	(1.00)	.8	(1.33)	1.0	(.63)
3721	.4	(.33)	.4	(.30)	.3	(.21)	.4	(.25)	.4	(.66)
3821	.4	(.22)	.6	(.20)	.4	(.36)	.6	(.31)	.7	(.36)

A= Discharge/Employment
B= Discharge/New Hires

increase in the expansions and decrease in the contractions. But the discharge rates as percentages of the number of new hires move in opposite direction. The comparison of values in the parentheses in the boom and recession columns reveals this.

Since there are two forces moving in opposite direction toward the relationship between discharge and layoff, it is not always possible, a priori, to determine whether discharge is positively or negatively related to layoff. If any one concentrates his observations on the rapid expansion and rapid contraction phases of business cycles, he may find negative relationship. If he studies general steady states of business cycles,[1] he tends to observe positive relationship between them. This is because, in steady states, neither higher discharge rate due to the rapid expansion of work force nor higher layoff rate due to the rapid reduction of it exists and, the quality criteria for discharge and layoff move more or less conformably.

In this study, layoff and discharge are treated separately and most efforts are given on the layoff behavior. Furthermore, when discharge appears in the empirical study as one or a part of an independent variable for layoff regression, I expect that it will have positive sign because I deal with time series data which have much more segments of steady states of business cycle than either rapid upward or downward curves.

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[1]By steady states of business cycles I mean that steadily increasing or decreasing phases of business cycles.

7) Interrelationship among the Decision Variables

So far I covered labor turnover decision variables which a firm must consider in its turnover management, investment in specific skill, wage rate, and "search", together with the relationship between discharge and layoff. Of course there is one more decision variable which is layoff per se. Strange it may sound, layoff is as much important a labor turnover decision variable as other variables. For example, wage cut is a possible option in lieu of layoff, although the impacts of both options may be quite different. Nothing inherently can prevent the firm from cutting wages, if labor supply curve and /or quit function the firm faces favor the option.

The firm must evaluate the costs and benefits of choosing one or more of these variables in its production and labor turnover management process. This obviously involves usual optimization process of the firm. This will be done in Chapter III.

CHAPTER III

THE MODEL

1. The Model

Assume that a firm produces an output X, a market good, with one input M, labor, with the following production function,

$$(3\cdot1) \qquad X_t = F\,(\,\phi_t M_t\,)$$

where ϕ_t is average quality of workers of all classes and M_t, the number of workers employed in period t. This is a first approximation to a more general production function,

$$(3\cdot2) \qquad X_t = F(\,\phi_{1t}M_{1t} + \phi_{2t}M_{2t} + \cdots + \phi_{nt}M_{nt}\,)$$

where ϕ_{it} is the quality of the i^{th} class of worker and M_{it} is the number employed of that class.[1]

Assume that the firm also jointly produces an output I, firm-specific human capital or firm-specific skill, with an input T, training

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[1] It can be shown that by definition

$$\mathrm{Cov}\,(M_{it}, \phi_{it}) = \frac{\sum_{i=1}^{n} M_{it}\phi_{it}}{n} - \bar{M}_t\bar{\phi}_t, \quad \phi_t = \bar{\phi}_t\,.$$

If the covariance is zero, then

$$\sum_{i=1}^{n} M_{it}\phi_{it} = n\,\bar{M}_t\phi_t$$

$$\sum_{i=1}^{n} M_{it}\phi_{it} = \frac{n\sum_{i=1}^{n} M_{it}}{n}\,\phi_t$$

$$\sum_{i=1}^{n} M_{it}\phi_{it} = \phi_t\sum_{i=1}^{n} M_{it} = \phi_t M_t.$$

Thus $X_t = F\,(\,\phi_t M_t\,)$.

I am indebted to Professor Grossman for this.

and testing,[1] with the following production function,[2]

(3·3) $I_t = I(T_t)$, where $I_T > 0$.

Note that the equation (3·3) is defined in terms of total specific human capital. As is shown later, the total specific human capital investment (I) is divided into worker-financed (I_w) and firm-financed specific human capital (I_F), i.e., $I = I_w + I_F$.

If there is no depreciation in specific human capital, the investment in specific human capital in period t-1, I_{t-1}, will raise the stock of specific human capital in period t, K_t, as (3·4),

(3·4) $K_t = K_{t-1} + I_{t-1}$[3] , where K_{t-1} is given.

It is assumed that the average quality of workers in the firm in period t, ϕ_t, depends on the number of layoffs in period t-1, L_{t-1}, the stock of specific human capital in period t, K_t, and the average quality of workers in the external labor market in period t, Ω_t. Thus

(3·5) $\phi_t = \phi(L_{t-1}, K_t, \Omega_t)$[4] , where ϕ_L, ϕ_K, $\phi_\Omega > 0$.

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[1] This testing is different from screening or test at the stage of hiring. This is a close observation or testing on the job to get more accurate information about a worker's work performance. The information gathered by this process is a unique form of firm owned specific human capital which will make the worker more valuable to the firm.

[2] The production function (3·3) may be specified differently in the following way; $I_t = I(T_t, M_t)$ because specific training involves number of workers. I_t will increase as M_t increases when T_t is held constant. However, this formulation does not add much to the present analysis. The production function (3·3) is adopted merely for simplicity.

[3] Note that there is another source of depreciation other than "pure" depreciation of the specific skill. That is the changes in the composition of the work force in period t-1. Put differently, (3·4) can be written as (3·4·1) $K_t = (1 - \rho) K_{t-1} + I_{t-1}$, where ρ is the rate of depreciation due to the changes in the composition of the work force. ρ may depend on quit, layoff and discharge rate. So as quit, layoff and discharge rate rise, K falls. In order to avoid double counting of the effect of the change in L on ϕ and on K in (3·5), it is assumed that the effect of the change in L on ϕ is net effect of the increase in L which is the difference between the effect of the change in L on ϕ and that on K.

[4] In full formulation, $\sum_{j=1}^{t-1} L_j$ can be more relevant than L_{t-1}.

The partial derivative of ϕ with respect to L, ϕ_L, is positive since it is presupposed that the firm lays off the least qualified first. The presence of Ω_t in the equation (3·5) is a unique feature of this model. (3·5) states that ϕ_t depends directly on Ω_t. This may sound unusual since in the conventional usage of internal and external labor market economists have emphasized different treatment of two markets by the firm or insulation between them.[1] However, the dependence of ϕ_t on Ω_t does not conflict directly with the basic concept of the two types of market. The concept of internal and external labor market assumes that two workers in both markets can not be compared with each other directly. For this point, the present study discounts the quality of workers in the external labor market. The concept, however, does not deny the close relationship between two markets in terms of inflow or outflow of workers. There may be certain barriers of entry, but considering the labor turnover policy of a firm, the external market is always the next door to internal market. Therefore, insofar as there is an inflow of workers from the external market the quality of the internal market, ϕ, is directly related to that of the external ,Ω, by the qualities of these newly hired.

The average quality of external labor market[2] in period t, Ω_t, is,

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[1] See, for example, Doeringer Peter B. and Piore, Michael J. op. cit., pp. 33-34.

[2] In order to evaluate the average quality of workers in the external labor market, it is necessary to assume that the boundry of the market is fixed, presumably by the size of the firm. Since the firm is concerned with the quality of workers in the market for labor turnover management purposes, the relevant factor to the firm's decision is short run phenomenon of the market. Therefore, it can be assumed that the boundry of the external market is fixed. Suppose, for example, the firm knows that it will hire no more than one hundred workers per period in the current or the

in turn, a function of the number of hiring, H_{t-1}, and the amount of "search", S_{t-1}.

$$(3\cdot6) \qquad \Omega_t = \Omega(H_{t-1}, S_{t-1})$$

where $\Omega_H < 0, \Omega_s > 0.$

As was mentioned in II, Ω_H is negative because the best qualified worker is assumed to stand the chance of being hired first.

The number of workers in period t+1, M_{t+1}, is

$$(3\cdot7) \qquad M_{t+1} = M_t + H_t - (L_t + Q_t + D_t)$$

where

Q_t ; number of quits in period t

D_t ; number of discharges in period t.

Therefore, the number of hiring, H_t, will be the sum of the net increase in employment between t and t+1 periods and the replacement, i.e.,

$$(3\cdot7\cdot1) \qquad H_t = (M_{t+1} - M_t) + (L_t + Q_t + D_t)$$

$$= \dot{M}_t + L_t + Q_t + D_t$$

where

$$\dot{M}_t = M_{t+1} - M_t.$$

The identity (3·7·1) can be rewritten as

$$(3\cdot7\cdot2) \qquad H_t = \dot{M}_t + (\ell_t + q_t + d_t) M_t$$

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immediately following periods. Then the firm will be interested only in the first one hundred (best) workers. Even if it searches more and gets more applicants, it will be interested in the same number of workers who may now be better qualified than those previously in the market boundry.

where

ℓ_t ; layoff rate in period t

q_t ; quit rate in period t

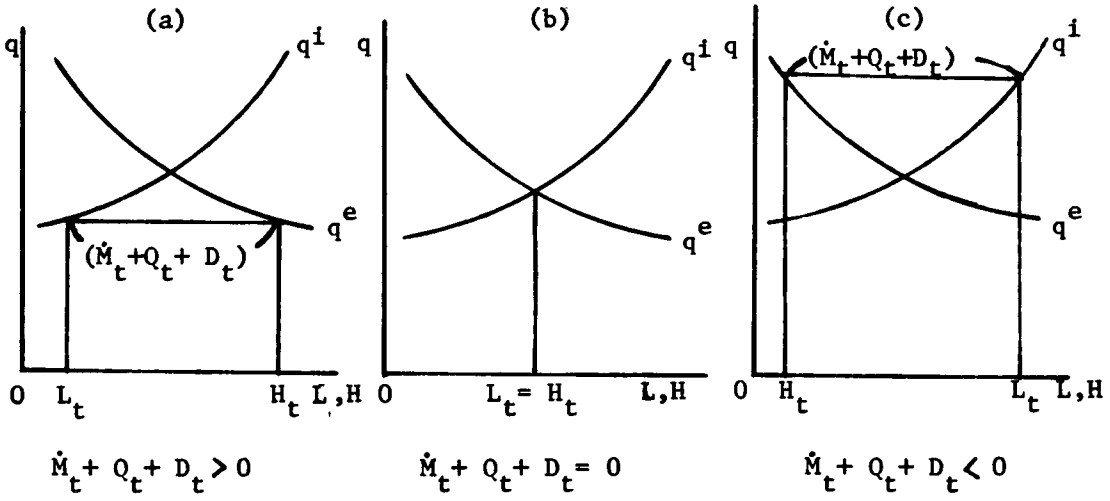
d_t ; discharge rate in period t

The identity (3·7·1) can be written as (3·8)

(3·8) $$L_t = H_t - (\dot{M}_t + Q_t + D_t)$$

This shows that layoffs will be the difference between hires and the aggregate numbers in the parenthesis. If the sum of the $\dot{M}_t$, Q_t and D_t is positive, then L_t will be the difference between H_t and $(\dot{M}_t + Q_t + D_t)$. If the sum is zero, i.e., the expected quit and discharge are equal to the decrease in the work force ($-\dot{M}_t = Q_t + D_t$), L_t will be equal to H_t. However, if the sum is negative, i.e., negative $\dot{M}_t$ exceeds $Q_t + D_t$, then L_t will be larger than H_t by the difference between $\dot{M}_t$ and $Q_t + D_t$. These three cases are shown in Figure 3. In the typical downturn of business, the case like (c) will be dominant. But the other two cases may also be relevant in the overall business cycles.

Figure 3. Relationship among Layoffs, Change in Work force, Quits, Discharges and Hires



$\dot{M}_t + Q_t + D_t > 0$ $\dot{M}_t + Q_t + D_t = 0$ $\dot{M}_t + Q_t + D_t < 0$

The quit rate in period t, q_t, is assumed to be a function of the wage rate of the firm, W_t, and opportunity wage rate elsewhere, W_t^o. It is assumed in this study that the quit function is known to the firm.

(3·9) $$q_t = q\ (W_t,\ W_t^o),$$

where $q_w < 0$, $q_{wo} > 0$.

The cost of production of X and I, and of labor turnover management can be divided into three parts:

(1) labor cost

(2) hiring cost

(3·10) $$C_t = C\ (H_t)$$

where $C_H > 0$

(3) layoff, specific human capital investment, and "search" costs

(3·11) $$Z_t = Z\ (L_t,\ T_t,\ S_t)$$

where $Z_L,\ Z_T,\ Z_S > 0$.

It is assumed that the marginal costs of labor turnover and investment in skill remain unchanged over time.

Therefore

(3·12) $$\text{Total Cost} = w_tM_t + C_t + Z_t$$

$$= w_tM_t + C(H_t) + Z(L_t,\ T_t,\ S_t)$$

$$= w_tM_t + C[\dot{M}_t + (\ell_t + q_t + d_t)M_t] + Z(\ell_tM_t,\ T_t,\ S_t)$$

The cash flow of the firm in period t, R_t , is

(3·13) $$R_t = P_tX_t - w_tM_t - C_t - Z_t$$

where P_t is the market price of good X in period t.

Substituting (3·1), (3·3), (3·5), (3·6),(3·7·2),(3·9) and (3·12) into (3·13).

$$(3\cdot14)\qquad R_t = P_t F(\phi_t M_t) - w_t M_t - C(H_t) - Z(L_t, T_t, S_t)$$

$$= P_t F\left[\phi\{\ell_{t-1}M_{t-1},\ K_t,\ \Omega(\dot{M}_{t-1} + (\ell_{t-1} + q_{t-1} + d_{t-1})M_{t-1},\ S_{t-1}]\}\ M_t\right]$$

$$- w_t M_t - C\left[\dot{M}_t + (\ell_t + q_t + d_t)M_t\right] - Z(\ell_t M_t,\ T_t,\ S_t)$$

Since investment in specific human capital requires at least one period of production (training) time, it is assumed that the optimization of the firm is done in two periods. The present discounted value of the cash flow in two periods, R^*, will then be

$$(3\cdot15)\quad R^* = \sum_{t=i}^{i+1} \Big\{ P_t F\left[\phi\{\ell_{t-1}M_{t-1},\ K_t, \Omega\left[\dot{M}_{t-1} + (\ell_{t-1} + q_{t-1} + d_{t-1})M_{t-1},\right.\right.$$

$$\left.\left. S_{t-1}]\}\ M_t\right] - w_t M_t - C\left[\dot{M}_t + (\ell_t + q_t + d_t)M_t\right] - Z(\ell_t M_t,\ T_t,\ S_t)\Big\}\ \delta^{t-i}$$

where $\delta = \frac{1}{1+r}$, r; market interest rate. The aim of the firm is now to maximize R^*. The optimum conditions of maximizing R^* for several variables under the firm's control can be drawn from (3·15) by partially differentiating it with respect to these variables. This paper, however, is concerned with the layoff behavior of a firm, and only the optimum condition of layoff rate will be presented in the main body of the study. The conditions for w_t, T_t and S_t will be given in the footnote. Those for M_t and $\dot{M}_t$ will be given in the Appendix A with the assumptions of infinite periods and continuous function.

The optimum condition for maximizing R^* with respect to ℓ_i is

$$(3\cdot16)\quad \frac{\partial R^*}{\partial \ell_i} = P_{i+1} \frac{dF}{d(\phi_{i+1}M_{i+1})}\left[\frac{\partial \phi}{\partial L_i} M_i + \frac{\partial \phi}{\partial \Omega_{i+1}} \frac{\partial \Omega}{\partial H_i} M_i\right] M_{i+1}\delta$$

$$- C_H M_i - Z_L M_i = 0, \quad \text{where } C_H = \frac{dC}{dH_i} \text{ and } Z_L = \frac{\partial Z}{\partial L_i}.$$

It is noted that the costs of layoff and hire do not incur in period i+1. It is of no use for the firm to lay off workers in the second period since this only affects quality in period i+2.

(3·16) can be written as

$$(3\cdot17)\qquad P_{i+1}\,\frac{dF}{d(\phi_{i+1}M_{i+1})}\left[\frac{\partial\phi}{\partial L_i}+\frac{\partial\phi}{\partial\Omega_{i+1}}\frac{\partial\Omega}{\partial H_i}\right]M_{i+1}\,\delta = C_H + Z_L$$

or

$$(3\cdot18)\qquad P_{i+1}F_{(\phi M)i+1}(\phi_{Li}+\phi_{\Omega i+1}\ \Omega_{Hi})M_{i+1}\,\delta = C_H + Z_L$$

where $F_{(\phi M)i+1}=\dfrac{dF}{d(\phi_{i+1}M_{i+1})}$, $\phi_{Li}=\dfrac{\partial\phi}{\partial L_i}$, $\phi_{\Omega i+1}=\dfrac{\partial\phi}{\partial\Omega_{i+1}}$, $\Omega_{Hi}=\dfrac{\partial\Omega}{\partial H_i}$ and

$\Omega_{Hi} < 0$ by (3·6).

The condition (3·18) states that the marginal net benefit of layoff and subsequent hiring in both markets must be equal to the marginal costs of layoff and hire.[1] Note that the second term on the left hand side is negative. Note also that H_t varies when L_t changes in such a way that the employment level remains unchanged.

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[1] The optimum condition for maximizing R^* with respect to w_i is $\dfrac{\partial R^*}{\partial w_i}=0$, i.e.,

$$(3\cdot18\cdot1)\qquad P_{i+1}F_{(\phi M)i+1}\phi_{\Omega i+1}\ \Omega_{Hi}q_{wi}M_{i+1}\,\delta = 1 + C_H q_{wi}$$

where $q_{wi}=\dfrac{\partial q}{\partial w_i}$.

The optimum condition for maximizing R^* with respect to T_i is $\dfrac{\partial R^*}{\partial T_i}=0$, i.e.,

$$(3\cdot18\cdot2)\qquad P_{i+1}F_{(\phi M)i+1}\phi_{Ki+1}\ I_{Ti}M_{i+1}\,\delta = Z_T$$

where $\phi_{Ki+1}=\dfrac{\partial\phi}{\partial K_{i+1}}$, $I_{Ti}=\dfrac{dI}{dT_i}$ and $Z_T=\dfrac{\partial Z}{\partial T_i}$

Note that an increase in training (I) in period i raises specific human capital K in period i+1. The optimum condition for maximizing R^* with respect to S_i is $\dfrac{\partial R^*}{\partial S_i}=0$, i.e.,

$$(3\cdot18\cdot3)\qquad P_{i+1}F_{(\phi M)i+1}\phi_{\Omega i+1}\ \Omega_{Si}M_{i+1}\,\delta = Z_S$$

where $\Omega_{Si}=\dfrac{\partial\Omega}{\partial S_i}$, $Z_S=\dfrac{\partial Z}{\partial S_i}$.

The conditions (3·18·1), (3·18·2) and (3·18·3) indicate that the marginal benefits of changing w_i, T_i and S_i must be equal to the marginal costs of changing these variables.

The first term, $P_{i+1}F_{(\phi M)i+1}\phi_{Li}M_{i+1}\delta$, is the discounted value marginal product of layoff in the internal market. The second term on the left hand side, $P_{i+1}F_{(\phi M)i+1}\phi_{\Omega i+1}\Omega_{Hi}M_{i+1}\delta$, is the discounted value marginal product of hire. This particular hire is of course conditioned by layoff. Note that pairwise comparisons of (ratio of) any two conditions out of (3·18), (3·18·1), (3·18·2) and (3.18.3) give optimum conditions for choosing those 2 variables compared.

Now the condition (3·18) can be rewritten as

(3·19) $\quad VMP^i = VMP^e + C_H + Z_L$, or

(3·20) $\quad VMP^i = VMP^{e*}$

where VMP^i ; discounted value marginal product of layoff in the internal labor market.

VMP^e ; discounted value marginal product of hire in the external labor market.

VMP^{e*} ; VMP^e adjusted by C_H and Z_L

The same condition (3·20) is more revealing. It states that, other things being held constant, the value marginal product of layoff in the internal labor market must be equal to the value marginal product of hire in the external market adjusted by the relevant layoff and hiring costs.

It is now clear that q^i and q^e curves in the panel[1] in Figure 3 must be replaced by VMP^i and VMP^{e*}. This is shown in Figure 4. VMP^i is upward sloping and VMP^{e*} is downward sloping curves. There must be an intersection of the two curves because $\phi_{Li} > 0$ and $\phi_{\Omega i+1}\Omega_{Hi} < 0$ ($\phi_{\Omega i+1} > 0$, $\Omega_{Hi} < 0$). If the equilibrium occurs at an intersection, point $L_t = H_t$,

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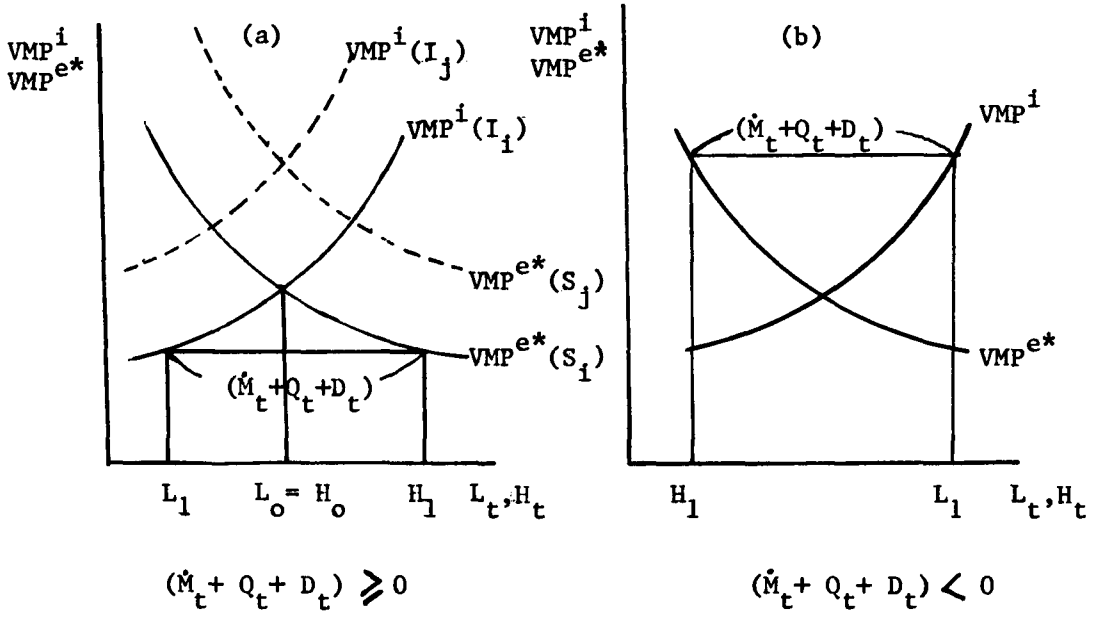
[1] q^i and q^e were used in Figure 3 to show the relationship among L, H, $\dot{M}$, Q and D.

$(\dot{M}_t + Q_t + D_t)$ is zero. If the sum of $\dot{M}_t$, Q_t and D_t is greater or less than zero, L_t will deviate from H_t as is shown in Figure 4. In

Figure 4. Value Marginal Products of Layoff and Hire



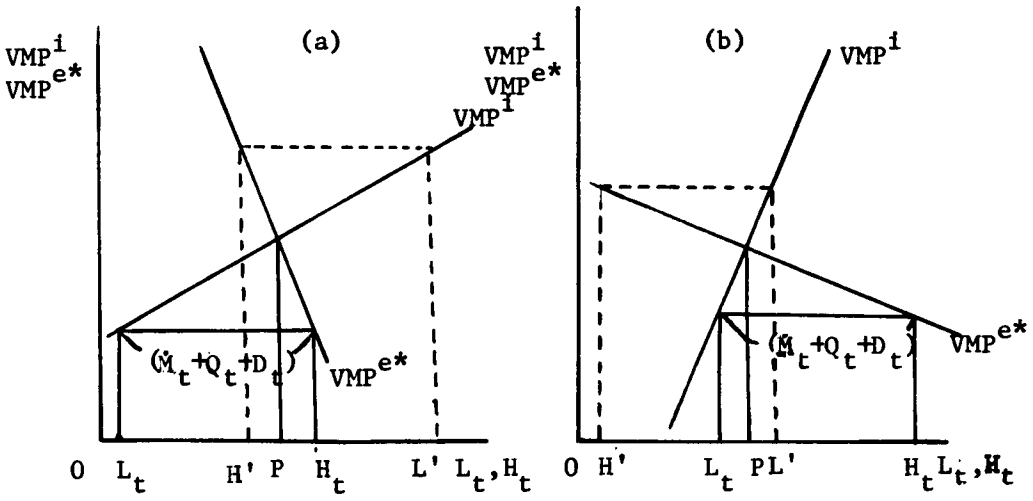
$(\dot{M}_t + Q_t + D_t) \geqslant 0$ $\qquad$ $(\dot{M}_t + Q_t + D_t) < 0$

the panel the cases of $\dot{M}_t + Q_t + D_t \geqslant 0$ are shown in (a) and the case of $\dot{M}_t + Q_t + D_t < 0$ is illustrated in (b).

It is noted that one can draw families of curves for both markets if one allows for I_t and S_t to change. In other words, $VMP^i(I_i)$ will move up to $VMP^i(I_j)$ in the internal market if the firm invested a greater amount of specific human capital in the previous periods. This will cause L_t and accordingly H_t to fall, when $\dot{M}_t$, Q_t, and D_t are held constant. In the external market, $VMP^{e*}(S_i)$ will move up to $VMP^{e*}(S_j)$ if the firm searches more, ceteris paribus, and this will result in more L_t and H_t.

In two diagrams in Figure 5, several interesting cases of the relationship between two labor markets are illustrated. Figure 5(a)

Figure 5. Value Marginal Products of Layoff and Hire with Different Labor Market Conditions



shows the contrasting elasticities of the workers' quality with respect to L_t and H_t. It can be said that the elasticities are relatively "high" in the external but "low" in the internal market. Put differently, VMP^{e*} drastically drops in the external market when H_t increases, whereas VMP^i very slowly increases in the internal market. Due to this very "low" elasticity in the internal market, most of $\dot{M}_t + Q_t + D_t$ is absorbed by L_t and reflected by the large decreases in L_t from the point P where $\dot{M}_t + Q_t + D_t = 0$ (compare PL_t and PH_t). This may well be the case we find in the general expansion of business activities including the very firm under discussion. In such case, the increase in work force will most likely to be met by the decrease in layoff because of the tight external

labor market condition.[1] Figure 5 (b) shows exactly the opposite situation.

In Figure 5, the cases where $(\dot{M}_t + Q_t + D_t)$ is positive, i.e., the expansion phase of a firm, were illustrated. But it is a contraction phase that is more interesting and relevant for layoff. In such condition, as shown in Figure 5 (a) and (b) with the dotted lines, any increase in absolute sum of $(\dot{M}_t + Q_t + D_t)$ is mainly absorbed by the increase in L_t in the case of (a) and H_t in the case of (b).

According to this model, the investment in specific human capital (I_t), through K_{t+1}, and "search" of the firm (S_t) certainly play an important role in the internal and external labor markets, respectively. Recall that they cause VMP curves to shift in each market. In this respect, they help explain a firm behavior on labor turnover and consequently on layoff. Layoff can now be explained not only in terms of one variable,but in terms of closely related labor turnover option variables.

Total specific human capital (investment), I, is appeared in the model as the sum of I_w and I_F. Total specific human capital as a stock,[2] K, is obviously the sum of worker-financed (K_w) and firm-financed specific human capital (K_F). It is assumed in this study that the relationship between K_w and K_F is positively associated, i.e.,

$$K_w = h_o + h_1 K_F \ , \ h_1 > 0. \tag{3·21}$$

Insofar as (3·21) is assumed, total specific human capital (K) is sufficient

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[1] The downward or upward adjustment of the criteria for layoff, discharge, and hiring is widely acknowledged phenomena in the literature. The downward adjustment is sometimes called labor 'dilution'. See Reder, Melvin, "Wage Structure and Structural Unemployment," Review of Economic Studies, (October, 1964), p. 312.

[2] I am grateful to Professor Galatin for his comment on this.

to play a role in the model. However, K_w and K_F should be treated separately and the wage function defined by K_w and general training must be employed, in order to test the specific human capital hypothesis with available data. This is shown below.

The specific human capital theory implies that layoff (L) is negatively related to K_F. This can be written as

$$L = a - b_1 K_F \tag{3·22}$$

Given the firm-financed specific human capital data, one can test this hypothesis directly. But they are not available for empirical study yet. The way that this hypothesis can be tested indirectly is to utilize available data such as wage rate and education. Since wage rate (W) is usually defined as a function of worker-financed specific human capital (K_w) and general human capital (G), the relationship between K_w and K_F must be specified to substitute W and G into (3·22) through K_w.

Let the wage function be

$$W = b_2 K_w + b_3 G. \tag{3·23}$$

Then by substituting (3·21) into (3·23)

$$W = b_2 h_o + b_2 h_1 K_F + b_3 G \tag{3·24}$$

and

$$K_F = -\frac{h_o}{h_1} + \frac{1}{b_2 h_1} W - \frac{b_3}{b_2 h_1} G . \tag{3·25}$$

Substituting (3·25) into (3·22),

$$L = h^* - \frac{b_1}{b_2 h_1} W + \frac{b_1 b_3}{b_2 h_1} G, \tag{3·26}$$

where $h^* = a + \frac{b_1 h_o}{h_1}$.

Therefore

$$\frac{\partial L}{\partial W} = -\frac{b_1}{b_2 h_1} < 0 \tag{3·27}$$

(3·28) $$\frac{\partial L}{\partial G} = \frac{b_1 b_3}{b_2 h_1} > 0$$

(3·27) and (3·28) state that the wage rate is negatively related to layoff rate if general training is held constant and that general training is positively related to layoff rate when the wage rate is fixed. If there is any evidence that years of education (E) can be treated as a proxy for total general training, (3·27) and (3·28) can be stated with respect to W and E too. However, there must be some reservations in assuming education (E) as a proxy for general training (G).

If G is defined as a function of formal education (E) and all other general trainings (G^*), i.e.,

(3·29) $$G = a_1 E + a_2 G^*, \quad a_1, a_2 > 0$$

then (3·23) becomes

(3·30) $$W = b_2 K_w + b_3 G$$
$$= b_2 K_w + b_3 a_1 E + b_3 a_2 G^*.$$

Then by substituting (3·21) into (3·30)

(3·31) $$W = b_2 h_o + b_2 h_1 K_F + b_3 a_1 E + b_3 a_2 G^*$$

and

(3·32) $$K_F = -\frac{h_o}{h_1} + \frac{1}{b_2 h_1} W - \frac{b_3 a_1}{b_2 h_1} E - \frac{b_3 a_2}{b_2 h_1} G^*.$$

By substituting (3·32) into (3·22),

(3·33) $$L = h^* - \frac{b_1}{b_2 h_1} W + \frac{b_1 b_3 a_1}{b_2 h_1} E + \frac{b_1 b_3 a_2}{b_2 h_1} G^*.$$

The equation (3·33) states that if E and G^* are held constant, the increase in W lowers layoff rate, and that if W and G^* are held constant, the increase in E raises layoff rate. But if G^* is not held constant in both cases, then the results may not be obvious.

General trainings other than formal education, G^*, in (3·33) enables to introduce several related variables in the empirical study since G^* can be defined as a function of factors such as general on the job training, percentage of professionals, percentages of workers with different ages, sexes, etc. If G^* is general on the job training and it has a systematic relationship with specific training, the coefficient signs of wage rate and education variables in the layoff rate regression without holding G^* constant might be ambiguous. If G^* is not held constant, then

$$(3\cdot34) \qquad \left.\frac{dL}{dW}\right|_{\bar{E}} = -\frac{b_1}{b_2 h_1} + \frac{b_1 b_3 a_2}{b_2 h_1}\frac{dG^*}{dW}$$

$$(3\cdot35) \qquad \left.\frac{dL}{dE}\right|_{\bar{W}} = \frac{b_1 b_3 a_1}{b_2 h_1} + \frac{b_1 b_3 a_2}{b_2 h_1}\frac{dG^*}{dE}.$$

In (3·34), if $\frac{dG^*}{dW} < 0$, i.e., if general on the job training varies inversely with specific training (in this case the increase in wage rate is solely due to the increase in specific training since E is held constant), then $\frac{dL}{dW} < 0$. But if $\frac{dG^*}{dW} > 0$, the sign of $\frac{dL}{dW}$ is ambiguous. In (3·35), if $\frac{dG^*}{dE} > 0$, then $\frac{dL}{dE} > 0$, but if $\frac{dG^*}{dE} < 0$, then the sign of $\frac{dL}{dE}$ is also ambiguous.

2. Comparison with Other Models

There have been important studies and surveys on layoff behavior or on labor turnover phenomena in general in the past decades. In earlier days most studies have been carried out in the institutional perspective. It was not until very recent years that layoff and its related subjects have been dealt with in the neoclassical framework. Some of the important studies in these fields are; Slichter (1919), Brissenden and Frankel (1922), National Industrial Conference Board (1930), Lester (1950), Slichter et al. (1960), many Bureau of Labor Statistics studies, Becker (1962, 1964),

Parsons (1970, 1972, 1973), Pencavel (1972) and Landes (1973).

The present model differs from others in several points.

One feature of this model that differs from the existing ones is that each one of the major variables relevant to the firm's layoff decision is included and each of them plays its own role in the model. The decision variables for layoff other than employment level and its change are; investment in specific human capital, wage rate, and the condition of the external labor market or "search". These variables are posited in such a way as to affect either the workers' qualities in the internal or external labor markets or layoff directly, by making use of the two following basic assumptions. First, the firm is able to subjectively evaluate workers' qualities and, second, a firm tries to maintain the best qualified workers available.

The importance and various applicabilities of any one of these variables as an option to the labor turnover management, including layoff itself, depend on the situation a firm faces. Put differently, a firm can use different combinations of decision variables under different circumstances. This model, of course, allows for pairwise comparisons of optimum conditions of any two decision variables.

Another important difference is that this model predicts different coefficient signs for wage and education variables in the layoff regression from Parsons (1970, 1972).

Parsons, following the specific human capital hypothesis, predicted these signs as positive for wage rate and negative for education in his layoff regressions, and obtained the expected signs by using 1959 and 1963 cross section data. He, then, concluded that the specific human capital hypothesis was confirmed empirically.

However, two things can be demonstrated in a comparison of his prediction with mine. First, it can be shown that the prediction he put forward is not derived directly from the specific human capital hypothesis. In other words, this hypothesis does not necessarily predict those signs he expected. As mentioned above, the signs he predicts are a positive coefficient of the wage rate and a negative coefficient of education in the layoff regression. He predicted the signs only because he had his own implicit assumption which can be either one way or the other. The assumption is about the relationship between firm-financed and worker-financed specific human capital. Therefore, an equally plausible assumption will result in opposite prediction. As was shown in (3·21), I assume that firm-financed and worker-financed specific capitals are positively related , i.e.,

$$K_w = h_o + h_1 K_F \quad , \quad h_1 > 0. \tag{3·36}$$

Parsons assumes that they are negatively related, i.e., $h_1 < 0$. He was not explicit about this condition, but he seemed to assume

$$K_w = h_o + h_1 K_F, \quad h_1 < 0 \tag{3·37}$$

because he treated total specific human capital being fixed, i.e., $K^* = K_w + K_F$, K^* = constant.[1] It must be emphasized that the coefficient signs are not directly founded on the specific human capital hypothesis.

In conclusion, one proposition can be established: the coefficient signs of the wage rate and the education variables in a layoff regression depend on the assumption of the following relationship between K_w and K_F.

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[1] See Parsons, Donald O., "Specific Human Capital: An Application to Quit Rates and Layoff Rates," Journal of Political Economy, (November/December, 1972) pp. 1132 - 1136.

If they are positively related, $\overset{(-)}{W}$, $\overset{(+)}{E}$; but if they are negatively related, $\overset{(+)}{W}$, $\overset{(-)}{E}$.[1]

Second, it can be argued that the assumption of a positive correlation between K_W and K_F is more plausible than that of a negative correlation which Parsons made use of. I now turn to this question. The assumption of posotive relationship implies that an increase in investment in specific skill of one party (either firm or worker) will be accompanied by the other party's increase. In deciding investment in specific training a firm or a worker must take the expected length of employment into account. Since such an investment is basically an investment in human body, the unexpected termination of employment, i.e., quit or layoff, will hurt one party which does not originate the separation. A firm will find it more profitable to finance a worker who has more worker-financed specific training. For a worker, the opposite case will hold. Furthermore, a worker will find himself more vulnerable to be laid off if he overinvests in specific skill. This is because, when other things are held constant, he is the man who would have the highest chance to be retained in a unemployment pool if he was laid off. For the part of the firm, the overinvestment of firm-financed specific skill to a certain worker will weaken its bargaining position, whatever the content of the bargaining with the worker may be.

The observations described above suggest that the finance of such an investment will most likely be bilateral. They also imply a stable cost sharing, although the cost sharing scheme of different industries

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[1] I am indebted to Professor Grossman for his resolution on the contradicting predictions.

need not be the same. Therefore under ordinary situations one can expect that firm-financed and worker-financed specific skill be positively related.[1] Several other minor points could be touched on too.

This model differs from Parsons' in the indetermination problem in selecting the employees to be laid off. Since Parsons is mainly interested in the different layoff effects on "raw" and trained workers in the line of a specific human capital hypothesis, he understandably assumed the homogeneity of each worker group (his S_{1t} = trained workers, and S_{2t} = new entrants). This would give rise to an indetermination problem if a certain number of, not all of, workers in either S_{1t} or S_{2t} were to be laid off. The present model does not suffer from indetermination problem.[2]

His model explicitly treats layoff-rehire cycle and retention factors, they are not explicitly dealt with in the current model. However, the workers laid off occupy the positions of higher quality workers in the external labor market and receive favorable hiring policy (=recall) in this model too.

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[1]It seems that Parsons does not deviate from the above observations either. He writes "The sharing of such investments by worker and firm is likely to make the investments more profitable, since each can be more sure the other will not unilaterally sever the partnership by layoffs and quits." See Parsons, Donald O., op. cit., 1972, p. 1122.

[2]See the argument relating to this in II-2-1).

CHAPTER IV

THE ESTIMATIONS OF THE MODEL USING TIME SERIES AND CROSS SECTION DATA

1. Introduction

The empirical study is pursued along two broad lines. First, the model is estimated using time series and cross-section data in this Chapter. Second, applications of the hypothesis to closely related labor market behavior such as changes in worksharing attitudes, rehire vs. new hire behavior of the firm, and male-female layoff differentials is dealt in Chapter V.

In each section, the implication of the basic model for the point under consideration will be discussed briefly and relevant variables and empirical proxies will be presented. The regression equation will be specified and the argument for the expected behavior of each variable will be given. The nature and sources of data will be described, then the regression results will be presented and examined with respect to expected performance.

2. Layoff Rates Over Time, January 1958- December 1973

1) Empirical Formulation of the Model

According to the model presented so far, the relevant variables for the layoff rate regression are basically those which represent investment in specific human capital, the condition of the external labor market or "search", quit rate (or wage rate), discharge rate, and change in the employment level. Inventory can be included in this list too.

As mentioned previously, specific human capital investment and "search" determine particular VMP^i and VMP^{e*} curves of workers in each internal and external labor market within the potential families of curves (see Figure -4). The decisions on discharge, changes in employment level, quit rate manipulation, and real inventory, together with the conditioning variables of both labor markets as described, K and S, will determine the desired number of layoffs for a firm. I can write this fuctional relationship as

$$(4\cdot1) \qquad L = f\left[\, q(W\ ,\ W^{o}),\ K_F,\ D+\check{M},\ S,\ INVN \,\right]$$

where INVN is real inventory. This is the basic equation used in the layoff rate regressions.

I specify the regression equation as (4·2),

$$(4\cdot2) \qquad \begin{aligned} LOFF = {} & a_o + a_1 HWRATM + a_2 HWNET + a_3 OWNWRAT + a_4 DN \\ & + a_5 LDN1 + a_6 UNEM + a_7 UNEML1 + a_8 INVN \\ & + a_9 RWD + a_{10} TD \end{aligned}$$

The first three variables are wage-related variables. The real wage rate of the firm (or industry) divided by that of total manufacturing , HWRATM, is used as the independent variable which explains quit rates. The reason is that the wage rates appearing in the quit function must relate the wage rate of the firm to the general or average wage rate, for this is apt to be one of the factors in a quitter's mind. Wage rate of total manufacturing is used as an opportunity wage rate. The sign of a_1(HWRATM) is expected to be positive because HWRATM is negatively related to quit rate and quit rate is negatively related to layoff rate, i.e.,

$$\underset{(-)}{\frac{\partial LOFF}{\partial q}} \quad \underset{(-)}{\frac{\partial q}{\partial HWRATM}} > 0.$$

Although the quit function in the model does not include any term from the demand side, job opening and help wanted variables for total manufacturing were tried as the quit-related variables. They were not found to have any effect, probably because of the poor quality of the data, and were dropped from the regressions.

As in the studies of Oi and Parsons, wage rate was adopted as a proxy for the specific human capital variable.[1] The absence of an adequate proxy for this variable necessitates this. The presumption here is that wage rate is closely related to firm-financed specific training. One must note, however, that wage rate consists of two parts, namely worker-financed specific training and general training. Therefore, using wage rate as a proxy for firm-financed specific training comes down to saying that the level of firm-financed specific training is directly related to the level of worker-financed specific training, if the level of general training remains stable.[2]

In the regression equation I used straight hourly wage rate adjusted by consumer price index (HWNET), and changes in the own wage rates between periods t-1 and t (OWNWRAT). OWNWRAT was included to capture the effect of the immediate change in specific human capital from t-1 to t period on layoff rate. It must be pointed out that some of variation in HWNET and OWNWRAT may be due to business cycle (wage rate rises in an expansion and falls in a contraction). To the extent that other variables do not fully

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[1]See Oi, Walter Y. "Labor as a quasi-fixed factor," Journal of Political Economy, (December, 1962), p. 454, and Parsons, Donald O., op. cit., 1970, pp. 17-21.

[2]See p. 46 for the relationship among worker-financed specific training (K_w), formal education (E), and general training other than E (G^*) with respect to layoff rate.

capture business cycle effect, HWNET and OWNWRAT may capture it. Since layoffs are countercyclical, one may observe a negative relationship between layoff and the wage variables. Note that there are proxies for demand fluctuations over business cycle such as employment change, unemployment rate, trough dummy, and inventory. The expected signs of the coefficients of HWNET and OWNWRAT are negative.

The fourth and fifth variables are; (a) the sum of the discharge rate and the rate of employment changes from t-1 period to t period, DN, and (b) the one period lead of DN, LDN1. Quit rate is not included in DN and LDN1 because HWRATM is expected to play the necessary role. LDN1 appears in the regression equation since a firm lays off workers in anticipation of demand decline. This anticipation in layoff is consistent with the specific human capital hypothesis. The Department of Commerce[1] also classifies layoff rate as a leading indicator of business cycles.[2] The same variables with more than two month leads were tried but found insignificant and deleted. The signs of the coefficients of DN and LDN1 are expected to be negative.

As a proxy for the external labor market or "search", the unemployment rate of each industry, UNEM, was used. The implicit assumption in this choice is that first, a firm will rely on this variable as a

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[1]See Department of Commerce, Business Conditions Digest, (March, 1974) p. 20.

[2]Note that to treat LDN1 being a lead is the same as if (3·7) in Chapter III was defined as $(3\cdot7)^*$ $M_t = M_{t-1} + H_t - (L_t + Q_t + D_t)$. The behavior of a firm is not expected to be different from one way or the other by assuming either (3·7) or $(3\cdot7)^*$. In the empirical study, N(or $\dot{M}$) is defined as the change in employment between t-1 and t periods.

good indicator of the condition of the external labor market, and second, it has a high (negative) correlation with the cost of "search". By using UNEM as a proxy for "search" on the empirical level, the possible problem of dependency between changes in employment ($\dot{M}$ or NCHAN) and "search" can be eliminated because the source of the change in UNEM is quite independent of $\dot{M}$ of this particular firm's employment level. The sign of the coefficient of UNEM is expected to be positive since

$$\frac{\partial LOFF}{\partial S} \quad \frac{\partial S}{\partial Z_s} \quad \frac{\partial Z_s}{\partial UNEM} > 0.$$

$$(+) \quad (-) \quad (-)$$

Put differently, I expect the sign of a_6(UNEM) to be positive because a firm tends to do more laying off if it worries less about losing good workers and if it sees better chances of replacement due to lower "search" cost.

But the unemployment rate of the previous period, UNEML1, is expected to have a different effect on layoff. The situation would be the same as the effect the current (t) external labor market condition would have on the layoff of the following period (t+1), if period t+1's market condition were held constant. If the unemployment rate of period t increases, and that of period t+1 is held constant, the layoff of period t will increase and, ceteris paribus, the layoff of period t+1 will decrease. Therefore the sign of a_7 (UNEML1) is expected to be negative.

The real inventory variable (INVN) was included in the regression, but the sign of a_8 (INVN) is expected to be ambiguous. The reasons are as follows. If inventory is a subtitute for output, then the increase in inventory will have the same effect on labor as output expansion, resulting

in a negative correlation to layoff. But if it is a substitute for labor input, then it will be positively related to layoff. There is no a priori reason to maintain that one is stronger than the other.

To control cyclical effect, two dummy variables were used. The reduced work dummy, RWD, is defined such that it takes 1 when an observation has shorter weekly hours of work than the standardized weekly hours which is based on a 7-year moving average of average annual weekly hours; otherwise it takes 0. This dummy variable is necessary because first, layoffs occurred during almost every month in the industry data, and second, all the observations were included in the regression regardless of the state of the business cycle. Trough dummy, TD, is for the same purpose but it captures the extreme effect of trough on layoff. Along the same lines, peak dummy was tried but found insignificant. The signs of a_9(RWD) and a_{10}(TD) are expected to be positive.

In addition to the explanation on every variable in the formulation, a couple of points about union effect on layoffs should be mentioned here. The basic model was developed under the assumption of no-union in the firm. But as is shown in Table 3 on page 60, the degree of unionization of the data industries are fairly high. If there is a union contract, this affects the behaviors of workers as well as the management. This might cause more isolation between the internal and the external labor market. As a result the firm might be forced to discount the workers' quality in the external labor market more heavily. This would in turn lead to less layoffs. In a union contract, the most important thing to be considered for both workers and the management with respect to layoffs is the seniority right because the workers who have higher seniority can bump the positions of lower workers.[1] Since the seniority consideration

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[1]See pp. 22-23 for the seniority right and "bumping".

involves administrative costs for transfer or "bumping", the firm tends to reduce layoffs in this respect. The union contract and the seniority right, however, can guarantee the preferential recall of laid-off workers when demand increases. So workers in the highly unionized firms (or industries) may prefer layoff to worksharing[1] or wage cut.

There is another point which reduces union impact on a firm's layoff behavior. If a firm takes the seniority right into account in the decision making of layoff, it does not deviate very much from the expected decision which the specific human capital hypothesis would predict because one can interpret seniority as a kind of index of specific human capital. It is likely that unionization has both positive and negative impacts on layoffs. In the light of the point mentioned above, it is difficult to conclude how does unionization affect the firm's layoff behavior. Furthermore, it is not expected that the major decisions of firms can be affected seriously by ignoring unionization. The union effect on layoff would obviously be less in the time series than in the cross section layoff regression.[2]

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[1]See V-1 for the definition of worksharing and the effect of change in worksharing attitude on layoff. In the section V-1, the evidence is shown to support the notion that the highly unionized industries experience a change in attitude against worksharing more often and do so earlier than less unionized industries.

[2]A union variable was tried in the cross section layoff regression, but it was deleted because of insignificance.

2) The Empirical Result

(1) Data

The monthly data from January 1958 to December 1973 (192 observations) are used in the regression. Since no good firm data are available, SIC 3 or mostly 4-dight manufacturing industry data are used. The industries were chosen so as to include at least one or two representatives from each of the SIC 2-dight manufacturing industries. I chose SIC 2-dight industries by their size of employment. If an industry was relatively large by number of employment in 1971, I chose two SIC 3-dight industries from the group covered by that industry and if it was relatively small, I chose only one. After SIC 3-dight industries were taken care of, I checked SIC 4-dight industries in each 3-dight industry. Any large and representative 4-dight industry in each 3-dight industry was also chosen. If there is no such industry, then the 3-dight industry was chosen as data industry. This process accounted for 28 SIC 3 or 4-dight industries. The number of workers covered by these industries is about 27 percent of total manufacturing in 1971.

The distribution of the degree of unionization of these 28 industries is shown in Table 3.[1] The distribution conforms fairly well to that of all manufacturing industries.

The data for number of employment, hourly wage rates, weekly hours of work, weekly hours of overtime work, industry unemployment rates and all labor turnover variables are from Bureau of Labor Statistics sources.[2]

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[1]The result of the 1970 Bureau of Labor Statistics survey on unions was used for this. See BLS, Directory of National Unions and Employee Associations 1971, Bulletin 1750, 1972, pp. 80-81.

[2]See Appendix E for the definitions of variables and the data sources.

TABLE 3

Distribution of the Degree of Unionization of Data Industries

Degree of Unionization(%)	Number of Industries
75 or more	8
50 - 75	12
25 - 50	4
25 or less	4

(2) The Empirical Results

Before examining the empirical results, brief consideration of some technical problems of regression is in order.

With regard to the method of regression, a question was raised whether there was any simultaneity problem between [HWRATM and HWNET] and layoff rate. Since it is likely that HWRATM and HWNET depend on layoff rate, simultaneity problem should be cautioned. If there is a simultaneity between them, then the ordinary least square method would not be adequate. I therefore ran both ordinary least square(OLS) and two stage least square (TSLS) with slightly different regression formulation. The results of five industries are given in Appendix C. There was no significant difference between the results of both OLS and TSLS. Therefore the ordinary least square method was adopted throughout the empirical studies.

The autocorrelation problem must be cautioned too. Autocorrelation alone does not generally give biased estimates of the coefficients a_1, a_2 ,..., a_{10}. The estimates of the variance of the estimators, however, can be seriously biased downward. The Student's t tests of significance in such cases will no longer be legitimate.

In this study, about half of the industries showed that there were autocorrelations of error terms. For those industries, linear first-order

autocorrelation was assumed and the autocorrelation of error terms was adjusted to have efficient estimates.[1]

The definition of the variables and the regression results are shown in Table 4 and Table 5. The summary of Table 5 is given in Table 6.

The results largely confirm the hypothesis. The coefficient of the quit-related variable HWRATM, the ratio of real wage rate of the industry and that of manufacturing, was expected to be positive and 23 industries (82%) out of 28 industries showed conformity. The number of industries which had the expected sign and were significant at the 95% level was 14, i.e., 50% in terms of total industries and 61% in terms of industries having the "right" signs. This supports the hypothesis that HWRATM affects layoff through the changes in quit rates. Specific human capital variables HWNET and OWNWRAT were expected to be negative and 21 (75%) and 24 (86%) industries showed the "right" signs respectively. Among them 14 (67%) and 17 (71%) industries were significant. One interesting interpretation from this empirical result is that this supports the postulate of a positive relationship between firm-financed and worker-financed specific human capital. In most cases, if general training remains fairly stable within an industry, real wage rate or ratio of real wage rates in periods t-1 and t must reflect the changes in worker-financed specific human capital, K_w. These are in turn expected to have negative signs in layoff regression only if they are positively related to the firm-financed specific training, K_F. If they are negatively related to K_F, they will have positive signs in the regression because layoff is basically negatively related to K_F.

There is another factor which reinforces this argument. Suppose a firm has to decide upon which one of two workers with all the same

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[1] For the adjustment procedure, see Frank, Charles F. Statistics and Econometrics, New York, Holt, Rinehart & Winston, Inc. 1971.

TABLE 4

Definition of Variables in Time Series

Layoff Regression

Variable Name	Definition
LOFF	Monthly layoff rates per 100 employees
HWRATM	Ratio of real straight hourly wage rate of an industry and that of total manufacturing
HWNET	Real straight hourly wage rate of an industry
DN	Sum of the discharge rate and the rate of employment change between periods t-1 and t per 100 employees
LDN1	One month lead of DN
UNEM	Unemployment rate in an industry (2-digit industry classification)
UNEML1	One month lag of UNEM
INVN	Real inventory
RWD	Reduced work dummy RWD = 1 if the standardized weekly hours of work exceeds weekly hours of work for the month = 0 otherwise
TD	Trough dummy, TD = 1 for trough months, =0 otherwise
OWNWRAT	Ratio of HWNETs in period t and t-1
WS[1]	Worksharing which is the ratio of standardized (by 7-year moving average) weekly hours of work and the weekly hours of work of the month
DESLOFF[1]	Desired layoff; actual layoff plus reduced layoffs
RNHIRRAT[2]	Ratio of rehire (recall) rate and new hire rate

1. Additional variable used in the worksharing analysis. See V-1.
2. Additional variable used in the rehire-new hire analysis. See V-2.

TABLE 5

Layoff Regressions of Time Series Data

Dependent Variable = LOFF
( ); t - statistics

SIC	HWRATM	HWNET	OWNWRAT	DN	LDN1	UNEM	UNEML1	INVN	RWD	TD	CONSTANT	R^2	DW
2011	9.383	-67.48	7.195	-.116	-.080	.019	.193	-4.816	.081	-.076	-10.93	.41	1.98
	(2.767)	(-1.237)	(1.966)	(-4.544)	(-3.037)	(.406)	(3.831)	(- .564)	(.754)	(-.411)	(-2.725)		
2051	2.726	48.75	-3.077	-.029	-.307	.073	-.058	-16.57	.108	-.003	1.002	.28	1.84
	(2.651)	(1.910)	(-3.131)	(-3.073)	(-3.788)	(4.055)	(-3.275)	(-2.424)	(2.818)	(-.041)	(.809)		
221	-3.380	1.447	-1.424	-.018	-.030	.020	.019	.031	.008	.147	1.991	.30	1.72
	(-3.038)	(.786)	(-1.465)	(-1.818)	(-1.716)	(1.755)	(2.017)	(.685)	(.288)	(2.767)	(3.783)		
225	17.94	-181.0	-11.93	-.139	-.090	.012	.022	-73.64	.028	.103	3.549	.42	1.63
	(5.309)	(-4.005)	(-6.447)	(-8.410)	(-4.625)	(.387)	(.679)	(-3.984)	(.324)	(.690)	(3.958)		
228	1.175	-312.1	-6.604	-.073	-.040	.043	.021	48.46	.176	.267	8.333	.66	1.91
	(.690)	(-7.801)	(-3.232)	(-4.540)	(-2.291)	(2.063)	(1.033)	(6.224)	(3.043)	(2.845)	(4.523)		
2321	5.625	-165.3	-2.766	-.005	-.005	.043	-.040	1.583	.167	.406	2.345	.48	1.52
	(3.501)	(-4.000)	(-5.261)	(-1.170)	(-1.332)	(2.382)	(-2.204)	(.053)	(2.821)	(3.792)	(2.102)		
2341	.425	-304.7	-15.00	-.190	-.044	.015	-.005	-83.86	.035	-.014	19.33	.64	1.96
	(.198)	(-7.631)	(-5.504)	(-12.99)	(-3.096)	(.592)	(-.215)	(-8.147)	(.430)	(-.096)	(7.743)		
2421	-7.583	-54.24	-8.370	-.105	-.121	.103	-.075	-3.545	.356	.072	11.03	.65	1.69
	(-3.086)	(-1.410)	(-5.330)	(-7.222)	(-6.902)	(2.602)	(-1.961)	(-1.772)	(5.148)	(.625)	(9.486)		
2511	4.705	133.1	-12.09	-.118	-.064	.061	-.012	-4.996	.269	.215	7.094	.62	1.80
	(1.669)	(.834)	(-4.888)	(-7.129)	(-4.038)	(1.596)	(-.309)	(-1.991)	(3.696)	(1.843)	(3.149)		

SIC	HWRATM	HWNET	OWNWRAT	DN	LDN1	UNEM	UNEML1	INVN	RWD	TD	CONSTANT	R^2	DW
261,2	-.070	-40.81	-.916	.000	-.000	.111	-.026	1.171	.039	.158	1.469	.40	1.75
	(-.057)	(-2.725)	(-1.159)	(.509)	(-.228)	(4.340)	(-1.081)	(1.610)	(1.077)	(2.715)	(1.469)		
2653	3.036	-36.13	-11.45	-.089	-.092	.066	-.005	-52.16	.257	.275	10.74	.61	1.68
	(1.978)	(-.896)	(-4.918)	(-5.084)	(-4.714)	(1.964)	(-.139)	(-1.791)	(3.353)	(3.375)	(4.373)		
2823	3.872	-154.7	-8.438	-.087	-.095	.071	-.005	19.65	.108	.338	7.540	.49	1.69
	(2.634)	(-4.141)	(-3.168)	(-3.081)	(-3.180)	(1.442)	(-.095)	(2.240)	(1.573)	(2.930)	(2.439)		
2834	.024	-23.44	-.856	-.005	-.059	.056	-.003	1.200	.072	.135	1.308	.41	1.87
	(.210)	(-1.607)	(-.709)	(-.390)	(-4.080)	(2.401)	(-.109)	(.275)	(2.235)	(2.530)	(.958)		
291	-.418	9.902	.092	.002	.000	.003	-.039	-3.460	-.018	-.019	.614	.20	1.90
	(-1.766)	(2.175)	(.794)	(.958)	(.195)	(.176)	(-1.991)	(-2.485)	(-.708)	(-.426)	(2.932)		
301	3.832	-129.0	.265	-.006	-.007	.109	-.051	40.39	.086	.451	-1.001	.39	1.91
	(3.425)	(-2.986)	(.271)	(-1.176)	(-1.502)	(2.502)	(-1.112)	(2.990)	(1.287)	(4.248)	(-.857)		
314	1.174	-60.29	-16.27	-.174	-.025	.052	.096	6.622	.188	.130	15.62	.45	1.63
	(.692)	(-.645)	(-8.663)	(-8.803)	(-1.175)	(.858)	(1.594)	(1.219)	(2.490)	(.909)	(6.871)		
3221	3.201	-152.0	-.466	-.001	-.008	-.307	.103	30.55	.198	-.208	.527	.86	1.85
	(.806)	(-1.259)	(.411)	(-.196)	(-1.590)	(-.469)	(1.376)	(1.309)	(1.574)	(-.899)	(.588)		
3312	15.75	276.4	9.567	.000	.000	.292	-.327	21.80	.757	.127	-18.03	.41	1.72
	(25.55)	(43.81)	(2.611)	(2.317)	(2.976)	(4.830)	(-5.715)	(1.697)	(4.660)	(.453)	(-6.136)		
3321	-1.454	-73.63	-7.055	-.059	-.070	.081	.031	-12.68	.611	.623	12.03	.61	1.79
	(-.378)	(-1.394)	(-4.450)	(-4.005)	(-3.799)	(2.092)	(-.822)	(-1.374)	(6.027)	(3.488)	(3.440)		
3443	4.357	218.1	-1.703	-.054	-.051	.051	.081	-62.69	.100	.117	-3.047	.61	1.75
	(2.306)	(5.042)	(-.960)	(-3.724)	(-3.324)	(2.042)	(.708)	(-5.070)	(1.590)	(1.097)	(-1.985)		

SIC	HWRATM	HWNET	OWNWRAT	DN	LDN1	UNEM	UNEML1	INVN	RWD	TD	CONSTANT	R^2	DW
346	9.789	-146.1	-8.994	-.133	-.106	.192	-.120	-71.34	.617	.598	5.654	.73	1.66
	(2.001)	(-4.252)	(-2.863)	(-5.375)	(-4.078)	(2.031)	(-1.289)	(-6.801)	(2-580)	(1.383)	(1.533)		
3531	4.960	-233.9	-9.531	-.096	-.077	.039	-.024	-1.603	.457	-.039	10.94	.38	1.48
	(.956)	(-4.711)	(-4.261)	(-5.045)	(-3.789)	(.663)	(-.501)	(-.819)	(2.650)	(-.136)	(1.766)		
3585	1.893	-422.6	-20.93	-.214	-.228	.158	.108	-6.239	-.036	.005	29.84	.66	1.70
	(.473)	(-3.226)	(-6.614)	(-7.174)	(-7.039)	(1.578)	(1.116)	(-.656)	(-.228)	(.016)	(5.397)		
3621	2.800	38.90	-.968	-.0003	-.021	.023	.065	-12.64	.356	.602	-.988	.31	1.83
	(1.196)	(.913)	(-.263)	(-.071)	(-1.443)	(-.485)	(1.396)	(1.426)	(3.633)	(3.588)	(-.396)		
3662	2.671	-79.61	-.027	-.039	-.203	.042	.046	6.658	.114	.194	-.491	.49	1.78
	(2.721)	(-2.032)	(-1.052)	(-3.261)	(-8.742)	(1.453)	(1.636)	(1.759)	(2.188)	(1.902)	(-1.519)		
3711	44.95	-586.6	-11.02	-.096	-.086	.425	-.919	12.47	.971	-.394	-31.47	.39	1.74
	(3.330)	(-2.706)	(-2.489)	(-3.459)	(-3.016)	(5.265)	(-2.479)	(1.855)	(1.748)	(-.396)	(-2.388)		
3721	4.237	-23.54	-2.956	-.046	-.174	.085	.013	-2.429	.096	.066	-.640	.54	1.89
	(3.300)	(-2.619)	(-3.491)	(-3.162)	(-6.928)	(3.751)	(.583)	(-1.746)	(1.506)	(.608)	(-.781)		
3821	2.716	-192.0	-7.074	-.048	-.133	-.002	.036	44.18	.081	.180	8.761	.51	1.90
	(2.266)	(-3.093)	(-2.814)	(-2.121)	(-5.002)	(-.046)	(.946)	(1.599)	(1.294)	(1.663)	(3.176)		

TABLE 6

Summary of the Time Series Layoff Regression Results;

Signs of the Coefficients of

the Independent Variables

No. of Ind. = 28

Independent Variables	Expected Signs	Number of Ind. Having Expected Signs (A)	(A)/28	Number of Ind. Having Expected Signs & Significant[1] (B)	(B)/28	(B)/(A)
HWRATM	+	23	.82	14(2)[2]	.50 (.07)[2]	.61
HWNET	-	21	.75	14(3)	.50(.11)	.67
OWNWRAT	-	24	.86	17(1)	.61(.04)	.71
DN	-	25	.89	19(1)	.68(.04)	.76
LDN1	-	26	.93	19(1)	.68(.04)	.73
UNEM	+	25	.89	14(0)	.50(0)	.56
UNEML1	-	15	.54	6(2)	.21(.07)	.40
INVN	?	15(-)[3]	.54(-)[3]	7(-)[3](3)	.25(-)[3](.11)	.47(-)[3]
RWD	+	26	.93	14(0)	.50(0)	.54
TD	+	21	.75	10(0)	.36(0)	.48

1. Significant at 95% confidence level ($t_{.975}$= 1.97).
2. ( )= Number of industries having opposite expected signs and significant.
3. Figures shown are for the industries having (-) signs.

characteristics (including K_F but <u>not</u> K_w) to lay off. In this case, the firm will most likely lay off the employee who has more K_w, because this worker is expected to wait longer in the unemployment pool in order to be recalled than the other. In other words, a worker with more K_w will be laid off more frequently, ceteris paribus. The fact that K_w is positively related to layoff but the actual coefficients of HWNET and OWNWRAT have negative signs indicates that the positive relationship between K_w and K_F must be strong. If K_w and K_F do not have a strong positive relationship, or if they are negatively related, then it will be difficult to expect HWNET and OWNWRAT to have negative coefficients. In the first case, the positive effect of K_w on layoff may cancel out the negative effect of K_F, and in the second case, both K_w and K_F will have a positive effect on layoff.

The sum of discharge rate and rate of employment change, DN, and its one-month lead, LDN1, behave highly consistently with respect to the predicted signs. Many of the industries also do so to a significant degree. 19 industries (76%) for DN and the same number of industries (73%) for LDN1 are significant among the 25 (89%) and 26 (93%) industries having predicted signs respectively. The performance of the LDN1 variable supports the classification of layoff as one of the leading business indicators.

Recall that discharge rate is positively related to layoff rate in the steady states and that the data used in this study have many more segments of steady states than high expansion or high contraction. Therefore one may attribute the sources of the negative signs of these two variables to the rate of employment change. This is not surprising because the magnitude of change in employment will in most cases exceed that of discharge.

The external labor market condition or "search" variable, UNEM, is expected to have a positive sign and 25 industries (89%) bore this out. Among them, 14 industries (56%) are "right" and significant. There is one possible objection to this sort of causal relation, i.e., from (high) unemployment rate to (high) layoff rate because a causal relation going the other way around is also conceivable. At the theoretical level, however, I can argue that this causal relation, from UNEM to LOFF, is very plausible. It is because, first, a firm does not basically want to lose the workers who are laid off and, second, it must weigh the possibility of replacement or recruitment in the near future when it lays off employees. In this regard, the external market condition is a very important factor, and logic seems to favor a causal relationship from UNEM to LOFF. At the empirical level, however, once the industry layoff rate and industry unemployment rate are used, it is difficult to identify how the causal relation runs.

For the UNEML1 variable, 15 industries (54%) show the expected sign and among these, 6 industries (40%) do so to a significant degree. These figures were slightly higher for regressions without the adjustment of the autocorrelation problem. They were 18 industries (64%) with predicted sign and 8 industries (44%) with both predicted sign and significance.

As was mentioned earlier, the expected sign of the coefficient of the real inventory variable, INVN, is ambiguous. The empirical results also show this. But it seems that INVN is more likely a substitute for output because in most industries it behaves negatively. Reduced work dummy, RWD, and trough dummy, TD, perform quite well.

3. Cross Section Analysis of Layoff, 1960 and 1970

1) The Regression Formulation of the Model

The cross section layoff regressions differ from the time series layoff regressions in several respects.

First, each industry is now a unit of observation. 72 different SIC 3 or 4-digit industries are used in the regressions. Second, each variable is presented in terms of the annual average of an industry instead of by month. Third, some variables like HWRATM, RWD, and TD in the time series regressions are no longer valid. This is because for HWRATM, the denominator, real wage rate of total manufacturing, is the same for all observations. For RWD and TD, they simply do not exist. Fourth, there are new variables available in the cross-section regressions. Major changes are the inclusion of the education variable and several variables which represent different labor characteristics in different industries. By using the education variable along with wage rate, it is possible to examine some predictions of human capital theory.

The regression formulation of the model is basically similar to that of time series. The differences are as follows. As mentioned above, HWRATM, RWD and TD are no longer present. Since data are based on an annual average, the unit of a period I am now dealing with is a year. A one period lead or lag would mean a year's interval and this would be too long to serve as a unit for labor turnover decisions. Therefore, lead and lag of variables are not included in this formulation.

The sum of discharge rate and rate of employment change is divided into separate terms because both variables are already 12-month averages and summing up of two values which are themselves composite figures would lead to a less meaningful variable. Other than that, the difference is

the addition of new variables such as education, percentages of professional , old, young, female or government workers, and concentration ratio.

If I formulate the cross section layoff regression in its full variable form, it will be

$$(4\cdot3)\quad LOFF = b_0 + b_1 HWAGE + b_2 EDUCAT + b_3 DISC + b_4 NCHAN + b_5 UNEM + b_6 INVN + b_7 PROF + b_8 OLD + b_9 YOUNG + b_{10} FEMALE + b_{11} GOVT + b_{12} CONCEN$$

The expected signs of the coefficients of the variables are

$$(4\ 4)\quad \begin{array}{ll} b_2(EDUCAT),\ b_5(UNEM),\ b_8(OLD),\ b_9(YOUNG),\ b_{10}(FEMALE) & > 0 \\ b_1(HWAGE),\ b_4(NCHAN),\ b_7(PROF),\ b_{11}(GOVT),\ b_{12}(CONCEN) & < 0 \\ b_3(DISC),\ b_6(INVN) & ? \end{array}$$

The rationale for these predictions is as follows. The sign of b_1, the coefficient of wage rate (HWAGE), is expected to be negative, whereas the sign of b_2, the coefficient of education (EDUCAT), is expected to be positive. The reason for the wage rate (W) and general training (G) was spelled out in III-1. Only difference is that EDUCAT replaces G here. As was mentioned there, if the relationship between K_w and K_F is taken to be the other way around, one can get opposite signs for both wage rate and education variables.

The sign of b_3, the coefficient of discharge rate (DISC), is ambiguous. When I discussed the relationship between discharge and layoff in II-2-6), I showed that they would be positively related in the steady states of the economy but negatively related in the boom and recession periods. The periods this cross section study covers are 1960 and 1970. May of 1960 was recorded as a peak and November of 1970 as a trough of the business cycle in the Business Conditions Digest.[1] Depending on the number of months in

[1]Department of Commerce, Business Conditions Digest,(March, 1974), p. 116. The original source of the data is cited as National Bureau of Economic Research.

the years which belong to either steady states or rapid expansion and rapid contraction periods the sign can be predicted as either positive or negative.[1] It is difficult to predict the sign of b_3(DISC) when different industries are treated as different observations since different industries are likely to experience different business activities.

The sign of b_4, the coefficient of the rate of employment change (NCHAN), is expected to be negative.

The signs of b_5, the coefficient of unemployment rate (UNEM), and b_6, the coefficient of inventory per man (INVN), are expected to be the same as those obtained by time series layoff regression. They are positive and ambiguous, respectively.

The sign of b_7, the coefficient of the percentage of professional worker (PROF), is expected to be negative. Although professionals typically have not so much specific human capital, they might not be equally treated as blue collar workers. If some professionals are employed for a substantial period at a firm, the firm may be eager to keep these workers because the firm can have firm-owned specific information for which it financed. If these workers are laid off, they would less likely be waiting for rehire since they have little worker-financed specific human capital. This would discourage the firm from easily laying off these workers. In addition to this, the recruiting costs for professionals such as advertisement on the professional media or moving expense may be high too. Therefore it is likely that PROF is negatively correlated to layoff rate in the regression.

The sign of b_8 and b_9, the coefficients of the percentage of old

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[1] It is noted that not all 12 months belong to peak or trough months in 1960 and 1970.

and young workers respectively (OLD and YOUNG), are expected to be positive. The age group covered by OLD is ages 55 - 64 and that covered by YOUNG is ages 16 - 24. The sign of b_9 (YOUNG) is predicted to be positive because, on the one hand, young workers are less specifically trained and, on the other hand, the average quit rate of this age group is high, so a firm loses less by laying them off.

Predicting the sign of b_8(OLD) is not so straight forward. In general, old workers have more specific training and a lower average quit rate. They are more valuable workers to a firm in that respect. But given a specific human capital investment in an old worker or any other worker, a firm has comparatively less time to recoup its investment in the old worker, provided, of course, that the firm paid for the total or partial cost of training. Therefore, when demand declines, old workers are most vulnerable to be laid off among workers with the same specific training.[1]

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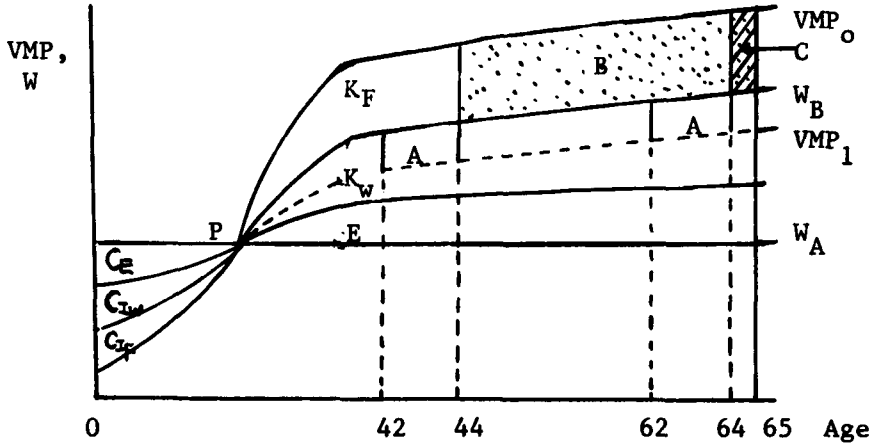
[1]This point may be illustrated by a diagram.



Assume that demand declines and that the value marginal product decreased from VMP_o to VMP_1 i.e., $W_B > VMP_1$. Suppose the recession continues for two years and wage rate does not decline. The firm pays W_B which is higher than VMP_1 by the amount of the area A for both age groups of workers (ages 42 and 62). The younger group has an expected recouping period from age 44 to 65 (dotted area: B+C). The older group, however, has a much shorter period (shaded area: C). Of course, if $A > C$, then the older workers will be immediately laid off. Even if $A < C$, the older group has more chances to be laid off than the younger one. I am indebted to Prof. Chiswick for this useful diagram came from his class lectures.

Note that wage rate and education are held constant in the regression. If there exists any systematic relationship between K_F and K_w, then this situation is analogous to the regression of OLD on LOFF holding K_F constant. Therefore b_8(OLD) is expected to be positive.

The sign of b_{10}, the coefficient of the percentage of female workers (FEMALE), is expected to be positive, as human capital theory predicts.

The signs of b_{11} and b_{12}, the coefficients of the percentage of government workers and the concentration ratio respectively (GOVT and CONCEN), are expected to be negative. The workers who are on the governmental payroll are to be less affected by demand decline. These workers are most likely employed at institutions which are funded by the governments of all classes. Therefore the percentage of this sort of workers will be negatively related to layoff rates. However, since the percentages per se in most industries are so small that it is difficult to expect for them to exert an important explanatory power in the regression. For the concentration ratio variable, two things can be mentioned. According to Parsons, there will be fewer firm's bidding on industry skill and more collusion in non-raiding agreements in more concentrated industries.[1] Such industries are also more orderly in terms of the stability of market shares.[2] If these are true, the concertration ratio will have a negative relationship with layoff rate.

Regarding the predicted signs of those variables which represent the labor characteristics of industries, one caution is in order. Since

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[1] Parsons, Donald O., op cit., 1970, p. 44

[2] Parsons, Donald O., op cit., 1970, p. 47

I do not control different business conditions in these regressions,[1] the expected signs, which depend heavily on the investment decision of specific human capital (of individuals), may not necessarily be correct. For example, if industries whose percentages of young workers are relatively high happen to experience rapid expansion during the regression periods, the variable YOUNG may capture this effect (negative effect on layoff) and may be strongly influenced by it.

2) The Empirical Results

(1) The Data[2]

The regressions are run using 1960 and 1970 data. 72 different SIC 3 or 4-digit manufacturing industries in the U.S. were selected by the technique described under the time series layoff regression [IV-1-2)-(1)]. Many data are drawn from Census of Population, Census of Manufacturers and Annual Survey of Manufacturers by the Census Bureau. Labor turnover-related variables and wage rates are from the sources of the Bureau of Labor Statistics. Inventory data are from Survey of Current Business by the Bureau of Economic Analysis, Department of Commerce.

Concentration ratio is defined as the percentage of value of shipment accounted by the largest 4 companies in each industry. The concentration ratio used for 1960 is that of 1963 because of the lack of data for 1960.

As mentioned earlier, May of 1960 was a peak and November 1970 was a trough in the business cycle.

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[1]Even if this is a cross section analysis, there is no guarantee that different industries will experience the same demand conditions.

[2]See Appendix E for the definitions of variables and the data sources.

(2) The Empirical Results

The definition of variables and the regression results are presented in Table 7 and Table 8. A few slightly different formulations were used in the regressions and thus four different results were presented for each year.

The first columns in 1960 and 1970 use the same formula and they differ from the specified formula (4·3) by the absence of the professional (PROF) variable. The second columns use the same formula as (4·3). In the third columns, the one year lag of wage rate, HWAGEL1, was included in the regressions.

The most interesting and striking results are the signs of the coefficients of wage rate and education variables in 1960 and 1970. In 1970 the signs agree with the predicted ones, but they do not do so in 1960. They are fairly stable and significant with slightly different regression equations too.

The positive sign on wage rate and the negative sign on education in 1960 are the same as the signs which are predicted under the assumption of <u>negative</u> correlation between K_w and K_F. The opposite signs confirm the prediction with the assumption of <u>positive</u> correlation.

One may attempt to attribute this result to different sharing of the investment costs of specific training in different phases of the business cycle since business conditions in 1960 were quite different from those in 1970. In other words, one can expect the opposite signs if there is any reason to believe that

$$K_w = h_o + h_1 K_F, \quad h_1 < 0 \text{ in } 1960$$

and

$$K_w = h_o + h_1 K_F, \quad h_1 > 0 \text{ in } 1970.$$

TABLE 7

Definition of Variables in Cross Section Layoff Regression

Variable Name	Definition
LOFF	Annual average of monthly layoff rates per 100 employees
HWAGE	Annual average of straight hourly wage rate of an industry
HWAGEL1	One year lag of HWAGE
EDUCAT	Median years of schooling completed
DISC	Annual average of monthly discharge rates per 100 employees
NCHAN	Rate of annual average number of employment changed between t-1 and t years per 100 employees
UNEM	Annual average of unemployment rate in an industry (by 2-digit standard industry classification)
INVN	Inventory per man
PROF	Percentage of professionals in an industry
OLD	Percentage of workers age 55-65 years
YOUNG	Percentage of workers age 16-24 years
FEMALE	Percentage of female workers in an industry
GOVT	Percentage of government employees in an industry
CONCEN	Concentration ratio

TABLE 8

Cross Section Layoff Regressions, 1960 and 1970

Dependent Variable = LOFF
( ); t- statistics

Independ. Variable	1960				1970			
HWAGE	.387 (1.856)	.387 (1.869)	-.170 (-.201)	.422 (2.265)	-.624 (-1.543)	-.484 (-1.229)	-7.921 (-1.882)	-.390 (-1.115)
HWAGEL1			.622 (.667)				7.958 (1.775)	
EDUCAT	-.453 (-3.445)	-.236 (-1.457)	-.243 (-1.492)	-.474 (-3.964)	.468 (1.876)	.618 (2.490)	.504 (2.000)	.668 (3.086)
DISC	1.212 (3.084)	1.164 (3.034)	1.187 (3.067)	1.217 (3.104)	1.637 (2.218)	1.916 (2.660)	2.034 (2.862)	1.877 (2.783)
NCHAN	-.045 (-3.108)	-.055 (-3.732)	-.052 (-3.356)	-.045 (-3.116)	-.005 (-.737)	-.003 (-.472)	-.002 (-.254)	-.003 (-.455)
UNEM	.464 (3.438)	.388 (2.871)	.397 (2.908)	.446 (3.546)	.436 (2.589)	.334 (1.991)	.349 (2.116)	.362 (2.341)
INVN	4.670 (1.609)	3.882 (1.368)	4.074 (1.421)	4.507 (1.581)	-8.030 (-1.555)	-6.097 (-1.210)	-3.846 (-.753)	-5.309 (-1.126)
PROF		-.050 (-2.181)	-.049 (-2.143)			-.073 (-2.385)	-.073 (-2.438)	-.077 (-3.407)
OLD	-.102 (-2.132)	-.152 (-2.937)	-.165 (-2.964)	-.107 (-2.334)	.164 (2.350)	.027 (.312)	.007 (.081)	

Independ. Variable	1960				1970			
YOUNG	-.130 (-2.322)	-.167 (-2.939)	-.169 (-2.942)	-.142 (-3.129)	.013 (.187)	-.028 (-.417)	-.004 (-.056)	
FEMALE	-.003 (-.382)	.003 (.328)	.004 (.482)	-.020 (-1.725)	-.013 (-1.160)	-.011 (-.923)	-.012 (-1.177)	
GOVT	.031 (1.027)	.044 (1.474)	.044 (1.448)	.034 (1.153)	.173 (5.684)	.170 (5.796)	.174 (6.019)	.172 (6.025)
CONCEN	-.484 (-.920)	-.399 (-.780)	-.504 (-.937)	-.531 (-1.044)	.256 (.343)	.389 (.541)	.563 (.789)	.378 (.537)
CONSTANT	4.872 (2.252)	4.621 (2.199)	4.696 (2.221)	5.273 (2.808)	-7.348 (-1.668)	-6.374 (-1.495)	-6.137 (-1.465)	-7.341 (-2.454)
R^2	.53	.57	.57	.53	.51	.55	.58	.55

This is because, as was shown in III-2, the predicted signs depend critically on the assumption of a relationship between K_w and K_F. However, it is not obvious and it is even difficult, to imagine that the sign of h_1 could be first one way, then the other, in two different years.

Another explanation for the sign reversals may be multicollinearity problem. Let

$$y = a + b_1 x_1 + b_2 x_2. \tag{4.5}$$

The coefficients b_1 and b_2 can be expressed in terms of zero order (simple) correlations as follows[1]

$$b_1 = \frac{r_{y1} - r_{y2} r_{12}}{1 - r_{12}^2} \frac{\sigma_y}{\sigma_1} \tag{4.6}$$

$$b_2 = \frac{r_{y2} - r_{y1} r_{12}}{1 - r_{12}^2} \frac{\sigma_y}{\sigma_2} \tag{4.7}$$

where σ_1 = standard deviation of x_1

σ_2 = standard deviation of x_2

σ_y = standard deviation of y

r_{y1} = simple correlation between y and x_1

r_{y2} = simple correlation between y and x_2

r_{12} = simple correlation between x_1 and x_2.

If r_{12} is not far from 1, then the numerator of

$$b_1 \cong r_{y1} - r_{y2}$$

and the numerator of

$$b_2 \cong r_{y2} - r_{y1}.$$

So $b_1 > 0$ if $r_{y1} > r_{y2}$, and $b_2 < 0$.

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[1] See Johnston, J., Econometric Methods, 1963, p. 57.

One more line of search for the resolution of this result is perhaps to consider the sources of variation in wage rate other than worker-owned specific capital (K_w) and education (E). Change in wage rate may depend on the condition of the business cycle too.[1] If wage rate changes in accordance with excess demand or excess supply, as is the case in different phases of the business cycle, one may write the wage function as follows

$$W_j = a_1 K_{w_j} + a_2 E_j + a_3 (C_j - \bar{C}_j) \tag{4·8}$$

where subscript j referes to j^{th} industry. One can interpret $C_j - \bar{C}_j$ as deviation from trend. Thus

$$x_j = C_j - \bar{C}_j > 0 \quad \text{in expansion}$$

$$-x_j \equiv y_j = \bar{C}_j - C_j > 0 \quad \text{in recession.}$$

From (3·21)

$$K_w = h_o + h_1 K_F. \tag{4·9}$$

Substituting (4·9) into (4·8) and ignoring the constant term and subscripts,

$$W = a_1 h_1 K_F + a_2 E + a_3 (C - \bar{C}). \tag{4·10}$$

In an expansion, the wage function is

$$W = a_1 h_1 K_F + a_2 E + a_3 x. \tag{4·11}$$

From (3.22)

$$L = a - b_1 K_F \tag{4.12}$$

Substituting (4·11) into (4·12), one can get

$$L = a - \frac{b_1}{a_1 h_1} W + \frac{b_1 a_2}{a_1 h_1} E + \frac{b_1 a_3}{a_1 h_1} x \tag{4·13}$$

or

$$L = a^* - a_1^* W + a_2^* E + a_3^* x \tag{4·14}$$

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[1] I am indebted to Professors Gordon and Grossman for this point.

If x is omitted,

$$(4\cdot15) \qquad L = \hat{a}^* + \hat{a}_1^* W + \hat{a}_2^* E,$$

where a_I^* can be positive or negative.

By omitted variable formula

$$(4\cdot16) \qquad E(\hat{a}_1^*) = - a_1^* + a_3^* b_{xw\cdot E},$$

where $b_{xw\cdot E}$ is the regression coefficient of x on w with E fixed. Presumably $b_{xw\cdot E} > 0$. So $E(\hat{a}_1^*)$ could be positive.

In a recession, x is negative. So

$$(4\cdot17) \qquad W = a_1 h_1 K_F + a_2 E + a_3(C - \bar{C})$$

$$= a_1 h_1 K_F + a_2 E - a_3(\bar{C} - C)$$

or

$$(4\cdot18) \qquad W = a_1 h_1 K_F + a_2 E - a_3 y$$

Substituting (4·18) into (4·12) one can get

$$(4.19) \qquad L = a^* - a_1^* W + a_2^* E - a_3^* y$$

And by omitted variable formula

$$(4\cdot20) \qquad E(\hat{a}_1^*) = - a_1^* - a_3^* b_{yw\cdot E}$$

Again presumably $b_{yw\cdot E} > 0$.

So a_1^* overestimated in absolute value. Put differently, it is more negative than it should be. Therefore the signs of W and E can be reversed.

The coefficient of discharge (DISC) has a positive sign and is quite significant in both years. This seems to imply that more segments of months in both years behaved like steady as far as discharges and layoffs are concerned.

The coefficient of rate of employment change (NCHAN) shows a

negative sign as predicted and is significant only in 1960. The coefficient of unemployment variable (UNEM) also shows the sign predicted and it is significant in both years.

The sign of the coefficient of the inventory variable (INVN) reveals a somewhat interesting point, although it is not equally significant in both regressions.[1] The results suggest that inventory is likely to be a substitute for labor input during an expansion period, and likely to be a substitute for output during a contraction period. The coefficient of PROF is negative as predicted and is also significant in both years.[2]

The coefficient of OLD is negative in 1960 and positive in 1970, but it is significant in 1960 and the first regression in 1970 only. In 1970, the inclusion of the professional variable in the second and third regressions reduced the significance of OLD. A negative coefficient in expansion and a positive coefficient in contraction is not a totally unexpected result. As I indicated when discussing the predicted sign of OLD, being in the age group 55-64 will definitely be advantageous when the company is expanding the work force, whereas it will hurt aged workers when a company is laying off its less valuable workers.

The coefficient of YOUNG is expected to be positive but it shows a negative sign. It is significant only in 1960. The codfficient of FEMALE is also predicted to be positive but it appears in most regressions as negative and it is in both years not significant.

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[1] It is significant at about 90% confidence interval in 1960 and is less significant than that in 1970.

[2] Parsons predicted the coefficient sign of this variable to be negative but he got positive and significant result in 1959 and 1963.

The coefficients of percentage of government workers (GOVT) and of concentration ratio (CONCEN) are predicted to be negative. The sign of the coefficient of GOVT is positive in both years and significant in 1970. That of CONCEN is negative in 1960 and positive in 1970 but in neither year is it significant.

CHAPTER V

EXTENDED EMPIRICAL STUDIES: THE APPLICATIONS OF THE MODEL TO THREE LABOR TURNOVER DECISIONS OF THE FIRM

1. The Effects of Changes in Worksharing Practices on Layoffs Over Time

As was discussed in II-2-5), the effects of change in worksharing practices on layoffs can be tested empirically. At issue is whether there has been any statistically significant change in layoff behavior due to change in worksharing practices taken place during the 1960s, for example. And if there has been such a change, then it would be natural to ask questions such as when did it occur or was it related to the degree of unionization?

Worksharing can be defined as shorter hours of work than usual because of demand decline. In this empirical study the ratio of the standardized weekly hours of work to the current month's weekly hours is used as a proxy for this variable. Standardized weekly hours of work can be defined as a weekly hours of work which is free from short run fluctuation of hours of work. It is a weekly hours of work a firm would continue to operate if demand was not decreased. It is computed by a seven year moving average of annual average weekly hours of work.

"Desired" layoffs are the sum of actual layoffs and reduced layoffs. In the regression, "desired" layoffs are controlled to give a proper meaning to the worksharing variable. This is because layoffs and worksharing must be negatively related and they will be so only if desired layoffs are controlled in the regression.

Desired layoffs were calculated in the following way.

Let

(5·1) $H^a \cdot M^a = H^s \cdot M^s$

where H^a ; actual hours of work

M^a ; actual number of workers

H^s ; standardized hours of work

M^s ; number of workers if they worked with H^s.

From (5·1)

(5·2) $$M^s = \frac{H^a M^a}{H^s} .$$

Let

(5·3) $L^r = M^a - M^s$, where L^r is reduced layoffs.

So

(5·4) $$M^s = \frac{H^a}{H^s} (L^r + M^s)$$

and

(5·5) $$L^r = \frac{H^s}{H^a} M^s - M^s = \left(\frac{H^s}{H^a} - 1\right) M^s .$$

The equation (5·5) shows the reduced layoffs.

As mentioned above the desired layoffs are the sum of actual layoffs and reduced layoffs, i.e.,

(5·6) $L^d = L^a + L^r$

where L^d and L^a are desired and actual layoffs respectively. Worksharing and desired layoff variables are included in the time series layoff regression as additional independent variables. The reduced work dummy, RWD, in the regression specification is now irrelevant and is omitted.

The regression equation with full variables will then be,

$$(5\cdot7) \qquad LOFF = c_o + c_1 HWRATM + c_2 HWNET + c_3 OWNWRAT + c_4 DN + c_5 LDN1 + c_6 UNEM + c_7 UNEML1 + c_8 INVN + c_9 TD + c_{10} WS + c_{11} DESLOFF.$$

The subgrouping of years and the method that I used to test the effect of the change in worksharing practices on layoff rate is as follows.

First, all the periods, from January 1958 to December 1973 (192 months), were divided into six subperiods to detect the time when this change occurred. The tests were done on the following five sets of data, obtained by regrouping the six sub-periods.

TABLE 9

Subgrouping of Years in the Worksharing Practices

Tests : Group 1 vs. Group 2

Years	Observations
1958 - 1959 vs. 1960 - 1961	(1- 24) vs. (25- 48)
1958 - 1961 vs. 1962 - 1964	(1- 48) vs. (49- 84)
1958 - 1964 vs. 1965 - 1967	(1- 84) vs. (85-120)
1958 - 1967 vs. 1968 - 1970	(1-120) vs. (121-156)
1958 - 1970 vs. 1971 - 1973	(1-156) vs. (157-192)

If the test statistics described below indicate a change of worksharing practices in one of these five sets of data, then it can be concluded that the change occurred during the years in Group 2 of that set.

Second, the Student t test was used to obtain the test statistics used in the empirical study. After running two regressions in each set, the coefficients of worksharing variables were tested against the null hypothesis, which postulates that their real values are equal. The t statistics formula is shown in Appendix D. If the null hypothesis is accepted, it means that there has been no statistically significant change in layoff behavior due to the change in worksharing practices between the two different periods under question. If the null hypothesis is rejected, then it is understood to mean that there has been such a change.

Once the null hypothesis is rejected, the next problem is to find out whether the change occurred for or against the worksharing practice during the period under consideration. Some economists have been asserting that firms tended to avoid to use worksharing because workers or unions opposed the practice. If this is the case, then I expect the absolute magnitude of the coefficient of the worksharing variable in the regression to increase in the second member of the regression data pair. In other words, it is now more expensive for a firm to use worksharing and given the same amount of worksharing as before, it will lay off relatively fewer workers than before, if indeed it uses the worksharing scheme at all. Worksharing must now be more effective in reducing layoffs. Therefore I interpret a greater absolute magnitude of the coefficient of the worksharing variable in the second data pair as evidence of opposition to the use of worksharing, and vice versa.

The results of the tests are shown in Table 10. The t-ratios of the

TABLE 10

Tests of Changes in Worksharing Practices

t- Ratios

SIC	(I) 1960-61	(II) 1962-64	(III) 1965-67	(IV) 1968-70	(V) 1971-73	Degree of Unionization[1]
2011	.139	2.095(-)[2]	1.185	.017	2.489(+)[2]	U= 2
2051	1.596(+)	1.396	.059	1.603(-)	.019	U= 2
221	1.296	1.707(+)	1.083	1.263	.626	U= 4
225	.659	2.141(+)	.334	.512	.912	U= 4
228	1.234	2.392(+)	1.189	.310	.485	U= 4
2321	1.561(+)	4.726(-)	.798	1.389	1.108	U= 2
2341	2.539+	2.023+	2.891(+)	1.000	1.204	U= 2
2421	1.075	.598	1.420(+)	.769	.779	U= 3
2511	3.798(+)	1.141	.334	.471	.899	U= 2
261,2	.875	.266	.817	.912	.492	U= 1
2653	1.639(+)	.338	.010	1.205	1.422+	U= 1
2823	.168	.893	1.922(-)	1.862-	.952	U= 2
2834	.036	2.578(+)	1.825+	1.323	.072	U= 2
291	.043	.093	.011	2.205(-)	1.069	U= 2
301	.402	.388	1.860(-)	1.116	1.520-	U= 2
314	5.954(+)	5.032+	5.475+	5.734+	5.388+	U= 3
3221	1.531-	1.499(+)	.252	4.671(-)	1.299	U= 2
3312	.020	2.106+	3.053(+)	N.A.	N.A.	U= 2
3321	.158	.106	1.561(+)	.765	1.407+	U= 2
3443	.541	1.010	1.798(+)	.896	1.335	U= 1
346	.552	.017	.178	.039	.432	U= 1
3531	.925	.507	.624	.379	.181	U= 3
3585	.845	1.181	1.441+	1.618(+)	.226	U= 3
3621	.148	.382	.445	12.355(-)	3.344(+)	U= 1
3662	.784	1.128	.977	3.817(+)	N.A.	U= 1
3711	.448	2.072(+)	1.021	.815	.790	U= 1
3721	.043	3.100(-)	.921	1.249	.173	U= 1
3821	.234	.097	1.016	4.748(-)	.634	U= 4

1. Degree of Unionization: U= 1 ; highest, U= 4 ; lowest.
2. ( ); the highest t- ratio for each sign in an industry.

five sets of subperiods in 28 industries are given. A + (-) indicates that the absolute magnitudes of the coefficients increased (decreased) during that set of periods. These + and - signs are shown only if the t- ratios are significant at the 90% confidence intervals. If there is more than one significant t- ratio in an industry, parentheses are used to indicate the ratios which are most significant, be they positive or negative.

There are 20 industries which have positive signs and 10 industries which have negative signs. They represent 71 and 36 percent of all industries respectively. However, in 3 industries (SIC 2051, 2321 and 3221), the positive signs later become negative. Among the industries having negative signs, 2 industries (SIC 2011 and 3621) have negative signs which later become positive. When all these cases are excluded, 17 (61%) industries are left with positive signs and 8 (32%) industries with negative signs.

The result supports the assertion that there has been approximately a 61% change in the attitude against worksharing. But there is 32 percent of counterevidences too. If these test statistics are examined at 95 percent confidence interval, the result will be 46 percent (13 industries) being for, and 25 percent (7 industries) being against the assertion. Such test results do not constitute conclusive support, but nevertheless almost twice as many industries showed a change in the asserted direction as did not.

The question of whether the degree of unionization played any role in these changes is examined and presented in Table 11.

TABLE 11

Number of Industries Experiencing a Change in Attitude against Worksharing by Period and Degree of Unionization

Degree of Unionization	I 1960-61	II 1962-64	III 1965-67	IV 1968-70	V 1971-73	Total
u = 1	1	1	1	1	1	5
u = 2	3	2	3		1	9
u = 3	1		1	1		3
u = 4		3				3
Total	5	6	5	2	2	20

The table reveals that among 20 industries, 14 (70%) belong to the industries having more than 50 percent unionization (u=1 and u=2). If I focus attention on the first three periods (I - III) and the two most highly unionized groups, (u=1 and u=2), enclosed by a dotted rectangle, the table also indicates that the higher the degree of unionization of an industry, the earlier the change occurred. Eleven industries (55%) appear in this area, whereas the expected number in this sample space would be 6 if all 20 occurrences were evenly distributed. These results can be interpreted as evidence to support the notion that the highly unionized industries experience a change in attitude against workersharing more often and do so earlier than less unionized industries.

2. Rehire (Recall) vs. New Hire

Along with the previous analysis, the rehire vs. new hire strategy of a firm can be analyzed within the framework of this model. In the model, it is understood that a firm is quite well informed of workers' qualities, in internal and external labor market and of workers' quits. This very conscious management of labor turnover makes its rehire-new hire strategy easily predictable. Assuming the absence of unionization, several variables under the firm's control can serve to explain this strategy of the firm's behavior on rehire-new hire policy.

Rehire or new hire occurs at the upturn of a business cycle after a trough has been reached. The sooner the point of hiring occurs after a trough, the more the number of the workers we will have that are rehired (recalled), whereas the further away the point of hiring occurs after a trough, the more workers there will be that are newly hired. This is most likely because, at the early stage of an upturn, the firm can save hiring and training costs by rehiring those laid off, instead of hiring new workers and it can recall, at that stage, better qualified workers among the workers previously laid off. As time passes, there will be less workers laid off, or less better qualified workers available among them and more new hires would be realized if the firm wishes to expand its work force. The same situation obtains even if there is no union. If there is any union, this tendency will be reinforced. If the union is powerful enough to force the management to recall workers laid off by contract, in an extreme case, all the workers laid off would have to be recalled before any of the new workers are hired.

Other possibilities of getting hired under the rehire or new hire policy in the various points of hiring after a trough indicate that the data

used in the empirical study produces the expected results. If data are chosen in such a way that a many more number of months from the start of upturn are included in the study, the results are expected to be biased against rehires. If less number of months are included, the results are expected to be biased against new hire. There has not yet been set a priori lengths of periods, which can explain in a single regression formula , the fair chances for both rehire and new hire for 28 industries. So the six-month period after a trough has been chosen arbitrarily in the regression. The reasons for choosing six-month period are: According to the Bureau of Labor Statistics, on the average, 70 percent of the total unemployment remained unemployed from 1 to 14 weeks during 1957-1970. The average duration of unemployment from 15 to 26 weeks constitutes about 18 percent and that for 27 weeks and over, 12 percent during the same period. These statistics suggest two things. First, most of the unemployed are either recalled by their employer or hired by other firms approximately within three months, although not all the unemployed are the workers who had been laid off. Second, those who had been unemployed for 4 to 6 months and for more than 6 months (27 weeks or more) are of a relatively small portion. Therefore, one can expect that the first 3 months are for rehire and the following 3 months for new hire.

The dependent variable of the regression is the ratio of rehire rate and new hire rate, RNHIRRAT. As explanatory variables, real straight hourly wage rate, HWNET, quit rate, QUIT, discharge rate, DISC, unemployment rate of the industry, UNEM, and real inventory, INVN, are used. Observations for the six-month period after each trough were used in the regression. All the other observations were deleted. The regressions were run for the same 28 industries described in the time series regression.

The regression equation is

$$(5\cdot8) \qquad RNHIRRAT = d_o + d_1 HWNET + d_2 QUIT + d_3 DISC + d_4 UNEM + d_5 INVN$$

The expected coefficient signs of the independent variables are

$$(5\cdot9) \qquad d_4(UNEM),\ d_5(INVN) > 0$$

$$d_1(HWNET),\ d_2(QUIT),\ d_3(DISC) < 0.$$

The rationale for positing the independent variables and the predictions of the coefficient signs is as follows.

HWNET is included because this is expected to be more closely related to new hire than rehire. Rehire depends basically on changes in demand and not on real wage rate. Put differently, the workers who are recalled by the firm in general come back to their jobs at their previous wage rate, whereas the firm may prefer to hire new workers when it pays higher wage rate. The sign of b_1(HWNET) will be negative since HWNET is expected to be positively related to the denominator, new hire, of the dependent variable.

QUIT is related to both rehire and new hire but with different meanings. If quit rate increases, when real wage rate is held constant, this may be negatively correlated to rehire, because the workers laid off would be less enthusiastic in responding to the recall whatever the reasons for the increased quit rate may be. They may think the firm relatively less attractive to them than other firms. This is because the workers laid off have more information about the firm than the workers who had not worked in the firm.

Quit rate is also likely to have positive correlation with new hire.

This involves the timing of quit and imperfect information on labor market. When general demand increases from a trough, a firm will begin to recall the workers laid off. The workers within the firm, or internal labor market, will perceive the demand increase of their firm before anybody else. They will, however, eventually know the general demand increase and some of them will quit to switch jobs. Since most quitters search while on the job and quit only after they secure a job elsewhere,[1] this will take time. Therefore quit rate is more likely to be associated with new hire. By these reasons, the coefficient sign of quit rate is expected to be negative.

Discharge rate, DISC, is included because this variable is closely related to new hire. As discussed in II-6, discharge rate is more or less proportional to the new hire rate, ceteris paribus. But this has no direct relationship with recall especially after business recession and trough. Therefore, the sign of the coefficient of this variable is predicted to be negative.

Unemployment rate, UNEM, has the same effects on rehire and new hire. It is positively related to both rehire and new hire. When unemployment rate is high, there will be higher chance for the workers laid off to be retained because in such a loose labor market it would be more difficult for them to find other jobs. This will lead for the firm to rehire those previously laid off, resulting in a positive correlation.

However, higher unemployment rate indicates there can be more

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[1]See Bancroft, G. and Garfinkle, S., "Job Mobility in 1961," Monthly Labor Review, (August, 1963), pp. 897-906.

better qualified workers (other than laid off workers) available in the external labor market and this may raise the better chances of replacement, resulting in positive correlation with new hire. One can expect conflicting forces working from UNEM variable toward the ratio of rehire and new hire, RNHIRRAT. Therefore, the sign of d_4(UNEM) may be argued to be ambiguous, i.e., it will be either positive or negative depending on the strengths of the correlations with numerator (rehire) and denominator (new hire).

I expect this sign to be positive because the strength of correlation with rehire is expected to be much stronger than that with new hire, especially in such a period (six months after a trough) and in substaintially unionized manufacturing industries.

Real inventory, INVN, has somewhat different meaning in this regression from that in the layoff regression. In the layoff regression I predicted the sign to be ambiguous because it was not clear, a priori, whether INVN is a substitute for output or input. In the rehire-new hire regression,this issue on the substitute for output or input does not matter since mere increase in the number of work force does not tell how the increase has to be met.

At the stage of recovery from a cyclical trough, INVN will be more closely tied to the relative number of rehire than new hire, assuming rehire decreases as time goes on. Therefore, the sign of d_5 (INVN) is predicted to be positive.

The Table 12 and Table 13 show the regression results and the summary of the results, respectively.

According to the summary table, the coefficient signs of the independent variables largely confirm the prediction. However, the

TABLE 12

Rehire - New Hire Regression

Dependent Variable = RNHIRRAT
( ); t - statistics

SIC	HWNET	QUIT	DISC	UNEM	INVN	CONSTANT	R^2
2011	-53.44	-.029	.344	.044	-4.159	14.41	.63
	(-1.212)	(-.475)	(.777)	(2.250)	(-.321)	(2.685)	
2051	1.113	-.004	-.008	.002	-.369	.160	.52
	(.274)	(-1.245)	(-.493)	(1.518)	(-.310)	(.573)	
221	-7.638	-.006	.004	.002	.022	1.611	.82
	(-2.032)	(-1.129)	(.238)	(1.140)	(3.436)	(3.033)	
225	-3.232	-.025	-.010	-.003	3.219	1.064	.43
	(-.363)	(-2.324)	(.156)	(-.763)	(.610)	(.999)	
228	1.066	-.005	-.047	.004	2.159	.102	.57
	(.079)	(-.414)	(-.835)	(.767)	(.376)	(.067)	
2321	-4.423	-.016	.002	.000	9.377	-.881	.66
	(-1.093)	(-3.188)	(.064)	(.255)	(3.597)	(-1.797)	
2341	-4.016	-.007	.006	.002	1.773	.555	.39
	(.921)	(-1.113)	(.316)	(1.807)	(.559)	(.952)	
2421	-12.69	-.005	-.046	.004	2.360	1.949	.53
	(-1.949)	(-.968)	(-1.158)	(1.328)	(2.002)	(2.547)	
2511	-84.86	-.006	-.031	.003	1.150	9.919	.53
	(-1.458)	(-.586)	(-.413)	(1.140)	(1.524)	(1.579)	
261,2,6	-9.011	-.010	-.009	.017	13.20	-.341	.43
	(-.404)	(-.767)	(-.225)	(2.344)	(.634)	(-.159)	
2653	-6.009	-.003	-.031	.004	5.207	.788	.54
	(-.756)	(-.403)	(-.658)	(1.061)	(1.037)	(.780)	
2823	-19.68	-.049	-.049	.016	4.090	3.814	.37
	(-.947)	(-.976)	(-.211)	(.735)	(.779)	(.810)	
2834	-3.038	-.001	-.005	.004	.427	.566	.32
	(-1.058)	(-.183)	(-.124)	(1.180)	(.499)	(1.040)	
291	-8.734	-.006	-.007	.007	-1.668	2.965	.52
	(-2.798)	(-.460)	(-.319)	(1.949)	(-2.031)	(2.709)	
301	-14.97	-.174	.319	.027	-57.87	11.69	.45
	(-.261)	(-.718)	(1.032)	(.422)	(-1.427)	(.746)	

SIC	HWNET	QUIT	DISC	UNEM	INVN	CONSTANT	R^2
314	-21.00	-.025	-.017	-.003	1.336	2.005	.47
	(-.846(	(-1.647)	(-.257)	(-.430)	(1.229)	(.932)	
3221	17.85	-.005	-.044	.005	-14.92	-1.121	.43
	(.974)	(-.404)	(-.525)	(.853)	(-.538)	(-.721)	
3312	-998.6	-.054	.353	.200	127.8	249.9	.62
	(-2.507)	(-.101)	(.136)	(2.354)	(1.323)	(2.335)	
3321	-13.61	-.008	-.084	.013	2.757	2.663	.60
	(-.638)	(-.276)	(-1.209)	(2.010)	(.542)	(.759)	
3443	20.25	-.026	.028	.000	-3.825	-2.796	.76
	(1.925)	(-3.020)	(.823)	(.123)	(-2.729)	(-1.292)	
346	53.57	-.019	-.463	.017	-17.12	-1.429	.37
	(.399)	(-.156)	(-1.309)	(.423)	(-.542)	(-.060)	
3531	-59.86	.010	.067	.023	1.192	14.02	.83
	(-3.284)	(.208)	(.663)	(2.156)	(.855)	(3.228)	
3585	-54.74	-.024	-.097	.002	3.027	12.41	.51
	(-1.532)	(-.587)	(-1.052)	(.210)	(1.119)	(1.791)	
3621	-41.01	-.024	.005	.026	1.563	8.998	.76
	(-1.406)	(-.651)	(.085)	(3.055)	(.790)	(1.456)	
3662	2.422	-.045	.016	.002	1.109	-.177	.74
	(.214)	(-2.742)	(.698)	(.586)	(1.057)	(-.073)	
3711	-3.637	.082	-.497	.038	-90.58	30.38	.38
	(-.032)	(.161)	(-.391)	(.857)	(-1.406)	(.671)	
3721	13.70	-.020	-.060	.015	.550	-3.758	.84
	(.930)	(-.674)	(-1.139)	(3.002)	(.327)	(-1.172)	
3821	-108.3	-.050	.028	-.009	27.50	22.61	.42
	(-2.783)	(-1.408)	(.459)	(-.972)	(1.941)	(2.969)	

TABLE 13

Summary of the Rehire-Newhire Regression Results;

Signs of Coefficients of Independent Variables

Dependent Variable = RNHIRRAT

No. of Ind.= 28

Independent Variables	Expected Signs	Number of Ind. Having Expected Signs (A)	(A)/28	Number of Ind. Having Expected Signs & Significant[1] (B)	(B)/28	(B)/(A)
HWNET	_	21	.75	6(1)[2]	.21(.04)[2]	.29
QUIT	_	26	.93	5(0)	.18(0)	.19
DISC	_	17	.61	0(0)	0 (0)	0
UNEM	+	25	.89	9(0)	.32(0)	.36
INVN	+	20	.71	4(2)	.14(.07)	.20

1. Significant at 90% confidence level ($t_{.95}$ = 1.67).
2. ( ) = Number of industries having opposite signs and significant.

significances of the coefficients are not satisfactory. UNEM, QUIT and HWNET variables perform relatively well. One possible source of the difficulties in the regressions is uniform application of the cyclical trough to different industries. If different troughs in each industry were singled out to be used in the regression, the results might have been improved.

3. Male-Female Layoff (and Discharge) Differentials

In recent years,male-female differentials in earning, training, and labor turnover rate have drawn considerable attention in the literature. Many studies tried to explain male-female differentials in the above aspects without resorting to different tastes for discrimination. Human capital theory, household production function model, among others have been increasingly applied in this field.

The model developed in Chapter III allows me to deal with this issue, although no attempt is made in the model to subdivide workers into male and female category. As far as a firm can evaluate the quality of workers and can group workers by sex, the hypothesis can be directly applied in this case. This is because the firm now has one more criterion for evaluating workers' qualities, i.e., a criterion based on sex. Other things being equal, the qualities of two male and female groups may not be evaluated any longer the way it had been done before.

Some relevant variables of the model will be employed to test this male-female layoff differentials. Empirical specifications have been added as follows. Suppose, the layoff rates of female and of male can be explained by the same independent variables. Then one may specify the regression equations of layoff rate of female and male, respectively, as:

(5·10) $$L_F = s_{10} + s_{11}X_1 + s_{12}X_2 + \cdots + s_{1k}X_k + u_1$$

(5·11) $$L_M = s_{20} + s_{21}X_1 + s_{22}X_2 + \cdots + s_{2k}X_k + u_2$$

Subtracting (5·11) from (5·10), I have;

(5·12) $$L_F - L_M = (s_{10} - s_{20}) + (s_{11} - s_{21})X_1 + (s_{12} - s_{22})X_2 + \cdots + (s_{1k} - s_{2k})X_k + (u_1 - u_2)$$

or

(5·13) $$LFMDIF = h_o + h_1X_1 + h_2X_2 + \cdots + h_kX_k + v^1$$

where $LFMDIF = L_F - L_M$

$$h_i = s_{ji} - s_{(j+1)i}, \quad i = 0,1,\cdots k, \quad j = 1, 2$$

$$v = u_1 - u_2$$

therefore,

(5·14) $$h_i \gtrless 0 \text{ as } s_{ji} \gtrless s_{(j+1)i}.$$

The equation (5·13) is the regression formula used in this empirical study. (5·13) and (5·14) state when dependent variable is the difference of layoff rates between female and male, the coefficient sign of each independent variable depends on the signs and magnitudes of coefficients of the variables which would have in the separate regressions like (5·10) and (5·11).

The regression equation used is;

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[1]The dependent variable can be shown as the ratio of female and male layoff if (5·10) and (5·11) were specified by double logarithmic function in the beginning.

$$(5\cdot15)\qquad LDFMDIF = h_0 + h_1 QUITM + h_2 QUITF + h_3 HWNET + h_4 NCHAN + h_5 UNEM + h_6 INVN + h_7 TROUGHD$$

where

LDFMDIF ; Difference of layoff and discharge rates of female and male workers

QUITM ; Quit rate of male workers

QUITF ; Quit rate of female workers

TROUGHD ; Trough dummy which is 1 if the observation belongs to trough months, otherwise 0.

The expected signs of the coefficients are;

$$(5\cdot16)\qquad \begin{aligned} h_1(QUITM),\ h_3(HWNET) &> 0 \\ h_2(QUITF),\ h_4(NCHAN),\ h_5(UNEM),\ h_7(TROUGHD) &< 0 \\ h_6(INVN) &\ ? \end{aligned}$$

The rationale underlying the prediction of the signs is as follows. When QUITF is held constant, the sign of $h_1(QUITM)$ will be positive because QUITM is negatively correlated with layoff rate of male. This prediction is a direct application of the basic model. By the same token, the sign of $h_2(QUITF)$is expected to be negative.

For a better explanation of real wage rate variable (HWNET), wage differential between male and female workers must be introduced. The wage rate of female workers is in general lower than that of male, basically because labor force participation behavior of two sex groups is different. Women turn out to be more frequent quitters and to have more segmented work histories than men due to reasons other than job switch. The frequent leave from the labor market, in turn, is related to their depreciations of skill. A firm prefers men to women as trainees in specific skills because their expected quit rates are lower than women. Women must pay more

training costs(or forgo a larger part of their earnings) than men if they want to have the same specific training as men. Therefore, female workers tend to be concentrated in low skilled jobs and poorly paid jobs.

If real wage rate (HWNET) increases, when QUITM, QUITF and total employment change (NCHAN) are held constant, this means that there are more male workers in the firm, provided, of course, average wage rates of male and female remain unchanged. With QUITM and QUITF being held constant, this happens only when more male than female workers with constant total NCHAN are employed. This in turn leads to the conclusion that the female layoff exceeds that of male. Therefore the sign of h_3 (HWNET) is positive.

This would be true in the case of the number of layoffs of female and male, but it would not strictly be true in terms of layoff rates except that the number of employees of female and male are the same. In the regression, however, the layoff rates rather than the layoff number were used because of the availability of data.

The increase in the employment change (NCHAN), when QUITM, QUITF and HWNET are held constant, will first of all reduce the total layoffs. Whether this total increase in work force would condition less layoffs both for male or female groups, will depend on QUITM, QUITF and HWNET conditions. Since HWNET is held constant wage structure between male and female groups will not change if the same ratio of male and female workers is maintained in the firm. But note that, even if QUITM and QUITF are held constant, QUITM is not equal to QUITF. If QUITM < QUITF is true and they are held constant under such condition, the increase in total work force,with the wage structure between the two sex groups remaining unchanged, would imply that the layoff of male exceeds that of female.

This will happen especially when the number of male hire is proportionately larger than that of female. However, if QUITM > QUITF[1] and male hires exceed female hires, then the sign of h_4 (NCHAN) will be ambiguous. The sign of h_4 (NCHAN) is predicted to be negative.

When the external labor market turns loose, assuming other variables being constant, such a market condition will enhance the chance of being replaced. Now, the problem is to determine which sex group this replacement will occur more frequently. Human capital theory and investment theory suggest that a firm will replace more male workers because of higher expected rate of return from investment in human capital of male than femal at the same training costs. If this is true, then there must be relatively more layoff of male than female, when QUITM, QUITF and HWNET are held constant, and the sign of b_5(UNEM) will be negative.

The signs of h_6(INVN) and h_7(TROUGHD) are expected to be ambiguous and negative, respectively. The ambiguity of inventory variable in the layoff regression was spelled out in the time series analysis. There were found more negative signs implying that real inventory is rather a subsitute for output than for input. In the present discussion, the sign is much more ambiguous because it is hard to tell how this variable affects the layoff rate of male and female respectively. The variable is added,

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[1] Some economists show the evidences of negative correlation between quit rate and the percent of female employees in the industry in recent years. See Armknecht, Paul A. and Early, John F. "Quits in Manufacturing: A Study of their Cause," Monthly Labor Review, (November, 1972) and Barnes, William F. and Jones, Ethel B. "Manufacturing Quit Rates Revisited: A Cyclical View of Women's Quits," Monthly Labor Review, (December, 1973).

however, to test the result. The coefficient sign of trough dummy, b_7 (TROUGHD), is expected to be negative because in the very trough months it can be expected that there will be more male layoffs. The reason is that layoffs of female in general start quite early in a recession, which results in a much less layoff for female than male group during the trough.

The regression results and the summary of the results are shown in Table 14 and Table 15 respectively.

Before examining the empirical results limitations on data have to be mentioned. Since the labor turnover statistics by sex is only available in quarterly data from 1958 to 1968, the unit of period in assumed production and labor management is now 3 months. In the quarterly data, there is no way of distinguishing discharge rate from layoff rate. Henceforth, the actual dependent variable used in the regression is the difference between female and male groups in their layoff and discharge rate. The reason for using this combined rate, while predicting the same sign of layoff rate, is that; first, the magnitude of discharge rate is expected to be much smaller than layoff rate[1] and second, the periods the regression cover are steadily increasing periods except for two troughs in April 1958, February 1961 and one peak in May 1960. Since in the steady states of economy discharge rate and layoff rate are positively correlated with each other. In addition, the data are available only by SIC 2-digit industries.

Despite all these shortcomings on data, regressions were run for twenty industries (SIC 19 - SIC 38).

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[1]Discharge rate and layoff rate in randomly selected six SIC 4-digit industries during January 1958 - December 1973 are .75 and 2.06 respectively.

TABLE 14

Male-Female Layoff Differentials Regressions

Dependent Variable = LDFMDIF
( ); t- statistics

SIC	QUITM	QUITF	HWNET	NCHAN	UNEM	INVN	TROUGHD	CONSTANT	R^2	DW
19	-.099 (-.291)	-.305 (-.826)	-68.03 (-.590)	.007 (1.121)	-.005 (-.092)	-357.5 (-.690)	-.086 (-.470)	2.936 (.737)	.09	2.05
20	-2.081 (-2.526)	1.647 (2.223)	-230.7 (-.437)	.004 (.293)	-.236 (-1.423)	.442E05 (.310)	.182 (.516)	7.677 (1.035)	.33	2.16
21	-.422 (-.724)	-.743 (-1.097)	-259.9 (-1.763)	-.001 (-.651)	-.365 (-1.477)	3448. (.463)	1.293 (2.416)	8.343 (2.378)	.33	2.24
22	.049 (.396)	-.543 (-3.370)	149.6 (1.809)	.002 (.776)	.046 (1.889)	-9427. (-.369)	.055 (.779)	-1.063 (-.785)	.71	1.96
23	.059 (.107)	-.055 (-.088)	495.5 (1.660)	.017 (1.656)	.112 (1.690)	-856.8 (-.034)	-.451 (-1.225)	-9.430 (-1.652)	.22	2.17
24	.438 (1.875)	-.270 (-.800)	159.2 (.472)	-.010 (-1.791)	-.006 (-.072)	-2202. (-1.031)	-.055 (-.200)	-2.909 (-.534)	.23	2.01
25	-.069 (-.210)	.070 (.195)	-70.53 (-.153)	-.006 (-.605)	.001 (.016)	116.5 (.036)	.1348 (.658)	1.155 (.188)	.08	2.47
26	-.584 (-1.838)	-.131 (-.417)	188.1 (1.889)	.056 (2.309)	.042 (.474)	-.389E05 (-.477)	.344 (2.760)	-1.511 (-.655)	.64	1.99
27	.174 (.388)	-.340 (-1.006)	87.74 (.852)	.006 (1.662)	.094 (1.376)	8273. (.745)	.1303 (1.092)	-3.765 (.794)	.34	1.89

SIC	QUITM	QUITF	HWNET	NCHAN	UNEM	INVN	TROUGHD	CONSTANT	R^2	DW
28	.540 (1.931)	-.124 (-.429)	65,51 (.998)	-.017 (-2.244)	.055 (1.001)	7842. (.452)	.001 (.005)	-2.003 (-.936)	.30	2.09
29	-.052 (-.113)	-.270 (-.993)	-108.2 (-1.085)	.001 (1.409)	.087 (1.218)	-2171. (-.737)	.060 (.441)	2.900 (.889)	.31	2.35
30	.040 (.073)	-.581 (-1.188)	-483.4 (-1.347)	-.054 (-3.602)	-.313 (-1.754)	.717E05 (.792)	-.185 (-.666)	13.48 (1.361)	.45	2.04
31	.621 (2.725)	-1.143 (-4.622)	-380.6 (-1.733)	.009 (1.941)	-.031 (-.291)	4712. (1.460)	.146 (.899)	4.509 (1.609)	.47	2.18
32	1.035 (2.436)	-1.585 (-2.556)	-281.2 (-1.216)	.025 (2.212)	-.072 (-.990)	-.216E05 (.279)	-.281 (-1.388)	8.146 (1.831)	.36	2.67
33	-.214 (-.437)	-1.260 (-1.770)	322.1 (1.601)	-.017 (-2.097)	-.076 (-2.027)	-.484E05 (-2.273)	-.310 (-1.324)	-4.972 (-.924)	.41	1.73
34	.928 (2.364)	-1.073 (-2.252)	52.43 (.259)	-.024 (-.929)	-.017 (-.290)	-.136E06 (-2.527)	.162 (.908)	3.409 (.967)	.46	1.57
35	-.214 (-.428)	-.409 (-.778)	280.7 (2.230)	.006 (1.138)	-.054 (-.787)	-.126E05 (-.344)	.008 (.044)	-5.663 (-1.715)	.31	2.23
36	.918 (1.959)	-.935 (-2.005)	123.3 (.726)	-.036 (-3.807)	.025 (.416)	-8091. (-.198)	.175 (1.058)	-1.138 (-.344)	.50	1.96
37	.792 (.758)	-4.134 (-2.905)	-515.5 (-1.577)	.624 (1.308)	-.077 (-1.448)	.104E06 (1.512)	-.183 (-.355)	12.46 (1.487)	.25	2.52
38	.375 (1.079)	-.256 (-.683)	-130.8 (-.895)	-.022 (-2.553)	.012 (.256)	860.4 (.428)	-.044 (-.320)	2.771 (1.095)	.32	1.53

TABLE 15

Summary of Male - Female Layoff Regression Results

Signs of the Coefficients of

the Independent Variables

No. of Ind.= 20

Independent Variables	Expected Signs	Number of Ind. Having Expected Signs (A)	(A)/20	Number of Ind. Having Expected Signs & Significant[1] (B)	(B)/20	(B)/(A)
QUITM	+	12	.60	5(2)[2]	.25(.10)[2]	.42(.25)[2]
QUITF	-	18	.90	7(1)	.35(.05)	.39(.50)
HWNET	+	10	.50	4(2)	.20(.10)	.40(.20)
NCHAN	-	9	.45	6(5)	.30(.25)	.67(.45)
UNEM	-	9	.45	2(2)	.10(.10)	.18(.18)
INVN	?	11(-)[3]	.55(-)[3]	2(-)[3](0)	.10(-)[3](0)	.18(-)[3](0)
TROUGHD	-	12	.60	0(2)	0 (.10)	0 (.25)

1. Significant at 90% confidence level ($t_{.95}$ = 1.67).
2. ( )= Number of industries having opposite expected signs and significant.
3. Figures shown are for the industries having (-) signs.

It seems the empirical results in general agree with the predictions, although the performances of most variables are not quite satisfactory. The results of the quit rate variables are relatively good. They support that the quit rate of a sex group negatively and more strongly related to the layoff rate of its own sex group. The signs of coefficients of the real wage rate (HWNET) and the employment change (NCHAN) show indifference to the layoff rate of female and of male, but they behave favorably to the predictions in terms of the statistical significances of the coefficients. The result of the external labor market condition variable (UNEM) suggests that there are few chances of replacements and that the chances would be neutral to male and female workers if any replacement occurs. The regression result of the real inventory variable (INVN) is also weak but it can be interpreted that the real inventory is more likely a substitute for output and also for male workers. The coefficient of trough dummy variable (TROUGHD) shows predicted sign in the twelve industries (60%) but none of them are significant.

CHAPTER VI

SUMMARY AND CONCLUSIONS

This study starts from the question of how a firm can handle the problem of layoff, or more generally, how a firm can maintain the optimum level and quality of work force. The analysis is basically divided into two parts. The first part is devoted to developing a model which analyzes a firm's layoff policy behavior and related problems by probing into the interrelationship of labor turnover policy variables, with special emphasis on labor quality. For this purpose, relevant variables and their relationship with layoffs are discussed in Chapter II, and a quantitative model is developed in Chapter III. The decision variables other than employment level and its change are; investment in specific human capital, wage rate, and the condition of the external labor market or "search".

One of the features that distinguishes this model from others is that each one of major variables is included and each of them plays its own role in the model. These variables are posited in such a way as to affect either the workers' qualities in the internal or external labor markets or layoff directly, by making use of the two following basic assumptions. First, the ability of a firm to subjectively evaluate workers' qualities and; second, a firm behavior in maintaining the best qualified workers available.

The second part(Chapters IV and V) is devoted to the empirical tests of the hypotheses drawn from Chapter III. The results of the estimation of the model using monthly data of 28 U.S. industries are confirmed well. The performance of the model with cross sectional data (72 U.S. industries;

1960 and 1970), is also substantial and interesting. In the cross section analysis of layoff, emphasis is placed on the tests of the specific human capital hypothesis. One finding is that the positive coefficient of wage variable and the negative coefficient of education variable in a regression, that Parsons predicted and empirically tested, is not directly founded on the specific human capital hypothesis. It has been shown that the prediction of the signs critically depends on the assumption of relationship between firm-financed and worker-financed specific training. If any one assumes it differently, one can get different set of signs. The finding was empirically tested and the opposite set of signs were obtained in 1960 and 1970. In addition, in III-2, it was shown that the assumption of positive relationship between firm-financed and worker-financed specific training was more plausible.

In the empirical study, the assertion about the effect of change in worksharing practices on layoff is tested using Student t test. Data period was subgrouped such a way that if any effect of change in worksharing practices on layoff occurs it can be detected in any of the subgroup years. The test results were not conclusive, but tests on a substantial number of industries (61% was for and 32% was against) support the assertion that workers and managements change their attitude from <u>for</u> to <u>against</u> worksharing scheme. It has also been shown that the test results support the notion that the highly unionized industries have a change in attitude against worksharing more often and do so earlier than the less unionized industries. The results of this worksharing attitude test add one more force for widening skill wage differential.

The model implied some rehire vs. new hire strategies and male-female layoff differentials of a firm. For the assumptions of firm's

ability of quality evaluation, quality consciousness, and close linkage of the internal and external labor markets enabled predictions of the performance of relevant variables. The empirical tests are done separately, and the results presented. In general, they support the predictions, but the results are not quite satisfactory.

In conclusion, the hypotheses drawn from the basic model are borne largely out throughout the various empirical tests. If firm data had been available instead of SIC 3 or 4-digit industry data, the empirical tests could have been more precise and specific.

APPENDIX A

The Optimum Condition of Changing Level of Employment (M_t) and Its Net Increase ($\dot{M}_t$)

I repeat some equations from (3·1) to (3.12).

(A·1) $$X_t = F (\phi_t M_t)$$

(A·2) $$I_t = I (T_t), \quad I_T > 0$$

(A·3) $$\phi_t = \phi (L_{t-1}, K_t, \Omega_t) ; \quad \phi_L, \phi_K, \phi_\Omega > 0$$

(A·4) $$\Omega_t = \Omega (H_{t-1}, S_{t-1}), \quad \Omega_H < 0, \quad \Omega_S > 0$$

(A·5) $$H_t = \dot{M}_t + (\ell_t + q_t + d_t) M_t$$

(A·6) $$q_t = q (W_t), \quad q_w < 0$$

(A·7) $$\text{Total Cost} = W_t M_t + C (H_t) + Z (L_t, T_t, S_t)$$

$$= W_t M_t + C\left[\dot{M}_t + (\ell_t + q_t + d_t) M_t\right] + Z\left[\ell_t M_t, T_t, S_t\right]$$

The cash flow of the firm in period t, R_t, is

(A·8) $R_t = P_t X_t - W_t M_t - C (H_t) - Z (L_t, T_t, S_t)$. By substitution,

(A·9) $$R_t = P_t F\left[\phi\left\{\ell_{t-1} M_{t-1}, K_t, \Omega\left[(\dot{M}_{t-1} + (\ell_{t-1} + q_{t-1} + d_{t-1}) M_{t-1}), S_{t-1}\right]\right\} M_t\right]$$
$$- w_t M_t - C\left[\dot{M}_t + (\ell_t + q_t + d_t) M_t\right] - Z(\ell_t M_t, T_t, S_t)$$

If the equation (A·9) is continuous and if the firm operates for infinite periods, then the present discounted value of R_t for infinite periods, V, will be

(A·10) $V = \int_0^\infty e^{-rt} R_t dt$, where r is market rate of interest.

In order to use calculus of variation, (A·9) is assumed for simplicity as (A·9·1) following the condition (3·7)* on page 55 ;

(A·9·1) $$R_t = P_t F\left[\phi\left\{\ell_t M_t, K_t, \Omega\left[(\dot{M}_t + (\ell_t + q_t + d_t) M_t), S_t\right]\right\} M_t\right]$$
$$- w_t M_t - C\left[\dot{M}_t + (\ell_t + q_t + d_t) M_t\right] - Z(\ell_t M_t, T_t, S_t)$$

Substituting (A·9·1) into (A·10), one can get

$$(A\cdot11)\qquad V = \int_0^\infty e^{-rt}\Big\{P_t F\Big[\phi\ \{\ell_t M_t,\ I(T_t),\ \Omega[\dot{M}_t + (\ell_t + q_t + d_t)M_t), S_t]\}\ M_t\Big] - W_t M_t - C\big[\dot{M}_t + (\ell_t + q_t + d_t)\ M_t\big] - Z\big[\ell_t M_t,\ T_t,\ S_t\big]\Big\}\,dt.$$

This can be expressed as

$$(A\cdot12)\qquad V = \int_0^\infty H^*(\ M_t,\ \dot{M}_t,\ W_t,\ \ell_t,\ T_t,\ S_t)\ dt$$

where

$$H^* = e^{-rt}\Big\{P_t F\Big[\phi\ \{\ell_t M_t,\ I(T_t), \Omega[(\dot{M}_t + (\ell_t + q_t + d_t)M_t), S_t]\}\ M_t\Big] - W_t M_t - C\big[\dot{M}_t + (\ell_t + q_t + d_t)M_t\big] - Z\big[\ _t M_t,\ T_t,\ S_t\big]\Big\}.$$

The optimum conditions for maximizing V with respect to ℓ_t, W_t, T_t and S_t, with the assumption of two period optimization, were given in the text for ℓ_t and in the footnote for W_t, T_t and S_t (See III-1).

Since H^* depends on M_t and $\dot{M}_t$, the first order condition for M_t is given by the Euler Equation

$$(A\cdot13)\qquad \frac{\partial H^*}{\partial M_t} = \frac{d}{dt}\left(\frac{\partial H^*}{\partial \dot{M}_t}\right)\quad .$$

Take partial derivative of H^* with respect to M_t,

$$(A\cdot14)\qquad \frac{\partial H^*}{\partial M_t} = e^{-rt}\Big\{P_t \frac{\partial F}{\partial(\phi_t M_t)}\Big[\Big(\frac{\partial \phi}{\partial L_t}\frac{\partial L_t}{\partial M_t} + \frac{\partial \phi}{\partial \ell_t}\frac{\partial \Omega}{\partial H_t}\frac{\partial H_t}{\partial M_t}\Big) M_t + \phi_t\Big] - W_t - \frac{dC}{dH_t}\frac{\partial H_t}{\partial M_t} - \frac{\partial Z}{\partial L_t}\frac{\partial L_t}{\partial M_t}\Big\}$$

$$(A\cdot15)\qquad \frac{\partial H^*}{\partial M_t} = e^{-rt}\Big\{P_t F_{(\phi M)t}\Big[\ (\ \phi_{Lt}\ell_t + \phi_{\Omega t}\Omega_{Ht}(\ell_t + q_t + d_t))M_t + \phi_t\ \Big] - W_t - C_H(\ell_t + q_t + d_t) - Z_L\ell_t\ \Big\}$$

where $\ell_t = \frac{\partial L_t}{\partial M_t}$, $(\ell_t + q_t + d_t) = \frac{\partial H_t}{\partial M_t}$.

Take partial derivative of H^* with respect to $\dot{M}_t$,

$$(A\cdot16) \qquad \frac{\partial H^*}{\partial \dot{M}_t} = e^{-rt}\left[P_t \frac{\partial F}{\partial(\phi_t M_t)} \frac{\partial \phi}{\partial \Omega_t} \frac{\partial \Omega}{\partial H_t} \frac{\partial H_t}{\partial \dot{M}_t} M_t - \frac{dC}{dH_t} \frac{\partial H_t}{\partial \dot{M}_t}\right]$$

$$(A\cdot17) \qquad \frac{\partial H^*}{\partial \dot{M}_t} = e^{-rt}\left[P_t F_{(\phi M)t} \phi_{\Omega t} \Omega_{Ht} M_t - C_H\right]$$

where $\frac{\partial H_t}{\partial \dot{M}_t} = 1.$

Take time derivative of (A·17),

$$(A\cdot18) \qquad \frac{d}{dt}\left(\frac{\partial H^*}{\partial \dot{M}_t}\right) = -re^{-rt}(PF_{(\phi M)t}\phi_{\Omega t}\Omega_{Ht}M_t - C_H)$$

$$+ e^{-rt}\left[P(\dot{F}_{(\phi M)t}\phi_{\Omega t}\Omega_{Ht}M_t + F_{(\phi M)t}\dot{\phi}_{\Omega t}\Omega_{Ht}M_t\right.$$

$$\left. + F_{(\phi M)t}\phi_{\Omega t}\dot{\Omega}_{Ht}M_t + F_{(\phi M)t}\phi_{\Omega t}\Omega_{Ht}\dot{M}_t) - \dot{C}_H\right]$$

where it is assumed that P_t remains constant over time. The optimum condition for M_t and $\dot{M}_t$ will be obtained by equating (A·15) and (A·18) using the relationship of (A·13). If, however, $F_{(\phi M)t}$, $\phi_{\Omega t}$ and Ω_{Ht} remain unchanged over time, then (A·18) becomes

$$(A\cdot19) \qquad \frac{d}{dt}\left(\frac{\partial H^*}{\partial \dot{M}_t}\right) = -re^{-rt}(PF_{(\phi M)}\phi_{\Omega}\Omega_H M_t - C_H)$$

$$+ e^{-rt}(PF_{(\phi M)}\phi_{\Omega}\Omega_H\dot{M}_t - \dot{C}_H)$$

By (A·13) $\frac{\partial H^*}{\partial M_t} = \frac{d}{dt}\left(\frac{\partial H^*}{\partial \dot{M}_t}\right)$,

(A·15) = (A·19)

i.e.,

$$(A\cdot20)\qquad e^{-rt}\left[PF_{(\phi M)}\left[(\phi_{Lt}\ell_t + \phi_\Omega\Omega_H(\ell_t + q_t + d_t))\,M_t + \phi_t\right] - W_t - C_H(\ell_t + q_t + d_t) - Z_L\ell_t\right]$$

$$= -re^{-rt}(PF_{(\phi M)}\phi_\Omega\Omega_H M_t - C_H) + e^{-rt}(PF_{(\phi M)}\phi_\Omega\Omega_H\dot{M}_t - \dot{C}_H)$$

By arranging it, (A·20) becomes

$$(A\cdot21)\qquad PF_{(\phi M)}\Big\{\Big[\Big\{\underset{\oplus}{\phi_{Lt}\ell_t} + \underset{\ominus}{\phi_\Omega\Omega_H}(\ell_t + q_t + d_t)\Big\}M_t + \underset{\oplus}{\phi_t}\Big] + \underset{\ominus}{r\phi_\Omega\Omega_H M_t} - \underset{\ominus}{\phi_\Omega\Omega_H\dot{M}_t}\Big\}$$

$$= C_H(r + \ell_t + q_t + d_t) + W_t + Z_t\ell_t - \dot{C}_H$$

or

$$(A\cdot22)\qquad PF_{(\phi M)}\left\{\phi_\Omega\Omega_H\left(r + \ell_t + q_t + d_t - \frac{\dot{M}_t}{M_t}\right)M_t + \phi_{Lt}L_t + \phi_t\right\}$$

$$= C_H(r + \ell_t + q_t + d_t) + W_t + Z_t\ell_t - \dot{C}_H$$

The condition (A.21) states that the maginal benefit of changing M_t and $\dot{M}_t$ must be equal to the marginal cost of changing them. In (A·22) it is shown that when $r + \ell_t + q_t + d_t = \frac{\dot{M}_t}{M_t}$, the marginal cost must be equal to $PF_{(\phi M)}(\phi_{Lt}L_t + \phi_t)$.

APPENDIX B

Names of Industries used in Time Series Layoff Regressions

SIC	Names of Industries
2011	Meat Packing Plants
2051	Bread, Cake, and Related Products
221	Weaving Mills, Cotton
225	Knitting Mills
228	Yarn and Thread Mills
2321	Men's and Boy's Shirts and Nightwear
2341	Women's and Children's Underwear
2421	Sawmills and Planing mills, General
2511	Wood Household Furniture
261,2,6	Paper and Pulp Mills
2653	Corrugated and Solid Fiber Boxes
2823,4	Synthetic Fiber
2834	Pharmaceutical Preparations
291	Petroleum Refining
301	Tires and Inner Tubes
314	Footwear, Except Rubber
3221	Glass Containers
3312	Blast Furnaces, and Steel Mills
3321	Gray Iron Foundries
3443	Fabricated Plate Work (Boiler Shops)
346	Metal Stampings
3531,2	Construction and Mining Machinery
3585	Refrigeration Machinery
3621	Motors and Generators
3662	Radio and TV Communication Equipment
3711	Motor Vehicles
3721	Aircraft
3821	Mechanical Measuring devices

APPENDIX C

Layoff Regression; Comparison of Ordinary Least Square

and Two Stage Least Square Methods

Dependent Variable = LOFF
( ); t- statistics

SIC	METHODS	HWRATM [1]	OWNWRAT	DN	LDN1	UNEM	UNEML1	INVN	RWD	CONSTANT	R^2
2011	OLS	100.7	-50.41	-.324	-.116	.066	.118	-43.14	1.998	-10.90	.25
		(3.045)	(-2.342)	(-2.253)	(-.784)	(1.241)	(2.091)	(-4.679)	(1.635)	(-.281)	
	TSLS	104.7	-50.88	-.327	-.114	.066	.118	-43.40	2.028	-14.82	.35
		(1.502)	(-2.245)	(-2.199)	(-.762)	(1.237)	(2.040)	(-4.325)	(1.554)	(-.208)	
2823	OLS	57.83	-55.87	-.934	-.363	.104	-.009	13.72	2.473	-3.807	.44
		(3.985)	(-6.414)	(-6.018)	(-2.386)	(2.050)	(-.188)	(1.891)	(3.808)	(-.196)	
	TSLS	140.8	-51.81	-.837	-.373	.140	-.001	29.81	2.327	-101.3	.34
		(5.587)	(-5.454)	(-4.925)	(-2.254)	(2.499)	(-.017)	(3.406)	(3.297)	(-3.239)	
314	OLS	1.295	-59.72	-.949	.213	-.002	.172	10.43	2.847	45.01	.31
		(.072)	(-5.930)	(-5.790)	(1.315)	(-.034)	(2.568)	(2.975)	(3.396)	(2.543)	
	TSLS	78.12	-59.81	-.942	.268	.006	.198	11.96	2.372	-15.47	.25
		(2.078)	(-5.665)	(-5.485)	(1.564)	(.088)	(2.778)	(3.204)	(2.630)	(-.489)	
3443	OLS	36.78	-70.69	-.437	-.422	.094	-.020	-29.85	1.846	57.59	.69
		(2.046)	(-4.304)	(-3.349)	(-3.265)	(2.984)	(-.636)	(-4.552)	(2.249)	(2.154)	
	TSLS	116.6	-74.66	-.430	-.376	.084	-.010	-11.16	1.102	-34.82	.66
		(2.378)	(-4.282)	(-3.131)	(-2.710)	(2.497)	(-.289)	(-.882)	(11.46)	(-.586)	

SIC	METHODS	HWRTM[1]	OWNWRAT	DN	LDN1	UNEM	UNEML1	INVN	RWD	CONSTANT	R^2
3711	OLS	134.0	-89.71	-.738	-.542	.460	-.196	35.13	11.64	-67.98	.35
		(1.755)	(-2.141)	(-2.593)	(-2.244)	(5.475)	(-2.481)	(.577)	(2.076)	(-.698)	
	TSLS	193.3	-97.22	-.758	-.554	.463	-.189	23.11	11.14	-133.7	.35
		(.992)	(-2.037)	(-2.602)	(-2.265)	(5.467)	(-2.302)	(.325)	(1.913)	(-.604)	

[1]In running two stage least squares, the variables used for the instrument variables are; OWNWRAT, DN, LDN1, UNEM, UNEML1, RWD, INVN, HELP, TD, where HELP is the index of help wanted.

APPENDIX D

Derivation of Student t Statistics Used in V-1

Let two regression equations in each set be

(D·1) $$Y_1 = \beta_o + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_i X_i + \cdots + \beta_k X_k + u$$

(D·2) $$Y_2 = \gamma_o + \gamma_1 X_1 + \gamma_2 X_2 + \cdots + \gamma_i X_i + \cdots + \gamma_k X_k + v$$

with n_1 number of observations in (D·1) and n_2 in (D·2). If X_i is work-sharing variable, then the null hypothesis is

(D·3) $$H_o;\ \beta_i = \gamma_i \ .$$

It is assumed, following convention, that u and v are normally distributed. Then the estimators

(D·4) $$\hat{\beta}_i \sim N\left[\beta_i,\ a_{ii}\sigma^2\right]$$

(D·5) $$\hat{\gamma}_i \sim N\left[\gamma_i,\ b_{ii}\sigma^2\right]$$

And

(D·6) $$(\hat{\beta}_i - \hat{\gamma}_i) \sim N\left[(\beta_i - \gamma_i),\ (a_{ii} + b_{ii})\sigma^2\right]$$

(D·7) $$Z = \frac{(\hat{\beta}_i - \hat{\gamma}_i) - (\beta_i - \gamma_i)}{\sqrt{(a_{ii} + b_{ii})\sigma^2}} \sim N\left[0,1\right].$$

Let the residuals in n_1 and n_2 observations be

(D·8) $$Y_{1i} - \hat{Y}_{1i} = e_{1i}$$

(D·9) $$Y_{2i} - \hat{Y}_{2i} = e_{2i}$$

Since the sum of two Chi-square (χ^2) variables has also a Chi-square distribution with the sum of degree of freedom of both Chi-square variables,

(D·10)
$$\chi^2 = \frac{\sum_{i=1}^{n_1} e_{1i}^2}{\sigma^2} + \frac{\sum_{i=1}^{n_2} e_{2i}^2}{\sigma^2} = \frac{\sum_{i=1}^{n_1} e_{1i}^2 + \sum_{i=1}^{n_2} e_{2i}^2}{\sigma^2} \sim \chi^2,$$

$$\text{d.f. } (n_1 - k) + (n_2 - k) = (n_1 + n_2 - 2k)$$

Therefore

(D.11)
$$t = \frac{Z}{\sqrt{\frac{\chi^2}{\text{d.f}}}} = \frac{(\hat{\beta}_i - \hat{\gamma}_i) \Big/ \sqrt{(a_{ii} + b_{ii})\sigma^2}}{\sqrt{\frac{\sum_{i=1}^{n_1} e_{1i}^2 + \sum_{i=1}^{n_2} e_{2i}^2}{\sigma^2} \Big/ (n_1 + n_2 - 2k)}}$$

$$= \frac{(\hat{\beta}_i - \hat{\gamma}_i)\sqrt{(n_1 + n_2 - 2k)}}{\sqrt{(a_{ii} + b_{ii})\left(\sum_{i=1}^{n_1} e_{1i}^2 + \sum_{i=1}^{n_2} e_{2i}^2\right)}}$$

(D·12)
$$= \frac{(\hat{\beta}_i - \hat{\gamma}_i)\sqrt{(n_1 + n_2 - 2k)}}{\sqrt{\left(\frac{c_{ii}(n_1 - k)}{\sum_{i=1}^{n_1} e_{1i}^2} + \frac{d_{ii}(n_2 - k)}{\sum_{i=1}^{n_2} e_{2i}^2}\right)\left(\sum_{i=1}^{n_1} e_{1i}^2 + \sum_{i=1}^{n_2} e_{2i}^2\right)}}$$

where
$$c_{ii} = a_{ii}\sigma^2 = \text{Var}(\hat{\beta}_i)$$

$$d_{ii} = b_{ii}\sigma^2 = \text{Var}(\hat{\gamma}_i)$$

$$\sigma^2 = \frac{\sum_{i=1}^{n_1} e_{1i}^2}{(n_1 - k)} = \frac{\sum_{i=1}^{n_2} e_{1i}^2}{(n_2 - k)}$$

$$\therefore \quad a_{ii} = \frac{c_{ii}(n_1 - k)}{\sum_{i=1}^{n_1} e_{1i}^2} \qquad b_{ii} = \frac{d_{ii}(n_2 - k)}{\sum_{i=1}^{n_2} e_{2i}^2}.$$

It is easy to compute t statistics (D·12) because $\hat{\beta}_i$, $\hat{\gamma}_i$, c_{ii}, d_{ii}, $\sum_{i=1}^{n_1} e_{1i}^2$ and $\sum_{i=1}^{n_2} e_{2i}^2$ are all given in the regression results by computer.

APPENDIX E

The Definitions of the Variables and the Data Sources

1. Time Series Regression

LOFF = Monthly layoff rates per 100 employees, U.S. Bureau of Labor Statistics, Employment and Earnings, United States, 1909-72, Bulletin 1312-9, 1973, and U.S.Bureau of Labor Statistics, Employment and Earnings (Monthly), various months in 1973 and 1974. Hereafter these two sources will be abbreviated as E and E and E and E (Monthly), respectively.

HWRATM = Ratio of real straight hourly wage rate of an industry and that of total manufacturing, E and E and E and E (Monthly)

HWNET = Real straight hourly wage rate of an industry, E and E and E and E (Monthly).

OWNWRAT = Ratio of HWNETs in period t and t-1, E and E and E and E (Monthly)

DN = Sum of the discharge rate and the rate of employment change between periods t-1 and t per 100 employees, E and E and E and E (Monthly)

LDN1 = One month lead of DN, E and E and E and E (Monthly).

UNEM = Unemployment rate in an industry (2-digit industry classification), Eand E (Monthly), 1958-1974.

UNEML1 = One month lead of DN, E and E (Monthly), 1958-1974.

INVN = Amount of Inventory (end of month, by book value) divided by GNP deflator,

Inventory : Department of Commerce, Survey of Current Business, various months in 1958-1974.

GNP deflator : Department of Commerce, op. cit., 1958-1974.

RWD = Reduced work dummy

RWD = 1 if the standardized weekly hours of work exceeds weekly hours of work for the month

= 0 other wise

weekly hours of work: E and E and E and E (Monthly).

TD = Trough dummy, TD = 1 for trough months, = 0 otherwise

Trough months: Department of Commerce, Business Conditions Digest, March, 1974, p. 116

2. Cross Section Regression

LOFF = Annual average of monthly layoff rates per 100 employees, E and E.

HWAGE = Annual average of straight hourly wage rate of an industry, E and E.

HWAGEL1 = One year lag of HWAGE, E and E.

EDUCAT = Median years of schooling completed, U.S. Bureau of Census, Census of Population; Industrial Characteristics, 1960 and 1970 (= CP, IC)

DISC = Annual average of monthly discharge rates per 100 employees, E and E.

NCHAN = Rate of annual average number of employment changed between t-1 and t years per 100 employees, E and E.

UNEM = Annual average of unemployment rate in an industry (by 2-digit standard industry classification), E and E (Monthly), 1961, 1971.

INVN = Inventory (by book value) per man, Department of Commerce,

Survey of Current Business, 1961, 1971.

PROF = Percentage of Professionals in an industry, CP, IC.

OLD = Percentage of workers age 55-65 years, CP,IC.

YOUNG = Percentage of workers age 16-24 years, CP, IC.

FEMALE = Percentage of female workers in an industry, CP, IC.

GOVT = Percentage of government employees in an industry, CP, IC.

CONCEN = Percentage of value of shipment accounted by the largest 4 companies in each industry.(The concentration ratio used for 1960 is that of 1963 .), U.S. Bureau of Census, Annual Survey of Manufacturers, 1971.

3. Other Regressions

QUIT = Monthly quit rates per 100 employees, E and E and E and E (Monthly)

QUITM = Quit rate of male workers(quarterly data), E and E.

QUITF = Quit rate of female workers(quarterly data), E and E.

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