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ON RECALLS, LAYOFFS, VARIABLE HOURS, AND LABOR ADJUSTMENT COSTS*

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The paper analyzes the employment policy of a firm that can vary both hours and the level of employment. The analysis differs from previous work in the adjustment cost literature in that the firm is able to change its employment not only through hires, layoffs, and quits, but also by recalls of employees who were previously laid off. Thus, we introduce the possibility of the firm inventorying the labor input. It is shown that this labor inventory potential is necessary if the firm is to ever lay off workers. Further, it is demonstrated that linear rather than strictly convex adjustment costs are then required if the firm is to always recall employees who were previously laid off prior to hiring new workers.

1. Introduction

A seminal paper by Walter Oi (1962) examines the employment decisions of an employer who finds it costly to hire and train new workers. These costs are shown to create a wedge between a worker's value of marginal product and wage and, as a consequence, to reduce the employment fluctuations that result from variations in output demand. Or, put differently, labor is shown to be a 'quasi-fixed factor of production'.

Recent papers have begun to explore more fully the cyclical implications of the fixity of labor [see Sargent (1978, 1979), Nickell (1978), Leban and Lesourne (1980, 1983) and Leban (1982)]. As in Oi's work, these papers assume that all layoffs are permanent. Yet Feldstein (1978) and Lilien (1977, 1980) demonstrate that a majority of the layoffs in the United States end in subsequent recall.[1] In other words, it appears that firms can inventory the labor input just

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[1]As Feldstein (1978, p. 938) argues, those that are 'laid off know that they will soon return to their employer, protected by seniority arrangements and their job-specific human capital'. It should be noted that Leban (1982) and Leban and Lesourne (1983) are primarily concerned with analyzing employment in continental Europe, where permanent layoffs appear to be of much greater importance. Our analysis is more appropriate in the context of the United States.

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as they can inventory output. In this paper, we examine the effects that this ability to inventory the labor input has on the employment and hours decisions of a firm facing costs of adjusting its labor force.[2]

The paper is structured as follows. In section 2, the basic model is outlined. As noted above, the model differs from other work in the labor adjustment cost literature in that layoffs, if they occur, can be temporary in nature. That is, some of the workers that a firm lays off today are available for employment in the future.[3] Section 3 characterizes the firm's hiring, recall, and layoff behavior. In a model without recall potential, Leban has shown that layoffs are not optimal. In section 4, we show that layoffs can be optimal when the potential to recall is introduced. And, we establish this result in a model in which firms can vary their labor input not only by changing the number of workers that they employ, but also by changing the number of hours that employees work.[4] Section 5 turns to a discussion of the effects of linear adjustment costs on the timing of recalls and new hires. Section 6 contains some concluding remarks.

2. A model of employment with recalls and variable hours

Consider a firm that produces a perishable output. Letting $N(t)$ denote the number of workers employed by the firm at time t and letting $h(t)$ denote the number of hours worked by each employee at time t, the firm's output $Y(t)$ is given by

$$Y(t) = f(N(t), h(t)).^5 \tag{1}$$

The firm's labor force increases over time as a result of new hires and recalls and it decreases as a result of layoffs and quits. Letting $A(t)$ denote the number of workers hired at time t, $L(t)$ the number of workers laid off at time t, $R(t)$ the number of previously laid off workers recalled at time t, and $q(t)$ the rate at which employed workers quit at time t, the rate of change in the firm's labor force at time t is given by

$$N(t) = A(t) + R(t) - L(t) - q(t)N(t). \tag{2}$$

[2] For simplicity, we do not allow the firm to inventory its output. For a discussion of the effects of output inventories, see Topel (1982) and Okun (1981).

[3] In addition to the works cited above, other papers in the labor adjustment cost literature include Parsons (1972), Pencavel (1972), and Salop (1973). A summary of the earlier literature may be found in Parsons (1977).

[4] In this way, the model developed can be viewed as an extension of the work of Leban.

[5] $F(\cdot)$ is assumed to be a concave function with $F_N > 0$ and $F_h > 0$. For simplicity, we allow the firm to vary neither its capital stock nor its rate of capital utilization. Papers that analyze these choices include Leban and Lesourne (1980, 1983) and Abel (1981).

The firm can recall workers at time t only if it has an inventory of previously laid off workers. Denote this stock of laid off individuals by $S(t)$. The rate of change in this stock is given by

$$\dot{S}(t) = L(t) - R(t) - \theta S(t), \tag{3}$$

where θ is the rate at which laid off workers find employment elsewhere (and thus leave the firm's pool of laid off workers).[6]

As pointed out by Oi (1962) and others, it is costly to hire and train new workers. Let $a(A(t))$ denote the cost to the firm of hiring and training new workers at time t. This cost is assumed to be an increasing convex function of the firm's hire rate $A(t)$. Similarly, let $l(L(t))$ and $r(R(t))$ denote the cost to the firm of laying off and recalling workers at time t, respectively.[7] Since recalled workers retain some specific training from the past, it is less costly to recall a previously laid off worker than to hire a new one. That is, $a'(\cdot) > r'(\cdot)$.

The rate $q(t)$ at which employees quit the firm at time t depends on the utility value of being employed at the firm relative to that of being employed elsewhere. Following Leban, we assume that the firm can affect the quit rate $q(t)$ through the hourly wage $w(t)$ that it pays at time t.[8] In addition, we allow the firm's choice of hours to affect the rate at which its employees quit. Summarizing, we have

$$q(t) = q(w(t), h(t)).^{9} \tag{4}$$

Finally, let $X(t)$ denote the maximum amount of output that the firm can sell at time t and let $p(t)$ denote the price that the firm receives for its output at time t.[10] Assuming, for simplicity, that at time 0 the firm knows with certainty the future paths of both X and p and letting ρ denote the firm's discount rate, the value of the firm's stream of discounted profits is given by

$$\int_0^\infty \{ pF(N,h) - whN - a(A) - r(R) - l(L) \} \, \mathrm{e}^{-\rho t} \mathrm{d}t.^{11} \tag{5}$$

[6] By way of analogy with the inventory literature, one might think of θ as the rate at which the firm's inventory of laid off workers spoils. Lilien (1977) and Peris (1982) provide estimates of θ.

[7] We assume that $l(\cdot)$ and $r(\cdot)$ are both increasing convex functions.

[8] Earlier papers that made this assumption include Mortensen (1970) and Salop (1973).

[9] Using (4), we may solve for the wage rate w as a function of hours worked h and the quit rate q. Specifically, $w = g(h, q)$, where $g_q < 0$. As we discuss in the next section, the sign of g_h depends on the nature of workers' preferences for leisure.

[10] This specification allows us to examine the effect of changes in the firm's output price and changes in the sales constraint facing the firm.

[11] The assumption of perfect foresight on the part of the firm is quite common in the literature. See, for example, Nickell and Leban and Lesourne. Sargent (1978) makes the weaker assumption of rational expectations concerning output price.

The objective of the firm is to maximize (5) subject to (2), (3), (4), $X \geq F(N, h)$, and non-negativity constraints on the control and state variables. This problem differs from the standard optimal control problem in that it contains a state variable (S) that not only is constrained to be non-negative, but also does not enter into the objective function. As noted by Berkovitz (1962), since a non-negativity constraint on a state variable implies constraints on the controls as well, the traditional Kuhn–Tucker multiplier is inappropriate.[12]

3. Optimal hires, recalls, and layoffs

The first-order conditions to the firm's maximization problem are presented in the appendix. Consider first the firm's hiring behavior. Let $\mu_X(t)$ denote the multiplier corresponding to the firm's sales constraint at time t and define the effective price of output as $p^*(t) \equiv p(t)(1 - \mu_X(t))$. Note that if the sales constraint is not binding at time t, then $\mu_X(t) = 0$ and $p^*(t) = p(t)$. Furthermore, it can be shown that for a given $p(t)$, a reduction in the amount $X(t)$ that the firm can sell at time t leads to a reduction in $p^*(t)$.

If the firm hires at time 0, then its choice of hires satisfies

$$a'(A(0)) = \int_0^\infty \{ p^* F_N - wh \} \exp\left(- \int_0^t (\rho + q)\, \mathrm{d}u \right) \mathrm{d}t \equiv \lambda_N(0). \tag{6}$$

This is, of course, the well-known result that the firm hires workers up to the point at which the cost of hiring one more worker equals the worker's capitalized value, $\lambda_N(0)$. By way of analogy to Tobin's 'q' in the capital investment literature, $\lambda_N(0)$ may be termed Oi's 'q'. Since $\lambda_N(0)$ equals the value of the stream of discounted differences between a worker's value of marginal product and wage, it provides a measure of the degree of fixity of the labor input.[13]

Next consider the firm's recall and layoff decisions. Let $\hat{\lambda}_S$ denote the capitalized value to the firm of the marginal worker in the stock of unemployed. That is,

$$\hat{\lambda}_S = \lambda_S + \phi, \tag{7}$$

[12] In our problem, when $S = 0$, we have the constraint $\dot{S} \geq 0$. See Berkovitz (1962), Hestenes (1966, ch. 8) and Russak (1970) for further discussion of the complications introduced by non-negativity constraints on the state variables.

[13] Note that the appropriate discount rate incorporates both the interest rate ρ and the quit rate q. If workers were required to compensate the firm for the loss (or gain) they imposed when quitting at time t, eq. (6) would become

$$a'(A^*(0)) = \int_0^\infty (p^* F_N - wh)\, \mathrm{e}^{-\rho t} \mathrm{d}t,$$

which is Oi's result in continuous time given that workers have an infinite life.

where λ_S is the costate variable associated with the differential equation for $\dot{S}$ and ϕ is a non-negative multiplier associated with the constraint $S \geq 0$. If recalls are positive at time 0, then they satisfy

$$r'(R(0)) = \lambda_N(0) - \hat{\lambda}_S(0). \tag{8}$$

That is, the firm recalls workers up to the point where the cost of recalling one more worker equals the difference between the worker's capitalized value in the stock of employed and his value in the stock of unemployed.

If layoffs are positive at time 0, then the marginal worker is more valuable to the firm in the stock of unemployed than he is in the stock of employed. The firm's choice of layoffs then satisfies

$$l'(L(0)) = \hat{\lambda}_S(0) - \lambda_N(0). \tag{9}$$

4. Layoffs, variable hours, and the labor inventory

Leban obtains the result that layoffs are never optimal. Similarly, in the context of an implicit-contract model, Mortensen establishes conditions under which layoffs will not occur.[14] In our model, we can show the following:

Proposition 1. To rule out layoffs, it is sufficient that either (1) all layoffs are permanent ($\theta \to \infty$) or (2) the following three conditions hold: (a) the quit rate θ from the inventory of unemployed is not less than the quit rate q from the stock of employed workers, (b) workers do not prefer risk in consumption and leisure, and (c) output depends solely on total manhours.

Proof. If all layoffs are permanent, then $S \equiv \lambda_S \equiv \phi \equiv 0$. Thus, from eq. (A.4), $L(0) > 0$ implies $\lambda_N(0) < 0$. But from eq. (A.6) this is a contradiction.

Now suppose that layoffs are not necessarily permanent, but that assumptions (2.a), (2.b), and (2.c) hold. If $L(0) > 0$, then $\phi(0) = 0$ from (A.13). Thus, from (9), we have

$$l'(L(0)) = \lambda_S(0) - \lambda_N(0). \tag{10}$$

[14] The implicit-contract model differs from ours in two ways. First, behavior over time is typically collapsed into one period. Second, in this 'collapsed' period, workers know not only the wage they will receive and the number of hours they will work, but also the probability that they will be laid off. In the context of our model, these two assumptions imply that workers have perfect foresight with respect to wages, hours, and layoffs.

Differentiating (10) with respect to t, utilizing (A.7) and (A.8), yields

$$l''(0)\dot{L}(0) = (\rho+\theta)\lambda_S(0) + (p^*F_N - wh) - (\rho+q)\lambda_N(0)$$
$$= \rho(\lambda_S(0) - \lambda_N(0)) + (p^*F_N - wh) + \theta\lambda_S(0) - q\lambda_N(0). \tag{11}$$

Assumption (2.b) implies that $w_h > 0$ and assumption (2.c) implies that $F_N = (h/N)F_h$. Thus, from eq. (A.5), $p^*F_N > wh$.[15] Since $\lambda_S - \lambda_N$ is positive from eq. (10) and since $\theta \geq q$ by assumption (2.a), it follows from (11) that $\dot{L}(0) > 0$. Noting that the same argument holds for any t, it follows that for all t, $\dot{L}(t) > 0$. But this is not possible. Q.E.D.

In interpreting Proposition 1, note that condition (1) is that made by Leban. If all layoffs are permanent, then laying a worker off is equivalent to letting him quit in that in neither case will he be available to the firm in the future. However, since the firm can increase the rate at which its workers quit by lowering the wage that it pays, the firm prefers to reduce employment by inducing workers to quit than by laying them off. Thus, for layoffs to occur, it is necessary that the firm has the potential to inventory laid off workers.

Although the potential to inventory workers is necessary for layoffs to occur during periods of low demand, it is not sufficient. Instead of reducing employment, the firm may simply choose to reduce the number of hours that employees work. In an implicit-contract model, Mortensen (1978) shows that assumptions (2.b) and (2.c) in Proposition 1 make a policy of reducing hours preferable to one of layoffs since (2.b) 'implies that no worker prefers one consumption–leisure combination during the fraction of his work life that he spends employed and another combination during the remaining fraction spent unemployed to the average of the two all the time and (2.c) implies that there is no real cost (to the firm) in catering to this preference'. In our model, we need an additional assumption to rule out layoffs, namely, employed workers must not be more likely to quit than laid off workers are to leave the stock of unemployed [condition (2.a)].

It is straightforward to show that relaxing the above assumptions can lead the firm to choose layoffs when the demand for its output is low. Thus, there are three possible reasons for layoffs. First, if the rate q at which employed workers leave the firm is higher than the rate θ at which laid off workers leave, the firm can reduce its hiring costs in the future by laying off workers today.[16]

[15] If $p^*(0) = 0$, then the optimal value of h is zero. As a consequence, $p^*F_N - wh = 0$ and the proof is still valid.

[16] This case is, of course, not very likely since lower search costs for the unemployed as compared to employed individuals should result in $\theta > q$.

Second, the firm's production technology may be such that a reduction in output achieved by lowering employment may reduce the firm's cost by a greater amount than a reduction in output achieved by lowering hours.[17] Third, if workers have preferences for blocks of leisure, or if there exists tax-free unemployment compensation, then firms might have to pay workers a higher hourly wage when hours are reduced. This would encourage the firm to lay workers off instead of reducing their working hours.[18]

Having established the conditions that will lead the firm to inventory workers by laying them off and subsequently recalling them, we now look more carefully at the timing of the firm's layoff, recall, and hiring decisions.

5. The timing of hires and recalls: The role of linear adjustment costs

We generally observe firms exhausting their inventory of laid off workers before hiring new employees. What restrictions are required to obtain this result in a labor adjustment cost model?

Somewhat surprisingly, the assumption that it is more costly to hire a new worker than to recall one previously laid off does not guarantee that the firm will hire new workers only after recalls are no longer possible. From eq. (8), we see that there is an implicit cost to the firm of recalling a worker today. By recalling him today, the firm foregoes the opportunity to recall him in the future and, thus, may have to hire if it subsequently wishes to increase its labor force. If the future cost of hiring is sufficiently high, it may pay for the firm to delay recalling the worker (even though the firm could reduce its *current* costs by substituting recalls for hires).

Since the profitability of a strategy of deferring recalls rests on the gain to the firm of smoothing its paths of hires and recalls over time, it depends crucially on the strict convexity of the hiring and recall cost functions. If these functions are linear, there is no gain to smoothing.[19] Consequently, we have:

Proposition 2. If it is more costly to hire a new worker than it is to recall one on layoff and if adjustment costs are linear, then the firm will hire only after it has exhausted its inventory of potential recalls.

Proof. Suppose that $A(0)$ and $S(0)$ are both positive. Then $\mu_A(0) = \phi(0) = 0$, which implies that

$$a' - r' \leq \lambda_S(0). \tag{12}$$

[17] Feldstein (1976) presents a convincing argument for this case. Specifically, if there is only one work shift and if hours of capital utilization cannot be chosen independently of the length of the workweek, then a reduction in hours, but not in employment, reduces the rate of capital utilization.

[18] Nickell obtains layoffs as a result of this third reason. For a lengthier discussion of reasons 2 and 3, see Mortensen (1978).

[19] Nickell, Leban and Lesourne, and Leban all assume that adjustment costs are linear.

Let τ be that instant at which the firm's inventory of unemployed workers is first exhausted.[20] From (A.2) and (A.3),

$$a' - r' = \mu_A + \hat{\lambda}_S(\tau). \tag{13}$$

From eqs. (12) and (13), $0 \leq \mu_A \leq \lambda_S(0) - \hat{\lambda}_S(\tau)$. But this is a contradiction since $\lambda_S(0) < \hat{\lambda}_S(\tau)$.[21] Q.E.D.

Since linear adjustment costs yield the plausible result that the firm exhausts potential recalls before hiring any new workers, it is useful to examine other characteristics of firm behavior in the presence of linear adjustment costs. In making its current choices, the firm places less weight on future demand conditions if adjustment costs are linear than if they are convex. Consider, for example, the effect of an increase in effective demand at time τ on the firm's hiring behavior at time 0 if adjustment costs are linear. If the firm initially planned to be hiring at time τ, then an increase in $p^*(t)$ will cause the firm to increase its planned hiring at time τ. The value of an additional worker at time $\tau(\lambda_N(\tau))$ will be kept equal to the (constant) marginal cost of hiring. Since the value of an additional worker to the firm at time 0 is not affected, neither is the firm's choice of hires at time 0.[22]

In contrast to its effect on hires, an increase in effective demand at time τ generally causes an increase in recalls at time 0 (even if adjustment costs are linear). If laid off workers are more likely than employed workers to leave the firm, then there is an implicit cost to the firm of not recalling a worker. The greater is the firm's desired employment in the future, the greater is the cost to the firm of not recalling today. Thus, an increase in $p^*(\tau)$ causes an increase in recalls at time 0.

6. Conclusion

This paper has analyzed the effects that the potential to vary employees' hours and to inventory laid off workers has on a firm's employment policy. As such, it extends the recent work of Nickell, Leban, and Leban and Lesourne. The potential to inventory laid off workers was shown to play a crucial role in generating layoffs. Also important were worker's preferences for risk in their consumption and leisure. Finally, the timing of the employer's hiring and recall

[20] If S is never equal to zero, then $\lambda_S(0) = \phi = 0$. Thus, from (A.3), $\lambda_N(0) \leq r'$. Since $r' < a'$, it follows that the firm cannot be hiring.

[21] Note that $\lambda_S > 0$ and $\phi = 0$ during the time interval 0 to τ.

[22] Note that $\lambda_N(0) = \int_0^\tau (p^* F_N - wh)\exp(-\int_0^t (\rho + q)\,\mathrm{d}u)\,\mathrm{d}t + \lambda_N(\tau)\exp(-\int_0^\tau (\rho + q)\,\mathrm{d}u)$. Note also that if the firm is not initially planning on hiring at time τ, then an increase in $p^*(\tau)$ results in an increase in $\lambda_N(\tau)$ and, consequently, an increase in $\lambda_N(0)$ and $H(0)$.

decisions under various assumptions about the nature of adjustment costs was examined. It was shown that only if adjustment costs are linear will it generally be non-optimal for the firm to hire until after it has exhausted its inventory of potential recalls. This, and the fact that linear adjustment costs are typically more tractable than strictly convex adjustment costs, suggests that the assumption of linearity may be a useful one to make in future work.

Appendix

The current valued Hamiltonian corresponding to the optimal control problem (5) is given by

$$\begin{aligned} H(A,R,L,h,q,N,S) = \{ & pF(N,h) - w(h,q)hN - a(A) - r(R) \\ & - l(L) + \lambda_N(A + R - L - qN) \\ & + \lambda_S(L - R - \theta S) + \mu_A A + \mu_R R \\ & + \mu_L L + \mu_X p(X - F(N,h)) \\ & + \phi(L - R - \theta S)\}\mathrm{e}^{-\rho t}, \end{aligned} \tag{A.1}$$

where λ_N and λ_S are the costate variables associated with the state variables N and S, μ_A, μ_R, and μ_L are the Kuhn–Tucker multipliers associated with the non-negativity constraints on the control variables A, R, and L, and ϕ is the multiplier corresponding to the non-negativity constraint on the state variable S. A solution to the optimal control problem must satisfy the following conditions:

$$\partial H/\partial A = -a'(A) + \lambda_N + \mu_A = 0, \tag{A.2}$$

$$\partial H/\partial R = -r'(R) + \lambda_N - \lambda_S + \mu_R - \phi = 0, \tag{A.3}$$

$$\partial H/\partial L = -l'(L) - \lambda_N + \lambda_S + \mu_L + \phi = 0, \tag{A.4}$$

$$\partial H/\partial h = p(1 - \mu_X)F_h - wN - w_h hN = 0, \tag{A.5}$$

$$\partial H/\partial q = -w_q hN - \lambda_N N = 0, \tag{A.6}$$

$$\rho\lambda_N - \partial H/\partial N = \dot{\lambda}_N = (\rho + q)\lambda_N - (p(1 - \mu_X)F_N - wh), \tag{A.7}$$

$$\rho\lambda_S - \partial H/\partial S = \dot{\lambda}_S = (\rho + \theta)\lambda_S + \theta\phi, \tag{A.8}$$

$$\mu_A A = 0, \qquad \mu_A \geq 0, \tag{A.9}$$

$$\mu_R R = 0, \qquad \mu_R \geq 0, \tag{A.10}$$

$$\mu_L L = 0, \qquad \mu_L \geq 0, \tag{A.11}$$

$$\mu_X(X - F(N,h)) = 0, \qquad \mu_X \geq 0, \tag{A.12}$$

$$\phi S = 0, \qquad \phi(L - R - \theta S) = 0, \qquad \phi \geq 0. \tag{A.13}$$

The transversality conditions corresponding to the control problem are

$$\lim_{t\to\infty} \lambda_N \geq 0, \qquad \lim_{t\to\infty} \lambda_N N = 0, \tag{A.14}$$

$$\lim_{t\to\infty} \lambda_S \geq 0, \qquad \lim_{t\to\infty} \lambda_S S = 0. \tag{A.15}$$

As noted by Berkovitz, the costate variable λ_S is, in general, only piecewise continuous. At each jump point t_i,

$$\lambda_S^+(t_i) = \lambda_S^-(t_i) + k_i, \tag{A.16}$$

where the non-negative values of k_i are chosen so as to insure that (A.1)–(A.14) hold.

Integrating (A.7), invoking the transversality condition (A.14), we have

$$\lambda_N(0) = \int_0^\infty (p(1-\mu_X)F_N - wh)\exp\left(-\int_0^t (\rho + q)\,\mathrm{d}u\right)\mathrm{d}t. \tag{A.17}$$

Using (A.8), (A.15), and (A.16), we obtain

$$\lambda_S(0) = \sum_i \left(k_i - \int_0^{t_i} \theta\phi \exp\left(-\int_0^{t_i} (\rho + \theta)\,\mathrm{d}u\right)\right)\mathrm{d}t. \tag{A.18}$$

References

Abel, Andrew, 1981, A dynamic model of investment and capacity utilization, Quarterly Journal of Economics 47, 379–403.

Berkovitz, Leonard D., 1962, On control problems with bounded state variables, Journal of Mathematical Analysis and Applications 5, 488–498.

Feldstein, Martin, 1978, The effect of unemployment insurance on temporary layoff unemployment, American Economic Review 68, 834–846.

Hestenes, M.R., 1966, Calculus of variations and optimal control theory (Wiley, New York).

Leban, Raymond, 1982, Employment and wage strategies of the firm over a business cycle, Journal of Economic Dynamics and Control 4, 371–394.

Leban, Raymond and Jacques Lesourne, 1983, Adaptive strategies of the firm through a business cycle, Journal of Economic Dynamics and Control 5, 201–234.

Leban, Raymond and Jacques Lesourne, 1980, The firm's investment and employment policy through a business cycle, European Economic Review 13, 43–80.
Lilien, David M., 1977, The cyclical pattern of temporary layoffs in United States manufacturing, Mimeo.
Lilien, David M., 1980, The cyclical pattern of temporary layoffs in United States manufacturing, Review of Economics and Statistics 62, 24–31.
Mortensen, Dale T., 1970, Job search, the duration of unemployment and the Phillips curve, American Economic Review 60, 847–862.
Mortensen, Dale T., 1978, On the theory of layoffs, Discussion paper no. 322 (Northwestern University, Evanston, IL).
Nickell, Steven J., 1978, Fixed costs, employment and labour demand over the cycle, Economica 45, 329–346.
Oi, Walter Y., 1962, Labor as a quasi-fixed factor, Journal of Political Economy 70, 538–555.
Okun, Arthur M., 1981, Prices and quantities: A macroeconomic analysis (Brookings, Washington, DC).
Parsons, Donald O., 1972, Specific human capital: An application to quit and layoff rates, Journal of Political Economy, 1120–1143.
Parsons, Donald O., 1977, Models of labor market turnover: A theoretical and empirical survey, Research in Labor Economics 1, 185–223.
Pencavel, John H., 1972, Wages, specific training, and labor turnover in U.S. manufacturing industries, International Economic Review 13, 53–64.
Peris, Jose A., 1982, A dynamic model of the cyclical behavior of employment with unemployment insurance, Working paper no. 82-170 (University of Minnesota, Minneapolis, MN).
Russak, Bert, 1970, On problems with bounded state variables, Journal of Optimization Theory and Applications 5, 114–157.
Salop, Steven C., 1973, Wage differentials in a dynamic theory of the firm, Journal of Economic Theory 6, 321–344.
Sargent, Thomas J., 1978, Estimation of dynamic labor demand schedules under rational expectations, Journal of Political Economy 86, 1009–1044.
Sargent, Thomas J., 1979, Macroeconomic theory (Academic Press, New York).
Topel, Robert H., 1982, Inventories, layoffs, and the short-run demand for labor, American Economic Review 72, 769–787.