Lecture Note: Efficiency wages, the Shapiro-Stiglitz Model

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1 Why don't labor markets clear?

- Why is there unemployment?

- In the absence of minimum wages, why aren't wages bid down sufficiently by job seekers so that everyone who wants a job finds one?

- Can the neoclassical paradigm explain involunary employment?

An answer to these puzzles was famously proposed by Shapiro-Stiglitz in 1984: Unemployment is driven by the information structure of employment.

Two basic observations undergird their analysis:

1. Unlike other forms of capital, humans can choose their level of effort.

2. It is costly for firms to determine how much effort workers are exerting.

1.1 Sketch

1. Consider a situation where all workers can receive the market wage and there is no unemployment.

2. In this case, the worse thing that can happen to a worker is that she will be fired and instantaneously rehired.

3. There is therefore no penalty for not exerting effort ('shirking').

4. To induce workers not to shirk, firms pay above-market wages. Therefore, job loss imposes a penalty.

5. But if one firm pays above-market wages, then presumably they all will.

6. In this case, the incentive not to shirk disappears.

   - But unemployment results since wages are above the natural equilibrium level.

   - Unemployment creates its own penalty for shirking.

7. Hence, the model implies that *unemployment and monitoring are substitutes.*

8. Consequently, wages serve two functions: allocating labor and providing incentives for employee effort conditional on employment. As is usually the case when one instrument is used to solve two problems, this is likely to lead to inefficient outcomes.

1.2 BASIC SETUP

- N identical, risk neutral workers.

- Instantaneous utility is a function of wages and effort 'normalized' as:

$$u(w, e) = w - e.$$

- e is either 0 or a constant $e > 0$ (binary, not continuous).

- Unemployed workers receive $\overline{w} \geq 0$ and $e = 0$.

- b is the exogenous separation rate per unit time.

- r is the intertemporal discount rate.

- The workers objective function is therefore

$$\max_{e} E \left[\int_0^\infty u(w(t), e(t)) \exp(-rt) \partial t \right]$$

- The workers choice at any point in time is to exert effort or not. That's it.

- The odds of getting caught if shirking are q.

- If fired, the worker enters unemployment, waits for a new job.

- Question: What are the odds of finding a new job if fired (per unit time)?
  Answer: Endogenous outcome of the model.

1.3 ASSET EQUATIONS

- Consider a short, discrete time interval: $[0, t]$. The asset value of employment is

$$V_e = wt + (1 - rt) \left[bt V_u + (1 - bt) V_e \right]. \tag{1}$$

- Notice that we are for now taking V_u as given. The wt term is the flow of wages, and the second expression is the discounted value of future outcomes, bearing in mind that $(1 - rt) \approx \exp(-rt)$.

- Rewriting 1, we have

$$
\begin{aligned}
V_e &= \frac{wt + (1 - rt) bt V_u}{1 - (1 - rt)(1 - bt)} \\
&= \frac{wt + bt V_u - rbt^2 V_u}{rt + bt - rbt^2}
\end{aligned}
$$

- Allowing $t \to 0$ (moving into continuous time) gives

$$V_e = \frac{w + b V_u}{r + b} \Rightarrow r V_e = w + b(V_u - V_e).$$

Notice that value of employment is the flow value of the wage minus the capital loss of unemployment scaled by its probability.

- We now want to consider this problem separately for a shirker versus non-shirker:

$$
\begin{aligned}
r V_e^s &= w + (b + q)(V_u - V_e^s), \\
r V_e^n &= w - e + b(V_u - V_e^n).
\end{aligned}
$$

- Rearranging:
$$V_e^s = \frac{w + (b + q) V_u}{r + b + q}$$

and

$$V_e^n = \frac{(w - e) + b V_u}{r + b}. \tag{2}$$

1.4   No shirking condition (NSC)

- The NSC is simply that $V_e^n > V_e^s$, which implies that

$$\widehat{w} \equiv w \geq rV_u + \frac{e}{q}(r + b + q). \tag{3}$$

- This implies that

$$q(V_e^s - V_u) \geq e.$$

- *Unless there is a penalty associated with unemployment, everyone will shirk.* ($q \to 0$ implies no penalty).

- Comparative statics on effort supply and wages. The critical wage must be higher when:

    - Effort is more expensive in utility terms (e higher).

    - Utility of unemployment is higher.

    - Lower probability of being caught shirking (q lower).

    - Higher is the interest rate.

    - Higher is the exogenous quit rate (b). Why? If you are going to lose your job soon anyway, why not cheat?

1.5   The firm side

- M identical firms.

- Production at the firm level is $Q_i = f(L_i)$.

- Aggregate production is $Q = F(L)$.

- Assume each worker contributes one until of labor unless she shirks.

- Firms compete by offering wage packages only. No other variables.

- Assume $F'(N) > e$, full employment is efficient.

- The monitoring technology q is exogenous.

- The only way to punish shirkers is therefore to fire them.

1.6 EQUILIBRIUM CONCEPT

- In equilibrium: Each firm takes wages and employment levels at other firms as given, and finds it optimal to offer the going wage.

- Firms will obviously pay no more than the NSC wage: $w^* = \widehat{w}$.

- Hence, we'll have $f'(L_i) = F'(L) = \widehat{w}$.

- Wages high, workers value jobs for two reasons:

  - High wages increase utility.

  - Low employment due to high wages, leads to long unemployment spells.

  - Firms will lower wages until NSC binds.

- Wages low, workers shirk for two reasons:

  - Wages are low, workers only moderately prefer work to unemployment.

  - High employment, leads to shorter unemployment spells.

  - Firms will raise wages until NSC satisfied.

1.7 ENDOGENIZING UNEMPLOYMENT

- Now return to the worker's problem, considering V_u, which we endogenize:

$$rV_u = \overline{w} + a(V_e - V_u), \qquad (4)$$

where a is the job acquisition rate, and $\overline{w}$ is the unemployment benefit.

- Q: Where does a come from? Endogenous.

- Q: What must V_e be equal to in equilibrium? V_e^n. (It can never be efficient for firms to hire workers who shirk. If they shirk ever, they shirk always, so they are unproductive.)

- We can now solve 2 and 4 together:

$$rV_e = \frac{(w-e)(a+r) + \overline{w}b}{a+b+r}$$

and

$$rV_u = \frac{(w-e)a + \overline{w}(b+r)}{a+b+r}.$$

- Q: Where did q go? It's not visible because no one is shirking in equilibrium. *But* it will still affect the wage, as will be shown.

- Plugging back into to the NSC (3), we get

$$\widehat{w} \geq \overline{w} + e + \frac{e}{q}(a+b+r). \tag{5}$$

- Two additional implications follow:

    - Higher unemployment benefit, higher critical wage (of course).

    - Higher flows out of unemployment (a), higher critical wage (a critical result).

- Q: Since a is the instantaneous hazard of job acquisition, what is expected time to hire?
  A: $1/a$.

- Now, a can be solved in terms of parameters of the model.

- What is the equilibrium condition for a?
  A: In equilibrium, it must be the case that flows out of unemployment equal flows in.
  Hence:

$$a(N-L) = bL \Rightarrow a = \frac{bL}{N-L}.$$

- Substituting back into 5, we get

$$\widehat{w} \geq \overline{w} + e + \frac{e}{q}\left(\frac{bN}{N-L} + r\right).$$

- Note that $a + b = \frac{bL + b(N-L)}{N-L} = \frac{bN}{N-L}$.

- Note that $u = \frac{N-L}{N}$.

- Rewriting, we get

$$\widehat{w} \geq \overline{w} + e + \frac{e}{q}\left(\frac{b}{u} + r\right). \tag{6}$$

- See Figure 1.

- Equation 6 becomes a quasi-labor supply function (really an effort supply function). As the unemployment rate approaches 0, the critical wage tends toward infinity.

- See Figure 2.

- In equilibrium, $F'(L) = \widehat{w} = w^*$, i.e., where labor demand (MPL) intersects quasi-labor supply.

- This is a Nash equilibrium because:

  - From the firm's point of view, there is no point in raising wages. Workers are providing effort e, and firm can obtain all the workers it wants at wage w^*. But lowering wages would yield shirking.

  - From the worker's viewpoint, unemployment is involuntary. Job seekers strictly prefer work to unemployment. Would be happy to work at wage w^* *or lower* (any $w > e$) but cannot credibly commit to work at a lower wage than w^*.

- Question: What is the core inefficiency here? (Costly monitoring)

1.8 SOME KEY RESULTS

1. Wages don't fall *enough* during recessions to prevent unemployment from rising.
   If labor demand shifts inward, this lowers wages. But because wages have fallen, the probability of shirking has risen. If employment levels (and hence unemployment) remain the same, workers will therefore shirk. *Wages cannot fall enough to maintain employment levels at previous state. So, unemployment must rise during recessions.*

2. Possible corollary: Wage sluggishness. Moving from one w^* to another w^{**} will require each firm to repeatedly re-optimize wages in response to shifting unemployment rate. Firms cannot cut wages until unemployment rises sufficiently (a coordination problem).

The outcome solved above is *never* Pareto efficient. Why not?

1. Each firm employs too few workers because it faces private cost of hiring w^* rather than the social cost – which is equal to what? e. And $w^* > e$ in all cases.

2. There are also negative externalities. Each firm increases V_u for all other firms by hiring.

But the first problem clearly dominates since the 'natural rate of unemployment' is always *too high.*

A subtle point. This second problem is a pecuniary externality (i.e., my demand raises your prices).

- We don't normally worry about pecuniary externalities at competitive equilibria. Why worry here?

- Pecuniary externalities are second order at a Pareto efficient equilibrium (this follows from the envelope theorem for constrained problems).

- Because this equilibrium is not Pareto efficient, these externalities are first order.

1.10   SOCIAL PLANNER'S PROBLEM

- The social maximization for the problem here is what? (Constrained Pareto efficiency.)

$$\max(w - e)L \quad s.t. \quad :$$
$$w \geq NSC,$$
$$wL \leq F(L).$$

- Show Figure 4.

- Provided that $F'(L) > e$ (as we have assumed), more employment is always socially efficient.

- Hence, the socially efficient equilibrium has

$$w^* = \frac{F(L)}{L},$$

  which will correspond to a point where the average product of labor intersects the NSC quasi-labor supply function.

- But the market equilibrium has $F'(L) = w^*$.

- *Unless* $F(L)$ has constant returns to scale, i.e., $F'(L) \cdot L = F(L)$, market equilibrium will not be constrained Pareto efficient and employment is too low.

1.11 SOCIAL PLANNING PROBLEM: ANOTHER SURPRISE

To get to the constrained Pareto efficient outcome, the social planner would have to tax away pure profits to subsidize wages until $w^* = \frac{F(L)}{L}$. But:

- The social planner's solution will be more socially efficient but will not generate a Pareto improvement.

- Taxation will make firms strictly worse off and workers better off.

- Unless workers and firms are the same people, this welfare improvement requires redistribution.

- Hence, this model suggests a violation of the Second Welfare Theorem: efficiency and distribution are *not separable problems* in this economy.

1.12 SUMMARY

This is a brilliant paper that generated a huge literature. With a simple and sensible set of assumptions–workers can choose effort; firms cannot monitor them costlessly–it can potentially explain:

- Involuntary unemployment (workers seeking jobs at prevailing wages but wages are not bid down).

- Wage rigidity and sluggishness.

- Why recessions raise unemployment.

It also introduce into labor economics a set of tools that reappear in many places, particularly the equilibrium unemployment search models of Mortensen and Pissarides.

Of course, the 'cost' of this model is the assumption that workers are 'rational cheaters'–only punishment and wages motivate them. A large literature has assessed both the predictions of the model and the assumptions made on worker maximands. A variety of alternative 'efficiency wage' models offer similar predictions but different operative assumptions on human behavior. The Akerlof gift exchange model is an influential alternative.

Table removed due to copyright considerations. Please see the following:

Shapiro, Carl, and Joseph E. Stiglitz. Figures 1, 2 and 4. In "Equilibrium Unemployment as a Worker Discipline Device." American Economic Review 74, no. 3 (1984).

Brosnan, Sarah F., and Frans B. M. de Waal. Figures 1 and 3. In "Monkeys Reject Unequal Pay." Nature 425 (September 2003).