A list of Working Papers on the last pages

No. 230, 1989

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November, 1989

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Revised Draft June, 1989

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We would like to thank seminar participants at the Industrial Institute for Economic and Social Research (Stockholm), Northwestern University, and the University of Michigan for comments on a preliminary draft. Support for this research was provided by the International Labor Affairs Bureau of the U.S. Department of Labor and the Program in American Institutions at the University of Michigan.

We test the hypothesis that rigidity (stickiness) of, or even increases in, average wages during output contractions can be a rational response to the need to protect firm-specific investments in the training of and search for workers. These higher wages can be thought of as a "retainer" to maintain the worker's firm-specific capital. Years of tenure or the presence of mechanisms for enforcing contracts and bargaining, as unions are sometimes portrayed, can be used to identify greater firm-specific capital. Marginal wage rates, which are not directly observed, are found to be pro-cyclical, since for workers with more human capital, average wages are shown typically to decline slightly as one approaches normal hours from below and to rise sharply as one exceeds normal hours. Our conceptual analysis indicates a major role for downward price flexibility, in contrast to wage stickiness. Hence, our approach is not one which "explains" price stickiness via wage stickiness.

While the model we use is one of intertemporal labor attachment, our results are consistent with a possible "insider-outsider" interpretation in which incumbent (union or experienced) workers protect their wage rate as the fortunes of the firm deteriorate. However, for technologically progressive (TP) manufacturing industries (as measured by the rate of growth of output per labor hour over a prior ten year period), the wage premia for both overtime and undertime hours are more apparent, giving additional support to the role of firm-specific skills. As argued by Mincer and Higuchi (1988), workers in (TP) industries should typically have more firm-

specific skills,[1] and under our hypothesis this investment gives rise to hours increases rather than new hires during an upturn and to retainer wages to protect against attrition while hours are reduced during a downturn.

Special attention is given to imports as a possible source of hours innovations. In this case separation of the sample into TP and other, technologically stationary (TS) industries is very important. The TP industries are often producers of product cycle goods (Arndt and Bouton, 1988), and positive import share innovations are weakly associated with overtime hours. Conversely, in TS industries positive import share innovations are likely to be associated with reduced hours. We believe that these and other patterns make it important for analysis of labor market adjustment to disaggregate and to examine industries with technological change and learning-by-doing as being different from stable or well-established industries.

This paper employs microdata from the Panel Study on Income Dynamics to examine the wage rate and hours adjustments of those employed in U.S. manufacturing during the contraction of 1980-82.Unlike the prior two recessions in 1970-72 and 1974-75, during 1980.II-82, the U.S. was experiencing a recession combined with a large percentage decline in net exports. In contrast to increases of 44.2 and +43.6 percent in the two prior recessions, the 1980-82 recession had a net export decline of 44.1 percent.

1. As well, if the industry is in the rising segment of the growth of sales or product cycle curve, the skills are of greater value for future use.

Although there are differing theories as to why net exports declined[2], our interest is in exploring the labor market response of different industry types to changing product demand, including rapid growth of imports.

About two-fifths of the workers in our sample were in firms not adversely affected by the 1980-82 recession and which were experiencing a demand expansion, as indicated by increased labor hours over those observed in prior years. Given the need for added hours, the probable impermanence of the output increase, and the substantial firm-specific attachment costs, we find that more hours per worker were elicited through higher wage rates to their existing workforce. These substantial increases in observed average wage rates imply a very pronounced rising marginal wage rate. If one is interested in "wage flexibility" our results seem to indicate a flexible U.S. labor market. One of our planned projects is to develop similar analyses for other industrialized countries, notably West Germany, Sweden and Japan.

Our empirical evidence offers some modest support for the undertime wage proposition and strong evidence for the overtime proposition, particularly for unionized workers and those in TP industries. This implies that simply looking for downward flexibilty of average wages in manufacturing downturns may not be very informative unless one is possibly thinking of a permanent downturn. For temporary downturns one should consider the marginal wage schedule to draw any inference about the firm's

2. A common explanation is that derived from the Mundell-Fleming model (1965) which postulates currency appreciation arising from expansive fiscal policy combined with monetary restraint.

intentions. Empirically, we demonstrate the need to analyze the data by means of a switching regression framework to separate the expansion regime from the contraction regime.

The difficult part of the analysis comes in knowing how to treat imports. On one hand imports could represent a fall in the import supply curve and a resultant displacement of domestic production. This, in turn, could motivate a downward movement in the wage-hours package. However, an increasing import share could as well be the consequence of a demand shift outward under the conditions of an import supply curve of greater elasticity than the domestic supply curve. Finally, as discussed above, import penetration may occur in tandem with learning-by-doing as appears to be the case in semiconductors. Import shares were rising, price was falling, but output was growing and some workers were in overtime regimes. Yet for those workers in undertime regimes for TP industries, an increase in imports was associated with a lowered wage.

The existing literature suggests that import penetration, defined as an increase in the ratio of imports to the sum of imports and domestically supplied product, lowers manufacturing wages. It seems puzzling that such results are strongest for import levels or for changes in imports which have occurred over a long time period.[3] A relative wage impact of imports over longer periods of time is not consistent with intersectoral mobility of labor. What possible explanation is there for a

3. Research by Katz(1987) uses change in imports over the period 1960-1984.

long-run relation between imports and wage rates other than factor immobility? It is known that (now, historically) imports are more likely in TS industries[4]. Suppose these industries employ workers who are less skilled than the observationally similar workers in technologically dynamic sectors. Then long term import growth would be associated with lower wages.

This heterogeneity interpretation would be an extension of the idea that the U.S. comparative advantage is in skilled sectors[5] but with the recognition that some of the skill variables are not observable. Another interpretation of permanently lowered wages in the sectors with import gains is that of expense preference (Heywood, 1985). Imports erode the monopoly position of firms, and managers respond, in part, by increasing wage discipline over the workers. The results reported by Katz can also be given such an interpretation.

A normal pattern of life cycle earnings growth in theoretical as well as empirical analysis of earnings is one in which hours of work grow but at a declining rate (Ryder, Stafford and Stephan, 1976; Corcoran, Duncan and Ponza, 1983). During overtime regimes we would expect more experienced workers to be more reluctant to work added hours, and we generally observe more experienced workers to receive a larger wage premium during leisure rationing or overtime regimes. During undertime regimes

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4. Katz(1987) shows that the ratio of R and D to sales in the ten leading export industries is three times as great as in the ten lowest export industries. More recent evidence shows a decline in the U.S. position in product cycle goods (Arndt and Bouton, 1987)

5. Bowen, Leamer, and Sveikauskas (1987) indicate a rather weak dependence on skilled labor, but Stern and Maskus (1981) indicate a substantial role of human capital in exports.

we found evidence of higher wages for experienced workers in the full sample, suggesting that firms are then willing to compensate for departures from life cycle growth targets. Such hours accomodation and compensation will reduce attrition, and unless the undertime regime is permament the firm will desire this reduced attrition.

The organization of the paper is as follows: In the beginning of Section I a discussion of modelling issues is presented. Attention then turns to a specific dynamic model. Section II begins with a discussion of the data and variable construction and then turns to estimation of the regime and wage equations, disaggregated into groups indicated to be important from the theoretical models. A brief conclusion is offered in Section III.

I. Theoretical Framework

A. Introduction

The theoretical framework for our study draws on several elements in the existing literature. One is the literature on compensating wage differentials for work at hours different from normal or desired (Deardorff and Stafford, 1976; Abowd and Ashenfelter, 1981). Another is the dynamic labor demand literature (Sargent, 1979 (Chapter 16); Nickell, 1986) which emphasizes the intertemporal policy of employment stabilization relative to a temporally varying output path.[6] Combining these two models allows us to show how a firm will offer a time-varying wage-hours package either to meet or fall short of reservation utility obtainable in a sector which we call the flexible sector.

In the flexible sector workers are either free to choose their hours in a given firm or in Tiebout fashion can choose the firm which offers their ideal time-invariant wage hours package. The flexible sector corresponds to the simple story behind the static labor supply model. The flexible sector defines a reservation utility which must be matched or exceeded continually in the sector with temporally varying demand (TVD). The empirical plausibility of a healthy exit sector for workers is underscored by the fact that about two-fifths of our sample experienced hours

6. Here we are assuming a minor role for inventory as a device for stabilizing production under conditions of varying demand. There is some evidence of pro-demand movements in inventory (Blanchard, 1983). In manufacturing one reason not to use inventory is because if demand fails to materialize one must sell at a loss since disassembly is normally out of the question

increases even though the sample was restricted to manufacturing and was drawn for a recessionary period.

In our model we make no assumption that an "implicit contract" exists. Such contracts can at best be so imperfectly enforced that the operating environment is more one of what-have-you-done-for-me-very-lately? Overpayment in the boom period would not tie anyone during a downturn if reservation utility of the flexible sector is not met.[7] Our theoretical model shows that for temporary downturns in the TVD sector (manufacturing) workers with significant firm-specific attachment costs should receive an undertime premium in terms of their average wage rate, even though their marginal wage falls as hours are reduced below normal. During temporary expansions they should receive a rising average and marginal wage rate. The extent to which a firm will resort to hours variations is a function of the size of firm-specific attachment costs. Greater costs lead to greater use of overtime and undertime and to larger corresponding average wage premia. Rationing of leisure as well as work hours (Ashenfelter, 1980) leads to a wage premium.

Overtime and undertime regimes can be defined by reference to simple supply and demand conditions for the firm's product. As represented in Figure 1 we have two supply curves which together together represent short run supply to the domestic market. The assumption is that distribution system inertia can lead the

7. Here we rule out various forms of long-term deferred compensation such as pensions. We also do not deal explicitly with the idea that there may be covariation in the firm's condition and job opportunities elsewhere.

import supply to be less than perfectly elastic even if a given country's imports represent a small share of total world sales. The domestic (and import) "supply" curve slopes upward, possibly for the usual reasons of diminishing returns[8] but also for reasons of short run attachment costs leading to the need for overtime premiums to induce added hours of work. Attachment costs of labor lead to utility-based rising average costs in either direction from "normal" hours or output as will be discussed below. Short-run equilibrium is represented by the intersection of the domestic supply curve, S_D with residual demand, D_{R1}. The question at hand is whether we can identify different regimes of demand versus import supply shifts based on a few observable variables, namely, price, quantity and import share.

An outward shift in demand, D_2, will lead to a higher price, more domestic production and more imports. On the condition that import supply elasticity is greater than domestic supply elasticity, import share of total sales will rise. At initial demand D_1 an outward shift in the import supply function, occasioned by an appreciation of the domestic currency, for example, would also lead to a rise in import share, but it should also lead to a decline in price. On the other hand a rightward shift in the import supply function, occassioned by a change in exchange rates or a decline in import costs, would lead to a declining price and a rising import share.

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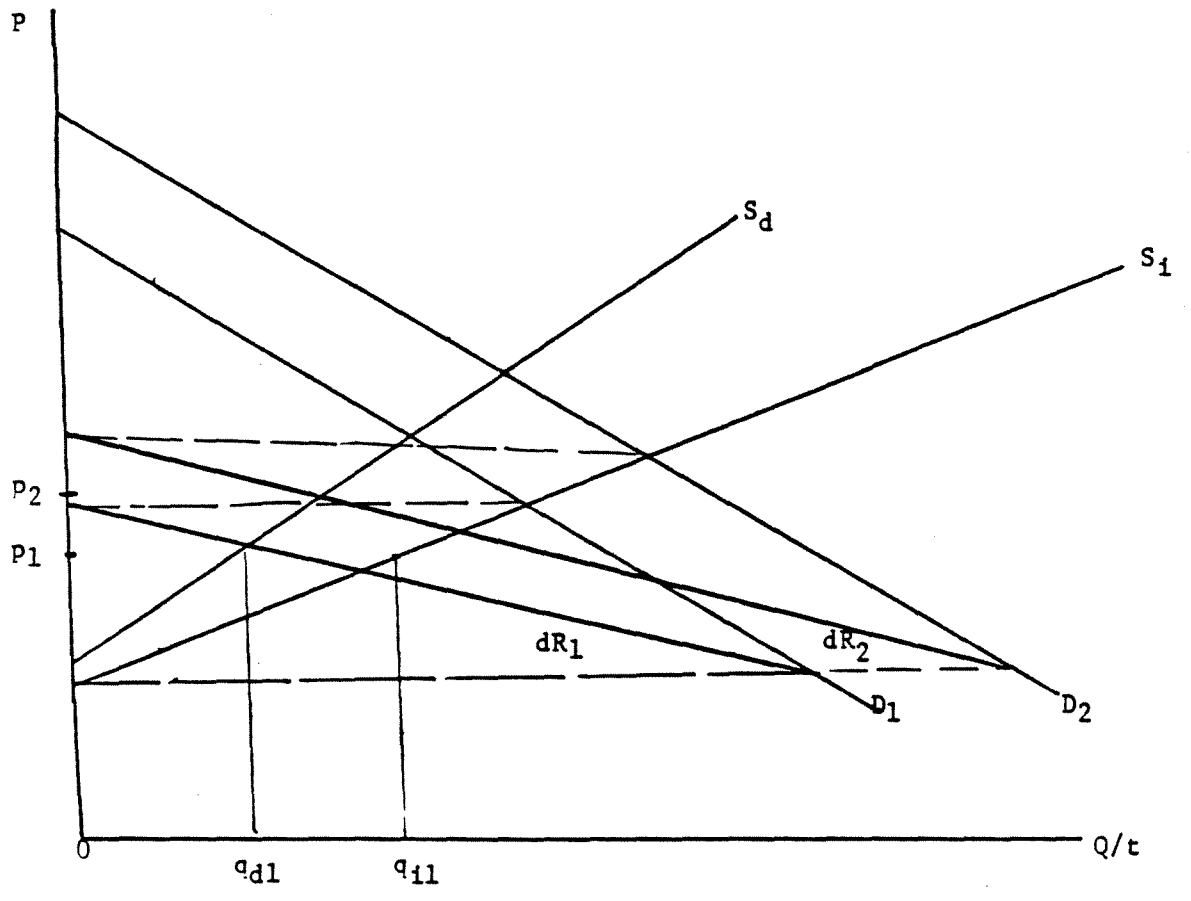
8. In manufacturing there may be close to constant returns to labor hours up to the designed capacity constraint. For discussion of such models see Albrecht and Hart (1983).

To summarize the implications of a straightforward supply and demand analysis, we can specify conditions which would represent shifts in the residual demand curve facing the domestic industry in terms of imports and price movemements: a rising price implies a residual domestic demand shift outward and a falling price implies a residual domestic demand shift inward and both could be accompanied by a rising import share. An important addition to this discussion is suggested by proponents of real business cycle theory or learning-by-doing.

In real business cycle theory favorable investment and production opportunties are seen as an important force shaping business cycles (Prescott, 1986). If so we would expect the domestic output expansion of an industry to be characterized by declining prices. Another version of this effect which does not necessarily imply economy-wide effects is found in the applied literature where learning-by-doing effects create declining prices and expanding output in manufacturing industries (Hayes and Wheelwright, 1984). Whether or not imports would decline would depend on whether the favorable industry shocks or learning effects are global or national in character. To summarize, there are several reasons <u>not</u> to expect a simple relation wherein import share increases lead to reduced hours or wages of domestic industry workers.

Figure 1

Imports and Residual Demand for Domestic Production



How will the firm react to these different regimes? More specifically, whether the consequence of a favorable residual demand shock or a favorable supply shock or learning-by-doing, how will the firm set about increasing labor hours? One simplifying assumption is that the firm-specific attachment costs are borne by the firm rather than the worker. This seems consistent with the seminal work in this area (Oi, 1962).[9] If so, the worker will have no regrets for leaving if flow utility does not equal short-term alternatives.[10] It is the firm's decision to either protect or abandon these labor force investments.

When there are such substantial attachment costs and when the output condition is seen as temporary, the firm will increase hours beyond normal hours, H^*, in the overtime regime by offering a rising marginal and average wage as illustrated in Figure 2A. The firm mandates that the workers accept a package, otherwise there would be a very different equilibrium.[11]

In this sense workers can be thought of as leisure rationed during overtime regimes and work rationed during undertime regimes: at the ex post average wage they would like more leisure or work, respectively. Only by offering a wage along or above the indifference curve U_R obtainable in the

9. Specifically it seems consistent with his data on training costs for employees of International Harvester. If we assume the training was firm specific, which motivates added hours rather than added workers during a boom, the wages need not be reduced to finance training and workers do not receive quasi-rents which keep them with the firm during a downturn.

10. A more complete model might include the effects on housing prices in a non-diversified housing market.

11. If they offered a wage of W_A and let workers choose hours then the equilibrium would most likely be below H_0.

flexible sector will the firm not risk quits during the expansion. As illustrated, both the marginal wage, W^M_O, and the average wage, W^A_O, are greater than the normal wage, which equals the wage in the flexible sector, W_F.

During a temporary downturn the firm will reduce hours below normal hours for its workers with firm-specific attachment costs. In this undertime regime, if it is uncorrelated with demand shocks of other firms with which they compete in the labor market, the firm will have to offer a wage-hours package with a higher average wage, W^A_U, in order to not risk losing workers to the flexible sector. In the limiting case txhey have the worker supply no hours of labor, and pay a "retainer" of C_f which implies an infinite average wage. Note that there is a lower marginal undertime wage, W^M_U.[12]

The marginal-average distinction is of profound significance given that, empirically, researchers are virtually always restricted to observing only average wages, particularly during the downturn.[13] If average wages are observed for experienced workers during overtime and undertime regimes it will certainly thwart efforts to estimate "the" short-run or intertemporal labor supply of manufacturing workers which do not consider these regimes: a rise in average wage could be

12. For workers in firms with TVD we will expect that the operation of successive regimes will generate a higher average wage for these employer initiated hours variations as has been shown by Ashenfeher and Abowed (1981). The difference is our work in that we investigate the development of the higher average by examination of the separate regimes rather than simply relating the average to the intertemporal variance of hours.

13. Workers are sometimes asked to report their wage for additional hours, but we know of no datasets in which researchers have attempted to get people to report their wage for additional hours reductions.

associated with a reduction of hours as well as an increase of hours.

From the indifference curves in Panel 2A we can map a marginal and average cost of hours in Figure 2B. With a little sylization and for the case of no learning-by doing, these curves can be thought of as being (very close to) the short-run output cost curves so long as output is below the design capacity of the firm's capital (Albrecht and Hart, 1983). If the elasticity of output with respect to hours is unity, assuming non-labor inputs are used in fixed proportions with labor hours and therefore also have a unitary elasticity with respect to output, then, below capacity, short run costs are just greater than labor hours costs by a proportional factor.

To simplify Figure 2, we will ignore other inputs which can be varied in the short run. One surprising feature of Figure 2B, which was shown in Deardorff and Stafford (1976), is that the average wage/product cost function need not be convex from below even when the indifference curves themselves have this property. During normal times the firm faces a marginal revenue schedule MR^*, workers work H^* hours and receive a marginal and average wage rate of W_F. In booms the firm faces a marginal revenue schedule MR_0, workers work H_0 hours and receive average and marginal wages as indicated in Panel 2A. Conversely, during contractions firms face a marginal revenue schedule MR_U, workers work H_U hours and receive the marginal and average wages

Figure 2A

Wage Hours Package and Reservation Utility

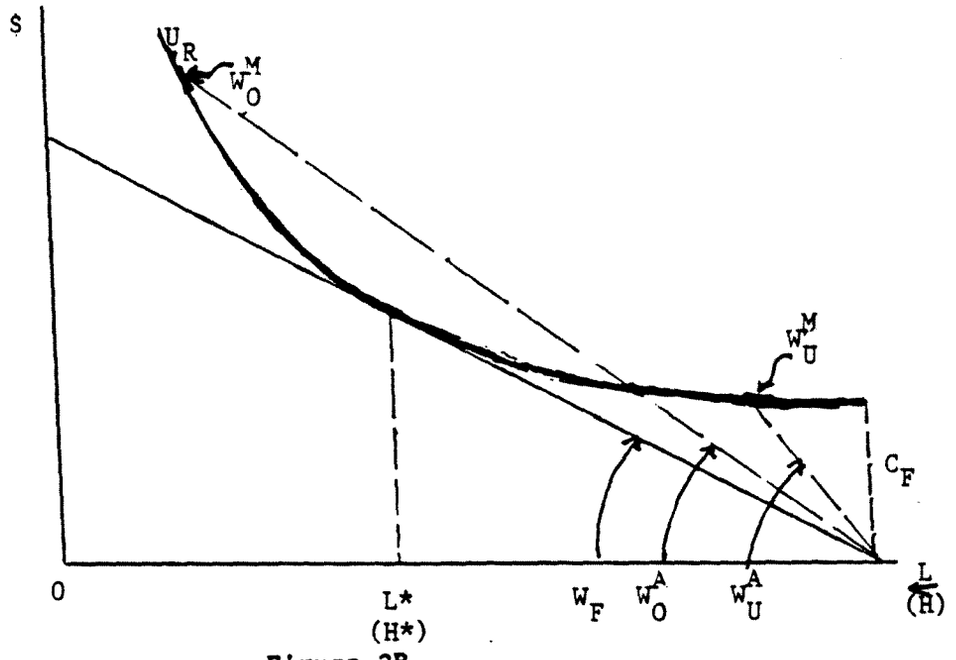
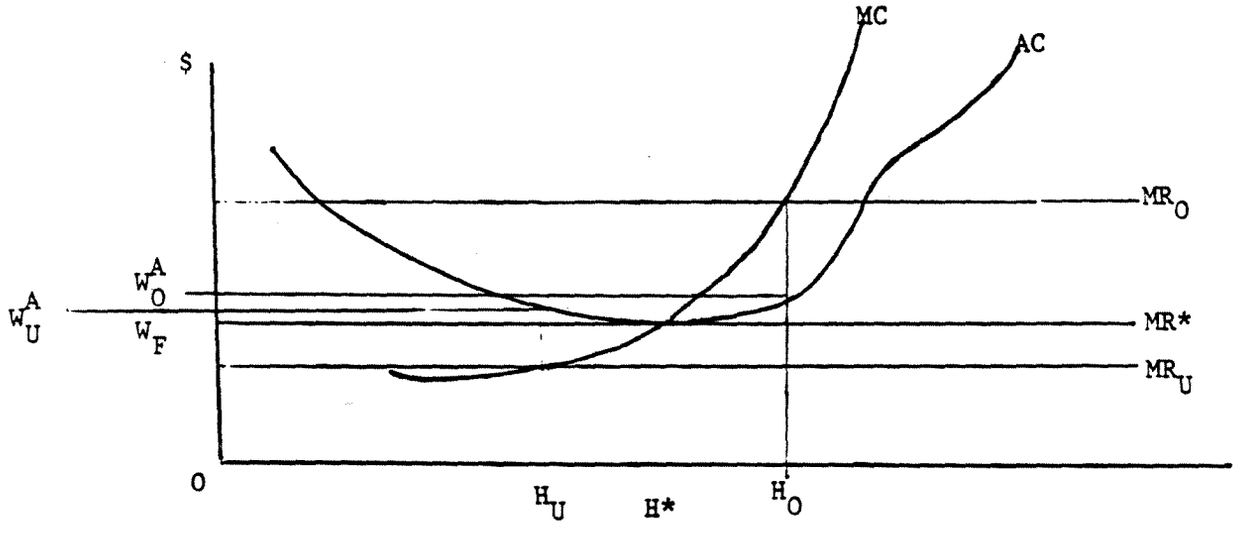


Figure 2B

Short Run Hours/Output Costs of Labor



indicated in Panel A.[14] Note that if some of the booms are learning-by-doing booms the cost curves could be shifting downward but the curves themselves could have the same shape.[15]

So far we have a straightforward story, but during a contraction the firm would not really want to keep all of its labor force. This consideration would cast matters into a form of dynamic labor demand model. So long as the contraction was perceived as other than a purely instantaneous fall in demand to be followed by a permanent recovery to the previous level, the firm would be willing to lose some of its workers to the flexible sector. As in the model of Mortensen (1970) the firm will have a measure of monopsony power. To the extent that the firm has a demand decline of some duration it can exploit this by paying a lower wage.

If we postulate that the rate of worker attrition is a function of the gap between the utility from a given firm's wage-hours package and U_R, then the firm might cut average wages to (e.g) $W^{A'}{}_U < W^A{}_U$ or further reduce hours. On the expansion side, as long as there will be some duration to the boom, the firm will increase its offered wage-hours package to generate a utility level above U_R so as to attract new workers. This will provide a utility rent to incumbent workers, assuming the firm cannot wage discriminate between new and incumbent workers.

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14. The marginal revenue schedules could slope downward but, as is well-known, it could then be possible to see price rise with a leftward shift in demand.

15. If learning-by-doing is present the firm will have incentives to operate beyond short-run mr=mc to acquire experience capital.

These intertemporal considerations appear to lead to a more steeply rising average wage than suggested in Figure 2A for expansions and less steeply rising, or possibly falling, average wage during the contractionary phase. This attenuation of wage increases during downturns will be formed termed the "au revoir" effect. Note that in steady state the firm will not have monopsony power and will have to offer a "going utility" package to retain its work force just as in the simple factor market model.

To illuminate the intertemporal aspects of the problem consider a model in the spirit of those developed by Leban (1982) but in which <u>both</u> hours per worker and hourly wage rate are specified as the firm's decision variables. These variables influence both the current output <u>and</u> the attractiveness of the firm as an employer of incumbent as well as new workers. The firm's objective function is given to be discounted net profits

$$(1)\quad \text{Max } V = \int_0^{\infty} e^{-rt}\pi(t)\, dt$$

where

$$(2)\quad \pi(t) = R(t) - C(t)$$

and

$$(3)\quad \pi(t) = p(t)q(t) - N(t)h(t)w(t) - A\,L(t),\ L(t)>0.$$

$$= p(t)q(t) - N(t)h(t)w(t),\ L(t)\leq 0.$$

Here the firm takes price, p(t), and sells output q(t) which is produced with number of workers, N(t), and hours per worker, h(t). The hourly wage is w(t), and the cost of workers

is both the earnings paid as well as the per worker attachment cost, A, for each of the L(t) newly acquired workers. Output is produced according to

(4) $q(t) = Q(h(t),N(t))$.

The firm's workforce, N(t), is augmented or reduced according to

(5) $\dot{N}(t) = L(t) = z(U(h(t),w(t)) - U_R(t))$.

The term z is a parameter which indicates the rate at which new hires or attrition occurs as a function of the gap between the utility achieved from the firm's wage hours package relative to that indirect utility attainable elsewhere. The argument for a time-varying U_R is that overall factors in the labor market could alter opportunities as the firm moves through a business cycle.

Omitting notation for the time dependence of variables and discounting, we have the first order conditions:

(6) $\partial H/\partial h = \partial H/\partial w = 0$ where

(7) $H = p\ Q(h,N) - Nhw - Az(U(h,w) - U_R) + \lambda_N z(U(h,w) - U_R.)$

Specifically,

(8) $pQ_h = Nw + (A-\lambda_N)\ z\ U_h$

and (9) $Nh = (\lambda_N - A)\ z\ U_w$

(10) $\dot{\lambda}_N = -\partial H/\partial N = -pQ_N + hw.$

An inference from (8) is that the marginal revenue product of hours be equated to the marginal hours cost, Nw, plus the labor force cost. The labor force cost has a current component, the per worker attachment cost times the new additions, AzU_h, and a future component, the contribution to discounted future profits of a larger labor force, λNzU_h. The value of attracting new workers for future use is like acquiring a human capital stock for the firm. A price increase which is expected to continue will lead the firm to increase the wage rate both to achieve more hours per worker and instantaneous profit improvements as well as to attract a larger labor force which in turn, will produce a larger future output at a lower future cost. The lowered future labor cost occurs since overtime labors and corresponding overtime wages need not be utilized indefinitely as the firm's workforce grows.

While as a permanent, upward shift in price leads to a wage increase beyond that expected for a transient upward price impulse, an unanticipated, permanent downward shift in price implies a reduction in wage below that for a downward price impulse. A downward price impulse leaves λ_N unchanged, but a longer duration downturn reduces λ_N. As can be seen in the model and in (9) the only value for the firm of a higher wage is to assemble and retain a workforce. If an insufficiently high wage leads people to "quit" at the beginning of a long or permanent downturn this is compatible with the firm's reduced long term

value of additional workforce. A most interesting question is that of the time path of λ_N. If there materializes a price decline which is expected to endure one would expect a discontinous jump downward in λ_N followed by a recovery to a new, lower steady state. This leads to a period of "dynamic monopsony" in which the firm adjusts its workforce by driving off people with reduced hours and possibly a reduced wage rate, depending on the attrition parameters.

Our model does not distinguish between a continuous path of reduced hours per worker or intermittent production. In short, firms may have a technology that makes on-off production a better method of output variation than reducing the rate of production over some time interval. Possibly demand declines are indicated by unexpected inventory accumulation and large accumulations can be best responded to by shutting off production shifts for m of n periods ($m < n$) or shutting down one of several plants as is common in the auto industry rather than reducing the rate of production by m/n throughout the n periods or across all plants.

Of course layoffs and new hires make sense when there are no firm-specific attachment costs. Then hours variations can be accomplished with no wage penalty to the firm or costs to the workers by hires (tiny wage increases in our model) and fires (tiny wage reductions in our model) just as assumed in the simplist models of factor demand and supply.

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II. Empirical Implementation

A. Data and Variable Construction.

The data used in our study are based on the availabilty of 3-digit SIC codes collected in the 1981 wave of the PSID. Using these three-digit industry codes we were able to develop industrial histories from 1976 to 1981 for traded goods industries (primarily manufacturing). These industrial histories included total revenue, import share ($m^* = M/(M + S)$) where M equals import sales in dollars and S equals domestic supply in dollars), and export share ($x^* = X/S$) where X equals export sales in dollars). The use of export and import price series was ruled out on the grounds that the two prices often moved in opposite directions, suggesting heterogeneity within the product classifications. Output price was taken from the Annual Survey of Manufacturers.[17]

The industry data were matched to individuals who reported earnings over the period, 1976-1981, and who reported working in these SIC's in 1981. For each individual we extracted information on annual hours, average annual wage rate, years of work experience (as of 1981), coverage by a union contract, and other labor market variables. Our resulting sample consisted of 801 panel observations. Our goal was to keep the empirical model and the set of variables simple. This is because a subsequent project will center on estimating equations of identical form on data

17. These data were provided to us by John Abowd.

from other industrialized countries. Our goal is to pool the data from several countries to test directly for differences in the adjustment process.

The 1980-81 wage expectation was defined by deflating the wage rate over the period 1976-1979 by the CPI, and by taking the natural logarithm of the resulting weighted average "real" wage. The 1980-81 wage innovation (w) was defined as the difference between the realized natural logarithm of the weighted average "real" 1980-81 wage and the 1980-81 wage expectation. The 1980-81 hours innovation (h) was similarly defined (exluding the deflation)! The 1980-81 output price innovation was defined by deflating the industry price series by the overall PPI and defining the price innovation (p) in a manner parallel to the definition of w. Innovations in import share, m, and in export share, x, and output, q, were defined as 1980-81 departures from the 1976-79 avarage.

The defintion of innovations was kept as simple as possible. This was because, given limitations of and accuracy of the wage data, a highly refined definition seemed inappropriate. Two year averages were used because it was felt that firms may not react to changing demand conditions on a very short term basis and because the problem of overlap of an episode of demand change across periods will be greater the shorter the interval of observation.

We are not dealing with a standard wage change relationship, but rather a compensation for hours departures. In addition to hours per se, we expect that the willingness to accept hours innovations will depend on point in the life cycle as implied by the basic life-cycle human capital labor supply theory (Blinder and Weiss, 1976; Ryder, Stafford and Stephan, 1976) as measured by years of work experience.

B. Econometric Model

The econometric model employed is that of switching regression. As indicated by the theoretical framework in Section I, during positive output price innovations we expect corresponding movements up the marginal and average labor cost curve for experienced workers. Under these conditions we expect a positive empirical relation between wage innovations and hours innovations. Conversely, during negative output price innovations we expect corresponding movements in the opposite direction which implies a negative relation between (algebraic) innovations in hours and innovations in <u>average</u> wages. Because wage is measured with substantial error (Duncan and Hill, 1984), our results are presented with wage as the dependent variable. Our database also included variables on technological progressivity, namely growth of output per labor hour over the period 1967-1976 and the sum of process and "imported" R and D from Scherer's input-output matrix of technology flows in 1974 (Scherer, 1984). The technology variables will be examined more closely in subsequent discussion.

We are assuming that regime separation corresponds to the sign of hours innovations. A positive residual demand shock or favorable shock of the real business cycle variety will lead the firm to move above H*, and a negative demand shock will lead the firm to move below H*. [18] The probability of being in the overtime regime was postulated to depend on output price innovations, and in some specifications innovations in imports and exports as well. The overtime regime was estimated as a sample selection model of two equations[19]:

(11) $\text{Prob}(h > 0) = \text{probit}(p, m, x, q) + e_1$.

(12) $w = b_0 + b_1 h + b_2 h^2 + b_3 m + b_4 x + b_5 \text{exp} + b_6 \text{exp}^2 + b_7 \text{lambda} + e_2$.

In a parallel fashion we defined a two-equation selection model for the undertime regime. While separate equation pair estimation will sacrifice some efficiency, this loss should not be great. Our strategy was to first estimate the relations for the entire sample and to then disaggregate into subsamples likely to have more firm-specific skill, since the theory indicates that labor attachment costs will motivate greater hours variation and corresponding compensation.

C. Empirical Results

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18. Empirically, ties (hours innovations equal to zero) were assigned to the overtime regime. No ties were observed in the data.

19. See Maddala(1983) for an extensive discussion of switching regression models and their links to sample selection models.

The probit equation for the full sample of 801 observations had a low predictive power, and as will be shown later the disaggregation into a technologically progressive and other sector is important for the characterization of overtime regimes. The probit equation for the overtime regime was:

$$\text{(11)} \quad \text{Prob}(h > 0) = \underset{}{-.252} \quad \underset{(.076)}{-.917\ p} \quad \underset{(.581)}{-3.49\ m} + \underset{(3.17)}{.551\ x} \quad \underset{(1.761)}{-\ 2.14\ \textbf{interact}} + \underset{(1.09)}{.107\ q} \ ; \quad \underset{(.104)}{\text{log likelihood} = -566,}$$

where **interact** is a variable defined as the impact of price innovations conditional on a positive import innovation. The results provide motivation for thinking about the supply side since positive hours innovations are associated with declining prices and growth of imports. Whether this is a more general pattern or only specific to this time period is hard to guess. We do know that for the U.S. 1980-81 was the beginning of a sharp decline in the net export position for product cycle goods (Arndt and Bouton, 1987, p.29), and these are goods which often experience price declines via learning-by-doing.

In Table 1 we present our results for the full sample. The estimation includes an equation for the overtime regime (347 observations), as well as the undertime regime (454 observations). The important pattern observed here and consistently throughout the estimation is a flat relation or a decline in average wage rate as hours approach normal from

below combined with a rise in the average wage rate as hours exceed normal. As will be demonstrated, this pattern is stonger for union workers than non-union workers and for experienced rather than inexperienced workers, and for those in technologically progressive industries.

Much of our analysis shows the need to disaggregate the and examine separate overtime and undertime regimes. Even for the overall sample a likelihood ratio test of the hypothesis that there is no difference between the undertime and overtime regimes was rejected with a chi-square of 38.2(9). For the technologically stationary sector the chi-square of the likelihood ratio test of the hypothesis of no difference between the undertime and overtime regime was 34.9. For the technologically progressive industries the chi-square test statistic was 59.5.

As in the probit for the overtime regime, import innovations have no real impact on wages in Table 1. From a supply and demand analysis this is to be expected for the reasons given for the ambiguous meaning to the observation of a rising import share. More experienced workers are better compensated in regimes of hours reductions. This is consistent with our theory, which emphasizes the need to keep experienced workers happy when their hours are rationed in order to prevent excessive attrition. This is a theme which recurs in our disaggregated analysis: wage premiums are greatest for the workers whom one would characterize as having the most specific human capital.

Life cycle theory indicates that as earnings potential rises the level of leisure should decline (Ryder, Stafford and Stephan, 1976), but the added value of larger, non-trajectory increments to leisure from rationed work hours should diminish sharply, implying a greater need for financial compensation to maintain a given level of utility.[20] A possible avenue for rationing of work time to be less costly would be if additional (off-the-job) training were an attractive alternative.[21] This too would be less likely for more experienced workers.

20. Here it is assumed that the marginal utility schedule for leisure is convex, as would be the case for isoelastic utlity functions, which are commonly used in life cyle models.

21. It is sometimes claimed that during downturns the firm can use the time to retrain on-the-job which would be difficult to observe, since our data identify only hours of work and not the activities at work.

Table 1

Wage Premium

Full Sample

(coefficient/standard error)

Group	Overtime ($h \geq 0$)	Undertime ($h < 0$)
Variable		
Hours (h)	.188/.090	-.185/.136
Hoursqd (h^2)	.005/.039	-.038/.112
Exp	-.0070/.0051	-.015/.004
Exp^2	.00009/.00013	.00025/00011
Imports (m)	-.501/1.681	.823/1.478
Exports (x)	-.879/.758	-.737/.491
Interact	-.183/.628	.653/.600
Lambda	-.053/.313	-.358/.346
Intercept	-.030/.290	-.063/.241
R^2	.082	.063
Sample size	347	454

In Tables 2 and 3 are presented the results for the subsamples of unionized and experienced workers (exp > 10). The probits for the subsamples are not reported since they were not very different from the overall sample. In Table 2 we can see that the overtime premium for union workers is very large and that there is no statistical relation between wages and hours in the undertime regime. In contrast, for the non-union workers (not reported) there is a positive but diminishing wage premium for longer hours, while the premium for undertime work is very pronounced.

What our results indicate is that there is a typically a significant rise in average wage rate as hours rise in the overtime regime, particularly for union workers. For both experienced and inexperienced workers there is a substantial rise in average as hours increase, although the far stronger fit for the overtime relation is for union workers, whom we assume to be those with substantial amounts of firm-specific attachment costs.

Table 2

Wage Premium

Union Workers

(coefficient/standard error)

Group	Overtime ($h \geq 0$)	Undertime ($h < 0$)
Variable		
Hours (h)	-.905/.392	.022/.164
Hoursqd(h^2)	.762/.360	.094/.103
Exp	-.0181/.01293	-.007/.007
Exp^2	.00042/.00032	.00017/00016
Imports (m)	5.75/5.10	-.086/2.449
Exports (x)	-.591/1.85	-.237/.722
Interact	.569/1.847	.749/.847
Lambda	-.653/.737	-.358/.346
Intercept	.672/.668	-.102/.410
R2	.149	.039
Sample size	111	152

Table 3

Wage Premium

Experienced Workers

(coefficient/standard error)

Group	Overtime ($h \geq 0$)	Undertime ($h < 0$)
Variable		
Hours (h)	-.118/.198	-.324/.192
Hoursqd (h^2)	.182/.138	-.056/.124
Exp	.0130/.0146	-.018/.028
Exp^2	-.00025/.00028	.00095/.00252
Imports (m)	3.30/3.06	-.411/1.110
Exports (x)	.865/1.14	-1.447/.745
Interact	-.273/.645	.236/.824
Lambda	-.523/.330	-.013/.216
Intercept	.239/.351	.165/.169
R^2	.052	.072
Sample size	184	170

Turning to the undertime regime, the main difference is that rather than there being a strong positive wage-hours relationship, there is a weak (and not statistically significant) negative wage-hours relationship. If output contractions were seen as only instantaneous, we would expect a stronger negative relationship for workers with more firm-specific capital. There are several reasons to expect not to observe a negative relationship: the "au revoir" effect already mentioned in the dynamic labor demand model, the use of non-wage compensation such as health insurance which is a large part of C_f (See Fiure 2A.) but is not in the labor income measure, possible effort variations on-the-job which would lead to an understatement of the wage increase as hours decline,[22] and a decline in the prevailing wage and going utility as the alternatives for a particular worker deteriorate, either because of a business cycle pattern or a positive covariance in wage changes in industrially connected or geographically adjacent industries.

The important point is that we do not see <u>average</u> wage reductions as hours decline during the undertime regime even though marginal wages in the wage-hours package are presumably declining. For a firm to not pay an undertime premium or to cut the wage rate along with hours would mean the sacrifice of its previous investments in labor force capital via attrition. The firm would be more willing to sacrifice this capital if the decline is perceived as a longer lasting affair.

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22. Increased effort per hour would also serve to understate the overtime premium.

An interesting question is whether firms need to provide larger compensation for rationing of work and leisure for people in different points of their life cycle for reasons other than differences in firm-specific skills. This cannot be tested directly since we do not have measures of firm-specific skill other than the indicators of work experience, unionization and technological progressivity of the industry. If we think of work experience as a measure of a person's place on a life cyle plan, the general pattern we observe is higher wages for rationed workers further out on their trajectory. See, for example, column 1 and especially column 2 of Table 1. A preliminary interpretation of this pattern, which recurs, though weakly, in the other tables, is that the firms offer greater compensation to more experienced workers who are displaced from their target life-cycle plan[23].

From our discussion of TP industries, there are two important reasons to separate the analysis into those with stationary technologies from those with dynamic technologies. A dynamic technology should imply that successful firms have workers with more firm and industry-specific human capital, the Mincer-Higuchi hypothesis, and should have employers more concerned about the duration of a worker's employment with the firm. A dynamic technology will imply a different relation between output price and employment and possibly between output price and import increases as well.

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23. An alternative is to think of the higher undertime wage as reflecting income insurance which more experienced workers will have had a better opportunity to secure.

Two measures were considered for categorizing industries as technologically progressive. One was growth of output per labor hour for three-digit industries for the period 1967-1976 (Bureau of Labor Statistics, 1979). The second was the sum of own process R and D expenditures and R and D expenditures used from other industries in 1974 (Scherer, 1984) at the two-digit level. While the two variables were positively correlated at the industry level (.256), the growth of output per labor hour seemed a better measure of technological change and product cycle since it was negatively correlated with 1980-81 price innovations (-.136). The sample was divided into those observations of workers in industries above and below the mean productivity growth. Estimation of the statistical model in equation (11) and Table 1 for these subsamples is reported in equations (12) and (13) and Tables 4 and 5.

There are major differences between the two sectors in the factors which lead to an overtime regime. In the technologically progressive sector (12), price declines and import increases predict a higher probability of an overtime regime, while in the technologically stationary sector these same conditions would predict a higher probability of an undertime regime. The variable **interact** is defined as the interaction between a dummy for whether import innovations are positive and the price innovation. The coeffiecients for this variable imply that the effect of positive import innovations is attenuated for price declines, and this seems a bit puzzling. On the other hand the main regime equation results are consistent with expectations.

In addition to different overtime regime equations, the relation between hours innovations and wage innovations differs, with a clearly pronounced overtime rate in the TP sector and a less clear but quite pronounced undertime rate in the TP sector. In the TS sector we see little evidence of either an overtime or an undertime premium. As found throughout the paper there is no clear or conceptually predictable impact of import innovations on wage innovations. During undertime regimes, imports are negatively related to wages in the TP sector and positively related in the TS sector.

(12) Prob(h > 0) = -.249 -1.60 p + 8.24 m + 2.18 x
(.119) (.665) (6.39) (4.420)

- 1.53 **interact** +.043 q ; log likelihood = -241,
(1.71) (.017)

(13) Prob(h > 0) = -.183 + 2.16 p - 13.0 m + .57 x
(.117) (1.79) (5.47) (2.43)

- 4.45 **interact** +.0202 q ; log likelihood = -304,
(2.08) (.0546)

Table 4

Wage Premium

Technologically Progessive

(coefficient/standard error)

Group	Overtime ($h \geq 0$)	Undertime ($h < 0$)
Variable		
Hours (h)	-.192/.172	-.327/.189
Hoursqd(h^2)	.322/.103	-.070/.126
Exp	-.0118/.0078	-.009/.007
Exp^2	.00019/.00020	.00007/00017
Imports (m)	-.906/1.446	-4.104/1.203
Exports (x)	1.618/1.644	1.803/1.332
Interact	.416/.679	-.409/.575
Lambda	.019/.182	.143/.189
Intercept	.072/.171	.234/.153
R^2	.195	.144
Sample size	159	184

Table 5

Wage Premium

Technologically Stationary

(coefficient/standard error)

Group	Overtime ($h \geq 0$)	Undertime ($h < 0$)
Variable		
Hours (h)	.169/.195	-.608/.700
Hoursqd(h^2)	-.22/.075	-.775/1.039
Exp	-.0050/.0111	-.0181/.0126
Exp^2	.0009/.00029	.00036/.00031
Imports (m)	6.105/4.372	8.280/4.940
Exports (x)	-1.323/1.259	-1.095/1.249
Interact	.889/1.453	1.995/.600
Lambda	-.964/.654	-.358/1.699
Intercept	.891/.649	-.694/.642
R^2	.103	.114
Sample size	188	270

III. Conclusion

This research indicates the importance of studying the labor market response to demand variations by separating observations into undertime and overtime regimes. Failure to do this will lead to an opaque picture of the adjustment process. Regardless of the exact mechanisms which lead to overtime and undertime regimes, it appears that in U. S. manufacturing there is a significant overtime premium, particularly for union workers and those in technologically progressive industries. Further, during undertime regimes there is not a reduction in wage rates, and for some groups wages rise with undertime hours, though the statistical precision of the relationship is not as strong.

The paper offers support for the belief that uncompensated hours rationing is likely to occur for workers with less firm-specific capital while workers with more firm-specific capital are more likely to be compensated for the rationing of work or leisure (Abowd and Ashenfelter, 1981). With firm-specific capital the wage path becomes endogenous and estimation of a "labor supply response" as if the wage changes were parametric shifts is apt to be misleading. Marginal and average wages must be distinguished, and a rising average wage during a period of reduced hours should be separated from a rising average wage during a period of overtime.

A goal of our research is to characterize the response of the manufacturing labor market to a rise in imports. Analysis of the impact of imports on wage rates needs to distinguish short

term or displacement effects from long term effects which may be observed because of worker heterogeneity rather than because of disequilibrium. Further, imports can increase as a share of the domestic market in the short run under a variety of conditions, some of which can reflect circumstances which most workers would regard as favorable.

One can see three avenues for the impact of imports. First, imports may be the cause of a leftward shift in the residual demand curve facing the domestic industry. In this case they would put the industry into an undertime regime. Within that regime, if the change is permanent, the firm is far more likely to pursue a policy of "cutting utilty" by a reduction in the wage-hours package, a reduction in both wage rate and hours of work. In some cases imports may be drawn in by a rightward shift of the within-country demand for a product. Thirdly, there can be learning-by-doing, and this can lead to overtime regimes with a declining price as well as there being an increase in imports, depending on whether the foreign producers are also learning-by-doing and the shape of short run domestic and import supply functions.

Our results appear to support the notion that U.S. labor markets are characterized by wage-hours adjustment to match changing conditions. Our intention is subsequently to test the hypothesis that other industrialized countries have a similar extent of labor market flexibility. Our research indicates a payoff to analysis of cyclical labor market phenomena through the

use time series anaysis of individual panel data now being collected in the United states and other industrialized countries.

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