

# Labor Economics, 14.661. Lecture 7: Efficiency Wages

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# Introduction

- First attempt to incorporate the internal organization of the firm with labor market equilibria: *efficiency wage models*.
- Very simple models of incentive problems (moral hazard or adverse selection) on the firm side combined with a simple model of the labor market.
- Canonical example: the Shapiro-Stiglitz model of efficiency wages due to moral hazard.
- Implications:
  - Labor demand reduced because of incentive problems→unemployment.
  - Interactions between incentives and markets (“unemployment as a discipline device”).
  - Potential inefficiencies (but care is necessary...).

# Environment

- Model in continuous time and all agents are risk neutral and infinitely lived.
- Workers have to choose between two levels of effort, and are only productive if they exert effort.

→ effort	→ 0	$\tilde{\text{cost}} = 0$ , not productive
	→ 1	$\tilde{\text{cost}} = e$ , productive

- Without any informational problems firms would write contracts to pay workers only if they exert effort.
- The problem arises because firms cannot observe whether a worker has exerted effort or not, and cannot deduce it from output, since output is a function of all workers' efforts.
- This introduces the *moral hazard problem*.
- In addition, workers cannot be punished for low output.
- This introduces the *limited liability problem*.

## Environment (continued)

- Continuous time → flow rates instead of probabilities.
- If a worker “shirks”, there is effort = 0, then there is a flow rate  $q$  of getting detected and fired.
- What does this mean mathematically?
  - Formally, this corresponds to a Poisson process in continuous time, meaning that in the interval of length  $\Delta t$ , the probability of a shirking worker being caught is  $q \cdot \Delta t + o(\Delta t)$ , where  $o(\Delta t)$  designates terms that are second-order in  $\Delta t$ , i.e.,  $\lim_{\Delta t \rightarrow 0} \frac{o(\Delta t)}{\Delta t} = 0$ .
- What does it mean economically?
  - Suppose that the worker’s actions affect the probability distribution of some observable signal on the basis of which the firm compensates him or decides to fire him.

## Environment (continued)

- Let
  - $b$  = exogenous separation rate
  - $a$  = job finding rate, which will be determined in equilibrium
  - $r$  = interest rate/discount factor
  - $w$  = wage rate (not conditioned on past outcomes)
- All of these are flow rates also.
- Solution, using simple dynamic programming arguments.
- Let us simplify the analysis by focusing on steady states.
- Consider the present discounted values (PDV) of workers as a function of their “strategy” of shirking or working hard.

# Dynamic Programming Equations

- Denote the PDV of employed-shirker by  $V_E^S$ . Then

$$rV_E^S - \dot{V}_E^S = w + (b + q)(V_U - V_E^S).$$

- Interpretation in terms of asset values:
  - the worker always receives his wage  $w$  (a “dividend” on his asset)
  - at the flow rate  $b$ , he separates from the firm exogenously, and at the flow rate  $q$ , he gets caught for shirking, and in both cases he becomes unemployed, receiving  $V_U$  and losing  $V_E^S$ . In continuous time, the probability that both events happen at the given instant is zero (or the probability that both events happen in a small interval is very very small). Thus at the flow rate  $b + q$ , the current asset is swapped with another assets with the value  $V_U$ .
  - finally, there is an appreciation of the asset, captured by the term  $\dot{V}_E^S$ .
- In steady state:  $\dot{V}_E^S = 0$ , so

$$rV_E^S = w + (b + q)(V_U - V_E^S). \quad (1)$$

## Dynamic Programming Equations (continued)

- Similarly, let the PDV of employed-nonshirker be  $V_E^N$ . We have

$$rV_E^N - \dot{V}_E^N = w - e + b(V_U - V_E^N).$$

Or in steady state

$$rV_E^N = w - e + b(V_U - V_E^N). \quad (2)$$

- Different from the PDV of shirkers, (1), because the worker incurs the cost  $e$ , but loses his job at the slower rate  $b$ .
- PDV of unemployed workers  $V_U$  is

$$rV_U = z + a(V_E - V_U), \quad (3)$$

where  $z$  is the utility of leisure + unemployment benefit, and

$$V_E = \max \left\{ V_E^S, V_E^N \right\}.$$

(Why?).

## Dynamic Programming Equations (continued)

- Key object: *incentive compatibility constraint* for workers so that they prefer to exert effort rather than shirk.
- *Non-shirking condition*:

$$V_E^N \geq V_E^S. \quad (4)$$

- What is the interpretation?
  - The firm will offer a wage to the worker, but must ensure that the worker finds exerting effort (rather than shirking) incentive compatible.
  - Will the firm ever offer a wage such that  $V_E^N > V_E^S$ ?



## Dynamic Programming Equations (continued)

- Let us first focus on steady state.
- Suppose that a shirking worker always shirks and worker who exerts effort always does so also (is this necessary?). Then we can write (2) as

$$V_E^N = \frac{w - e + bV_U}{r + b},$$

and (1) as

$$rV_E^S = \frac{w + (b + q)V_U}{r + b + q}.$$

- Combining those, we can reexpress (4) as

$$w \geq rV_U + e + (r + b) \frac{e}{q} \quad [\text{non-shirking condition}].$$

- Intuitively, the greater is the unemployment benefit and the greater is the cost of effort, the greater should the wage be.
- More importantly, the more likely the worker is to be caught when he shirks, the lower is the wage.

# Equilibrium

- Steady state requires that  $\implies$

flow into unemployment = flow out of unemployment

- In equilibrium, no one shirks because the non-shirking condition holds (similar to the agents doing the right thing in the agency models).
- Therefore,

$$bL = aU$$

where  $L$  is employment, and  $U$  unemployment.

- This implies

$$a = \frac{bL}{U} = \frac{bL}{N - L}.$$

## Equilibrium (continued)

- Let us now eliminate all endogenous variables from the non-shirking condition.
- In particular, let us now combine (2) and (3) to eliminate  $V_U$ .
- Making use of the “one step ahead deviation principle”, this can be done as

$$rV_E^N - V_U = \frac{w - e - z}{r + b + a}.$$

Then combining this with (4), we can reexpress this condition as

$$\text{Non-Shirking Condition : } w \geq z + e + \left[ r + \frac{bN}{N-L} \right] \frac{e}{q}$$

- A higher level of  $\frac{N}{N-L}$ , which corresponds to lower unemployment, necessitate a higher wage to satisfy the non-shirking condition.
- This is the sense in which unemployment is a worker-discipline device.

## Equilibrium: Interpretation

- Higher unemployment makes losing the job more costly, hence encourages workers not to shirk.
- Source of the idea that *unemployment is a worker discipline device* (what happens if unemployment is equal to 0?)
- Now in this light, let us revisit the implicit assumption that a firm always fires a worker who is caught shirking. What happens if the firm does not fire but pays a lower wage to such a worker? What happens if the firm fires such a worker only with some probability,  $\alpha$ ?

## Equilibrium (continued)

- Non-shirking condition  $\approx$  labor supply (why?)
- For equilibrium, we also need to consider labor demand.
- Suppose that the aggregate demand for labor is given from the production side represented by the aggregate production function

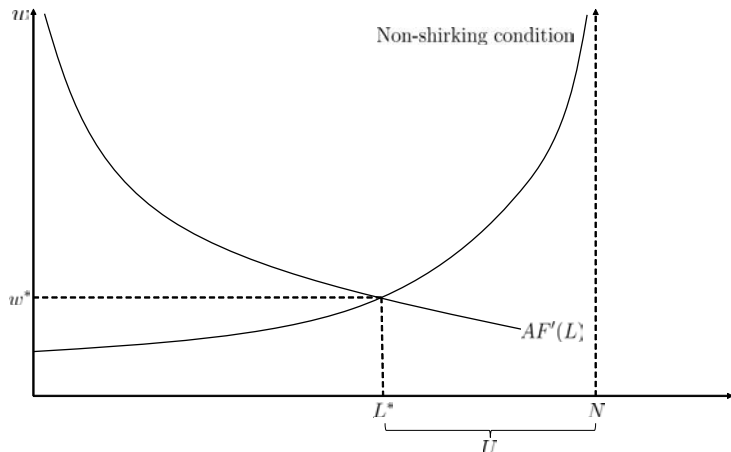
$$AF(L).$$

- Let us make the standard assumptions on  $F$ , in particular, it is increasing and strictly concave, i.e.  $F'' < 0$ .
- No adjustment costs are dynamics, so firms maximize static profits.
- Therefore, aggregate labor demand is given by

$$AF'(L) = w.$$

# Equilibrium (continued)

- Equilibrium in a picture.



## Equilibrium (continued)

- Mathematically, the equilibrium is given by

$$z + e + \left( r + \frac{bN}{N-L} \right) \frac{e}{q} = AF'(L)$$

- Loosely speaking, labor demand is equal to quasi-labor supply.

# Comparative Statics

- Straightforward comparative statics
  - $A \downarrow \implies L \downarrow$ : lower prod.  $\implies$  high unemployment
  - $z \uparrow \implies L \downarrow$ : high reservation wages  $\implies$  high unemployment
  - $q \downarrow \implies L \downarrow$ : bad monitoring  $\implies$  high unemployment
  - $r \uparrow \implies L \downarrow$ : high interest rates  $\implies$  high unemployment
  - $b \uparrow \implies L \downarrow$ : high turnover  $\implies$  high unemployment



## Non-Steady-State Dynamics

- Are there interesting non-steady-state dynamics?
- In search models, which are also characterized by a “flow in = flow out” type equation, there will be dynamics.
- So let’s first think about this equation. Instead of steady state, if we look at it more generally, we can write it as

$$\dot{U} = \text{workers losing their jobs} - \text{hires.}$$

- Could there be slow dynamics coming from this equation?
- Suppose that unemployment is above its equilibrium value,  $U^*$ , determined previously. What would happen?
- Answer: there will immediately be a huge increase in hires until unemployment reaches immediately  $U^*$ . Why?

## Non-Steady-State Dynamics (continued)

- Could there be non-steady-state dynamics coming from the non-shirking condition?
- Not really. With the argument given above, we have  $V_E^N = V_E^S$  at all points in time, and thus

$$\dot{V}_E^N = \dot{V}_E^S.$$

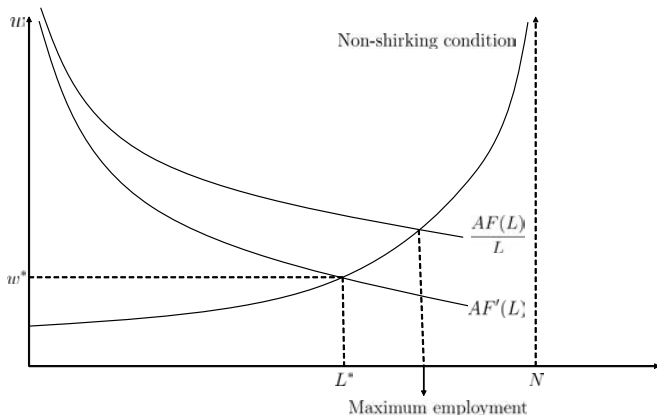
- But this implies that even without imposing steady state, the exact same non-shirking condition is obtained.
- Intuitively, the non-shirking condition has to hold at all points in time this, which removes the possibility of higher wages in the future incentivizing workers. (Or vice versa).
- But note a very important assumption here: no wage “discrimination” across workers. What would happen if firms could offer (and commit to) different wages for different workers, and in particular as a function of their tenure in the firm?

# Efficiency

- Since there is unemployment, rents and information problems here, it is also natural to ask the welfare question: is the level of unemployment too high?
- Answer: depends on what notion of welfare we are using and whether firms are owned by nonworkers.
- *Incorrect answer*: the equilibrium is Pareto suboptimal.
- Why is this incorrect?

## Efficiency (continued)

- Consider the equilibrium diagram with average revenue also included. This shows that employment and output can be increased.



## Efficiency (continued)

- Why is this?
- What are the externalities?
- ① By hiring one more worker, the firm is reducing unemployment, and forcing other firms to pay higher wages→unemployment is too low.
- ② By hiring one more worker, the firm is increasing the worker's utility at the margin, since each worker is receiving a rent (wage  $>$  opportunity cost)→unemployment is too high.
- The diagram shows that the second effect always dominates (now consider the average product line).
- The unemployment is too high from the viewpoint of *maximizing total output* or net surplus.
- Maximum output when  $w =$  average productive labor. Why?

## Why Not Pareto Improvements?

- A subsidy on wages financed by a tax on profits will increase output.
- But this is *not* a Pareto improvement.
- Who owns the firms?
- If firms are owned by capitalists, the above policy will increase output, but will not constitute a Pareto improvement.
- If firms are owned by workers, the above policy will constitute a Pareto improvement.
  - But in this case workers have enough income.
  - Why do they not already enter into “bonding” contracts or at least write better contracts as in our moral hazard models?

# Other Solutions to Incentive Problems

- The discussion so far already suggests that constant wages are not optimal.
- What will optimal wage schedules look like?
  - If workers are not credit constraint and no limited liability, *bonding contracts*.
  - If limited liability, then *backloaded compensation*
- What is the problem with backloading?
  - Perhaps firm-side moral hazard—firms may claim workers have shirked and fire them either to reduce labor costs when the worker's wage has increased enough (above the opportunity cost), or to collect the bond payments.

# Evidence on Efficiency Wages

- Two types of evidence offered in the literature in support of efficiency wages.
- *First*: presence of substantial inter-industry wage differences (e.g., Krueger and Summers, 1989).
  - Such wage differentials are consistent with efficiency wage theories since the monitoring problem ( $q$  in terms of the model above) is naturally more serious in some industries than others. But they are also consistent with lots of other models.
  - Moreover, the exact extent of “true” inter-industry wage differentials is quite debatable (e.g., Abowd, Kramartz and Margolis, 1999).
  - For example, these differentials may reflect compensating wages (since some jobs may be less pleasant than others) or premia for unobserved characteristics of workers, which differ systematically across industries because workers select into industries based on their abilities.
  - Even if there were such differentials across firms industries, this could be rent-sharing (e.g., Van Reenen, 1996, Hildreth and Oswald, 1997).



# Evidence on Efficiency Wages (continued)

- How can we control for compensating wage differentials?
  - ① Look at wage changes for workers who change industries (Krueger and Summers; Gibbons and Katz, 1992). What is wrong with this exercise?
  - ② Do workers vote with their feet? Quitting behavior (Krueger and Summers) and queuing behavior (Holzer, Katz, and Krueger, 1991).

## Evidence on Efficiency Wages (continued)

- *Second*: look for direct evidence for efficiency wage considerations.
- ① Krueger (1991) compares wages and tenure premia in franchised and company-owned fast food restaurants. Idea: less monitoring of workers in a company-owned restaurant. Why? He finds higher wages and steeper tenure-which profiles in company-owned restaurants.
- ② Cappelli and Chauvin (1991): look at the number of disciplinary dismissals, as a measure of shirking, in the different plants located in different areas, but all by the same automobile manufacturer (and covered by the same union). The firm pays the same nominal wage everywhere (because of union legislation), which translates into greater wage premia in some areas because outside wages differ. Result: when wage premia are greater, there are fewer disciplinary dismissals. Is this sufficient evidence?
- ③ Bewley (1999) and Campbell and Kamlani (1997) present survey evidence. Firms often unwilling to cut wages because this will reduce worker effort and increase shirking. Alternative explanations?

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