Basic Efficiency Wage Model

There is a large number, *N*, of identical competitive firms.

The representative firm seeks to maximize:

$$\pi = Y - wL$$

Output depends on the number of workers and their effort:

$$Y = F(eL)$$

Effort is a function of the real wage:

$$e = e(w)$$

Each of $\bar{Y}$ identical workers is willing to supply one unit of labor (but with effort left endogenous).

The problem for a profit maximizing firm is to maximize profit:

$$F(e(w)L) - wl$$

by choosing *L* and *w*.

First order conditions are:

$$F'(e(w)L)e(w) - w = 0 \tag{9.5}$$

$$F'(e(w)L)Le'(w) - L = 0 \tag{9.6}$$

Rearrange (9.5):

$$F'(e(w)L) = \frac{w}{e(w)} \tag{9.7}$$

Substituting (9.7) into (9.6):

$$\frac{w}{e(w)}Le'(w) - L = 0$$

Dividing by *L* and rearranging:

$$\frac{we'(w)}{e(w)} = 1$$

$$\left(\frac{w}{e}\right)\left(\frac{de}{dw}\right) = 1$$

This says that the elasticity of effort with respect to the real wage is 1.

Intuition:

I am considering raising the real wage. If effort goes up by 2% when I increase the wage by 1%, then I get more output per dollar spent on labor. So I will raise the wage (until the % effort gain is just equal to the % increase in the wage).

Now, for the economy-wide equilibrium, let $w*$ and $L*$ be the values of *w* and *L* that solve the firm's profit maximization problem.

Economy-wide labor demand is $NL*$. So long as $\bar{L}$ exceeds $NL*$, firms are unconstrained in their choice of *w*, and unemployment is $\bar{L} - NL*$.

More on Efficiency Wages: Extended Model

Generalize the effort function to:

$$e = e(w, w_a, u) \tag{9.9}$$

Recall the problem:

Max $\pi = F(eL) - wL$

First order conditions (for choices of *L* and *w*) take the form:

$$F'\left(e(w, w_a, u)L\right) = \frac{w}{e(w, w_a, u)} \tag{9.10}$$

$$\frac{we_1(w, w_a, u)}{e(w, w_a, u)} = 1 \tag{9.11}$$

Example:

Let $e = \begin{cases} \left(\dfrac{w-x}{x} \right)^{\beta} & \text{if } w > x \\ 0 & \text{otherwise} \end{cases}$

where

$$x = (1-bu)\,w_a$$

For this functional form, the first order condition for *w* corresponding to (9.11) becomes (show this!):

$$w = \frac{x}{1-\beta}$$

or

$$w = \frac{1-bu}{1-\beta} w_a \qquad (9.15)$$

In equilibrium, each firm pays the prevailing wage, so $w = w_a$. Substituting into (9.15):

$$1-\beta = 1-bu$$

$$\beta = bu$$

$$u = \frac{\beta}{b}$$

$$u_{EQ} = \frac{\beta}{b} \qquad (9.17)$$

This is the equilibrium, or “natural” rate of unemployment.

According to (9.15), each firm would want to pay a wage (*w*) lower than that prevailing (w_a) if *u* were higher than u_{EQ}.

One can further show that the “equilibrium” effort and wage are:

$$e_{EQ} = \left(\frac{\beta}{1-\beta} \right)^{\beta} \qquad (9.18)$$

(This condition above comes from the effort function, substituting the equilibrium unemployment rate in the expression for *x*, and then simplifying …)

$$w_{EQ} = e_{EQ} F'\left(\frac{e_{EQ}\left(1-u_{EQ}\right)\bar{L}}{N} \right) \tag{9.19}$$

(This condition comes from 9.10, letting $L = \frac{\left(1-\bar{u}\right)\bar{L}}{N}$ for each firm's number employed; where $\bar{L}$ is the labor force (fixed) and *N* is the number of firms).

Implications of this model:

Equilibrium unemployment depends only on the parameters of the effort function (not on population or the production function) . See (9.17).

A modest β can lead to a reasonable value for the natural rate of unemployment. E.g., if $b = 1$ and $\beta = 0.06$, then unemployment is 6% in equilibrium. (Note that β is the elasticity of effort with respect to the wage "premium").

If unemployment rises in a recession, firms do not have much incentive to alter the real wage rate (even though effort depends on unemployment). Romer shows this with a numerical example, but the logic is familiar. If we start at the profit-maximizing *w*, then a small change in *w* has a small impact on profit. Suppose unemployment rises. The firm (optimally) would lower the wage it pays. If it fails to do so, it is paying a wage that is "too high." But by paying a wage that is "too high" workers choose to exert more effort, which results in costs being lower. So the higher wage is largely offset by the cost-reducing impact of more effort, and the gains from adjusting wages are small.

This then leads to a fairly reasonable explanation for real wage inflexibility in the face of business cycle fluctuations. Recall that this is just what we needed for our New Keynesian models, real wage inflexibility to accompany nominal price rigidity.

Unlike the simpler efficiency wage model, the chosen wage now does depend on unemployment. Also the earlier efficiency wage model implied that the real wage and employment were invariant to technical change and population growth, which would, in turn, suggest that the unemployment rate might persistently rise or fall over time.