PERSISTENT EMPLOYMENT FLUCTUATIONS AND CAUTIOUS WAGE ADJUSTMENT

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The economy fluctuates continually in a way that calls for wage adjustments to preserve equilibrium. A durable tradition in macroeconomic thinking holds that stickiness or sluggishness of wage adjustment makes employment and unemployment fluctuate more that they would if equilibrium prevailed. The past decade has seen effective attacks on the theoretical foundations of this line of thought, though the majority of practical macroeconomists probably still believe in one of its variants. My purpose in this paper is to try to make some progress in improving the theoretical background for the hypothesis that excessive employment fluctuations are the result of slow wage adjustment.

My first major point is that the great majority of workers are established in their jobs. Their annual hours of work and annual weeks of unemployment can vary, but they are unlikely to change jobs. Therefore, their wages and levels of work effort are governed through bilateral relations with their employers, not through an open market. Wage adjustments occur within a predetermined framework, I will argue. The framework cannot change quickly. For reasons of information asymmetry, the most satisfactory framework is one where a wage formula dictates the wage and the employer chooses hours of work unilaterally. The framework can specify that wages adjust according to a formula in response to movements in observed variables. Of particular interest is the linkage to an observed indicator of excess supply.

The second major point is the need for caution in the design of a wage adjustment formula. The designers of a formula must guard most of all against the possibility that their formula may call for such large wage adjustments as to completely destabilize employment. I focus in particular on the elasticity of the excess supply of labor with respect to the wage. If that elasticity is more than twice the level contemplated in the wage adjustment formula, each adjustment will set off a change in excess supply so large as to call for an even larger adjustment in the opposite direction in the succeeding period. In my formal model of this problem, it becomes an imperative that wage adjustment be made sufficiently cautious that there is no possibility whatever of this unstable case. Any chance at all of explosive instability makes the expected deadweight loss in the employment relationship infinite.

Another reason for caution in the wage adjustment formula is measurement error. When the formula must set wages in response to imperfect measures of excess supply and other conditions, the optimal adjustment speed is lower.

When employment is determined by the unilateral profit maximization of employers with respect to a wage that responds cautiously, important persistent departures from equilibrium can occur. The deadweight loss from these departures has been the focus of criticism of the general line of thought attributing fluctuations to sluggish wage adjustment. The critics have said, surely private agents can get together to make the Pareto-superior changes that are so evidently available in the disequilibrium described by the theory. Because the agents don't make the obvious moves--say to increase employment during a recession--the theory must be wrong in suggesting disequilibrium. Instead, some real forces have conspired to bring a temporary decline in the equilibrium level of employment.

I argue, to the contrary, that persistent deadweight loss from disequilibrium is the constrained optimum for the employment relationship in a turbulent economy. Losses from other ways of managing the employment relationship would be even larger. In particular, the finding that most workers are in jobs that will last for decades suggests the importance of job-specific human capital. Inducing workers and employers to form this capital, and preserving it once it is formed, are matters of central importance. The deadweight loss of an economy with a spot labor market, with a fluid response to aggregate fluctuations but with distinctly suboptimal specific capital, might well be far greater that the admittedly high deadweight loss from fluctuations.

Wages are set and paid in dollars, and wage adjustment is viewed in nominal terms in this paper. The issue of the response of wages to published price indexes is investigated in detail in this paper in parallel with the issue of the response to measures of excess supply. There is no presumption of nominal stickiness, but there is an investigation of the actual role of prices and a comparison with the optimal role. Because prices increased the most during the two oil price shocks, when unemployment rose sharply, the optimal degree of indexing over the postwar period, viewed in retrospect, is negative. Actual indexing was positive, with an elasticity of about 0.4.

1. The consistency problem in the employment relation and wage formulas to solve it

Most workers have long-term relationships with their employers (Hall, 1980 and 1981). Because of job-specific human capital, their productivity in their current jobs exceeds their productivity in their next best jobs. Their hours and wages cannot be determined by standard competitive principles. Instead, either an unstructured bargaining process governs compensation and effort, or some kind of implicit contract or wage policy sets the terms of employment.

At the time a worker is recruited, an employer needs to make a long-term promise about compensation and work effort. The worker has to be convinced that this job offers at least as good a deal in the long run as any other job. But once a worker has worked for a few years, the employer has an incentive to cut his wages to the level of the best alternative now open to him, which may involve a significantly lower wage than was originally promised. Policy inconsistency is a serious problem in the employment relation. A successful employment arrangement involves some kind of solution to the inconsistency problem, a solution that prevents opportunistic wage cuts.

The type of employment arrangement considered in this paper relies on a wage adjustment formula to determine employment and compensation. Precommitment to a formula avoids the inconsistency problem. The success of the formula in achieving employment efficiency rests on its use of adequate information about the current state of the economy. The formulas studied in this paper make use of information about the excess demand for labor in the firm and information about the general level of prices.

Because the wage adjustment formula is a permanent commitment on the part of the employer at the beginning of a job that may well last for decades, the formula cannot change rapidly in response to changes in the economic environment. Instead, the formula governing the wage of a particular worker is the optimal solution to the problem as it is seen at the time the worker is hired. Changes in the environment that are not captured by the variables in the wage formula may influence the formulas for workers hired subsequently, but not the formulas for existing workers.

One of the goals of this paper is to characterize the economic environment for which the observed wage ajustment process is an optimal solution. It reaches two fairly sharp conclusions:

1. The wage adjustment process in the postwar U.S. contemplates a random upward drift in the price level--the formula behaves optimally in the presence of a random walk in the underlying nominal driving variable of the economy. However, the

formula does not contemplate the possibility of random drift in the rate of inflation. Rather, it incorporates the assumption that bursts of inflation will be temporary.

2. The wage adjustment process is built on the belief that there is random drift of the efficient wage level relative to the measured cost of living. The level of the cost of living has no effect in the long run on the level of the wage. However, recent changes in the cost of living are helpful in inferring the efficient current value of the wage. Because of the random drift in the cost of living relative to the wage, the wage adjustment formula makes extensive use of information about the excess demand for labor.

The theory of the labor market underlying this paper draws heavily on the conclusion of recent work that certain realistic circumstances make it desirable for the employment arrangement to be governed in the following general way: The wage formula sets a wage that is the best possible inference of the current opportunity cost of workers' time. Employers set employment so as to maximize current profit, taking the formula wage as the cost of labor. Such an arrangement is robust with respect to unexpected shifts in product demand, no matter what their magnitude. Its overall efficiency depends critically on the success of the formula in setting the wage to the opportunity cost of time.

1. The consistency problem in wage setting

The problem of formulating a consistent monetary policy has been emphasized by Kydland and Prescott (1978) and Barro and Gordon (1983). Related problems abound in all areas of policy making. Every judge sentencing an offender is tempted to give a light sentence on the ground that nothing at this stage can deter the crime already committed, even though the same judge would threaten the same criminal with a lengthy sentence before the crime took place. To take another example, the government has no desire to induce people to live in flood-prone areas, yet routinely bails out the victims of floods.

Employers face the same problem in setting wages. In a sense, it is irrational to pay the wage promised ten years earlier to a worker. The promise was necessary at the time of hiring, but is no longer needed to keep the worker on the job. Because the employer has this incentive to dishonor wage promises, workers may not believe in the promises. Lack of credibility will inhibit long-term relations that would be the efficient solution to the employment problem with extensive specific capital. Employers need ways to precommit to wage policies, so that workers can be confident that they will not be cheated in the future.

The best form of precommitment is to develop a wage and employment formula, which gives compensation and hours as functions of as many observable indicators of the state of the economy as possible. Were every important aspect of the economy measurable, employers could establish wage-employment formulas once and for all. These formulas would guarantee the efficient level of employment under all contingencies and could also provide the level of compensation expected by workers at the time of agreeing to the long-term relationship.

Of course, merely developing and announcing a wage formula does not solve the problem of consistency. Formulas can be changed. A fanciful solution is to build a machine incorporating the formula, with a meter showing the correct level for the current wage, put the machine in a sealed glass case, and swear that wages will always be set by the meter. Or, the firm could irrecovably grant the wage-setting power to a trusted third party, who would be required to follow the wage formula exactly.

A more realistic solution is based on reputation, as suggested by Carmichael (1983). A firm develops a reputation for obeying a suitable wage adjustment rule. Then it faces an incentive to stick to the rule, because it would lose its attractiveness to future recruits if it violated the rule.

The techniques and results in this paper do not rest on any particular solution to the consistency problem. Rather, they are compatible with any solution based on a wage-adjustment formula that depends on the two obvious signals for the wage--excess demand and the cost of living. They also require some degree of stability in the formula over time. Either formal precommitment or a reputational equilibrium provides the needed stability.

Robert Lucas' famous critique of econometric policy evaluation (1976) singled out work on wage adjustment as an area where the relations under study could not be considered as permanent structural features of the economy. Instead, the wage adjustment formula should change every time the economic environment changes. But solutions to the consistency problem invariably involve long-lasting predetermination of the wage adjustment formula. Lucas' critique is blunted as a result. Lucas' fundamental point--that the wage adjustment process ought to be the solution to a stochastic optimization problem--is precisely what motivates the work in this paper.

2. The basic form of the employment arrangement

A number of authors, including Hall and Lilien (1979) and Weitzman, have made the following point about bilateral contracts: If the value of the good to the buyer is variable, and no variable observed by both parties indexes that value, then an efficient contract will set a price equal to the marginal cost of the seller and let the buyer choose the quantity. If marginal cost is known to both parties, this contract gives the exactly efficient quantity.

In the problem considered in this paper. I will assume that the firm faces a marginal revenue curve,

$$L^{-1/\alpha}e^{q} \tag{2.1}$$

Here L is the level of employment, α is the elasticity of the demand for labor, and q is the log of a nominal shift in demand.

Now suppose that a rule provides that the log of the wage is to be w, even though the log of the true opportunity cost of labor is n. The rule has made an error in setting the wage of n-w. The firm sets L unilaterally by equating marginal revenue to the wage:

$$\log L = \alpha(q - w) \tag{2.2}$$

The efficient level of employment occurs at the point of equality of marginal revenue product and the opportunity cost of labor:

$$\log L^* = \alpha(q - n) \tag{2.3}$$

I define x as the employment error or excess demand for labor:

$$x = \log L - \log L^* = \alpha(n - w) \tag{2.4}$$

Excess demand does not depend on the demand shift, q. The form of the employment arrangement provides for an efficient response to demand shifts. Only the wage error, n-w, causes employment inefficiencies.

The deadweight loss from an employment error is proportional to the squared departure of log L from log L*, which in turn is proportional to the squared difference between n and w:

$$\text{(2.5)} \qquad \text{Deadweight loss} = (n-w)^2$$

The objective of wage-setting will be to minimize expected deadweight loss.

3. Designing the wage formula

I will consider the situation of an employer who is designing a wage adjustment formula to offer to a new employee. The employer and the employee agree on the stochastic environment. The wage adjustment formula minimizes expected deadweight loss for the next few decades given beliefs prevailing now about the future environment.

The wage adjustment process operates frequently in this model; the time period for the empirical work is the calendar quarter. Nothing important happens during the period when the wage is held fixed. At the beginning of each quarter, there are verifiable but noisy measures of the state of excess demand in the previous quarter, x_{t-1} and the cost of living, p_{t-1}. The wage adjustment formula derives a level for the wage this quarter based on the values of x, p, and w in earlier quarters:

$$(3.1) \qquad w_t = \phi x_{t-1} + \mu(L) w_{t-1} + \beta(L) p_{t-1}$$

This formula is similar to ones studied in papers on the Phillips curve, with two important differences. First, the way that wages and prices enter the formula is not restricted to first differences. As I will show shortly, the formula is in first difference form only in certain types of stochastic environments. It is interesting to test the first-difference form against the more general level form. Second, the excess demand variable, x_{t-1} has no lag expression multiplying it. If there were one, we could divide the whole formula by the lag expression to get an formula in this form. Recent research that has explored for rate-of-change and lagged effects of unemployment in the Phillips curve has failed to note the superfluous generality of a wage equation with full lags on wages, prices, and unemployment. Any question about the effects of lagged unemployment can be rephrased as a question about the lags on wages and prices.

In the general wage adjustment formula, the lag polynomials $\mu(L)$ and $\beta(L)$ must have only non-negative powers of L; otherwise they would call for unknown values of w and p.

The optimal wage policy minimizes $(n-w)^2$ with respect to the distribution of n conditional on the available information, x_{t-1}, p_{t-1}, p_{t-2}, ..., w_{t-1}, w_{t-2},... Earlier values of x are superflous: any information they contain is also available in the history of w. In other words, the wage adjustment formula sets w_t to the least-squares prediction of n_t based on lagged x, p, and w. I should note parenthetically that uncertainty is not ignored in this model; rather, a quadratic loss function is the natural assumption and minimization of quadratic loss leads to certainty equivalence.

The problem, then, is to choose ϕ, $\mu(L)$, and $\beta(L)$ so that

(3.2) $$E(n_t) = \phi x_{t-1} + \mu(L) w_{t-1} + \beta(L) p_{t-1}$$

There is one special characteristic of this problem that needs to be kept in mind in the minimization: The information in the excess demand indicator, x_{t-1}, depends on the wage policy; it is not an exogenous random variable.

Fundamental assumption:

The noise in the excess demand measure, x, is stationary; following a deflection, the noise tends to return to zero.

This assumption is fundamental in the following way: If both x and p contain non-stationary errors, there is no reliable information at all about the appropriate level of the wage, and it is hopeless to look for a wage adjustment formula based on x and p. The data suggest rather strongly that p contains a random walk error, so it is essential that x not drift away from the true measure of excess demand.

Now let:

$\alpha\varepsilon_t$: noise in excess demand indicator, x

ν_t: noise in nominal indicator, p

Then,

(3.3) $$x_t = \alpha(n_t - w_t + \varepsilon_t)$$

Define the observable variable z as

(3.4) $$z_t = \frac{1}{\alpha}x_t + w_t$$

(3.5) $$= n_t + \varepsilon_t$$

Also,

(3.6) $$p_t = n_t + \nu_t$$

With this specification, together with information about the processes for n, ε, and ν, it is possible to derive the optimal formula for inferring the current value of n given past values of x, p, and w.

(3.7) $$\hat{n}_t = \pi(L)z_{t-1} + \Psi(L)p_{t-1}$$

The lag polynomials $\pi(L)$ and $\Psi(L)$ involve only non-negataive powers of L, corresponding to lagged values of z and p.

Because the rule is to set the wage equal to the expected value of n_t, an implicit characterization of the optimal wage policy is

(3.8) $$w_t = \pi(L)z_{t-1} + \Psi(L)p_{t-1}$$

However, z_t on the right hand side involves lagged values of the wage, since the wage affects excess demand. Write this out explicitly:

(3.9) $$w_t = \pi(L)(\frac{1}{\alpha}x_{t-1} + w_{t-1}) + \psi(L)p_{t-1}$$

Now solve for w_t:

(3.10) $$w_t = \frac{\pi_1}{\alpha}x_{t-1} + (\frac{\pi(L)-\pi_1}{L\pi(L)} + \pi_1)w_{t-1} + \pi_1\frac{\psi(L)}{\pi(L)}p_{t-1}$$

This is the optimal wage adjustment equation.

Examples:

1. Nominal shift. n_t is a random walk; p_t is completely uninformative.

In this case, the problem boils down to a standard signal extraction problem (see, e.g., Nerlove (1967)). z_t is the sum of a random walk and white noise. The coefficients for inferring n_t from lagged data are

(3.11) $$\pi(L) = \frac{(1 - \omega_1)L}{1 - \omega_1 L}$$

$$\psi(L) = 0$$

The optimal wage adjustment equation is, after some simplification,

(3.12) $$\Delta w_t = \frac{1 - \omega_1}{\alpha} x_{t-1}$$

This is an old-fashioned Phillips curve, without any expectational shift. The strength of the response to excess demand depends inversely on the elasticity of demand, α. It also depends on the quality of the information in x. If there is only a little noise in x, ω_1 is close to zero and the weight on x_{t-1} is large. The more noise there is in x, the higher is ω_1 and the flatter is the Phillips curve.

2. The rate of change of the nominal shift is a random walk; p is completely uninformative

In this case,

(3.13) $$\pi(L) = \frac{(2-\omega_1)L-(1-\omega_2)L^2}{1-\omega_1 L+\omega_2 L^2}$$

$$\psi(L) = 0$$

The wage adjustment equation is

(3.14) $$\Delta w_t = \frac{2-\omega_1}{\alpha} x_{t-1} + (1-\lambda)(\Delta w_{t-1} + \lambda\Delta w_{t-2} + \lambda^2\Delta w_{t-3} + \ldots)$$

This is a modern Phillips curve with an expectational shift. The coefficient applied to excess demand has the same character as in the first example--the more noise there is in the variable, the smaller is the coefficient. The second term applies a set of weights summing to one to the lagged rate of wage growth. Once