Unemployment: Introduction

Natural vs. cyclical unemployment

- Friedman's definition of natural rate:
    - ○ "the level that would be ground out by the Walrasian system of general equilibrium equations, provided that there is [sic] embedded in them the actual structural characteristics of the labor and commodity markets, including market imperfections, stochastic variability in demands and supplies, the cost of gathering information about job vacancies and labor availabilities, the costs of mobility, and so on."
    - ○ "Let me emphasize that by using the term 'natural' rate of unemployment, I do not mean to suggest that it is immutable and unchangeable. On the contrary, many of the market characteristics that determine its level are man-made and policy-made."
    - ○ Note that natural unemployment is due to microeconomic factors, largely in the labor market, not level of macroeconomic activity
- Cyclical unemployment = actual – natural
    - ○ This is unemployment due to the business cycle that we have studied
    - ○ Cyclical unemployment reflects general excess demand or supply in the macroeconomy
- Natural-rate hypothesis: rate of inflation has no effect on the natural rate and is only correlated with cyclical unemployment
    - ○ Unemployment tends to return to the natural rate in the long run, so long-run Phillips curve is vertical at natural rate
    - ○ But does prolonged high unemployment raise the natural rate?
        - ▪ Possibility of hysteresis due to loss of job skills by long-term unemployed
        - ▪ Hysteresis could arise if unions increase wages after recession rather than allowing unemployment to fall
- Natural rate is not zero
    - ○ Heterogeneity among workers and firms means that search is nontrivial
    - ○ Some unemployed workers and vacant jobs even if macroeconomy is in equilibrium
    - ○ Analogy to inventories waiting to be purchased and shoppers looking for goods
- Flows vs. stocks
    - ○ Some models focus on stocks of unemployed and employed (and out of labor force)
    - ○ Until recently, we didn't have data on flows

- JOLTS (Job Openings and Labor Turnover Survey) data provide detailed information on job and worker *flows*: movements between jobs, between states, and the magnitude and behavior of job openings.
- Some exciting new work is emerging as the coverage of this survey (started December 2000) becomes a long-enough time series

Recent unemployment fluctuations

- Unemployment rates in all major countries rose from about 1973 to about 1985
- Rate in United States came back down to 5% or so
- Rate in Continental Europe stayed high
  - Their rate had been very low before 1973 (~2% in some countries)
  - Many countries have had unemployment rates averaging 8–10% since 1973, with Spain over 15%
- This has almost certainly been a rise in natural unemployment
  - Why?
  - The labor-market institutions of Europe (and U.S.) were largely the same in the 1990s as they were in the 1960s
  - U.S. and Europe had similar shocks, so that cannot explain different behavior
  - Must be how the different institutions responded to similar shocks that would explain different unemployment behavior
- Siebert and Nickell papers on reading list go into the evidence and explanations in some detail

Modeling natural unemployment

- There are two common (and complementary) approaches to modeling the natural unemployment rate
  - Excess-supply-equilibrium theories
    - Why don't wages fall when unemployment is high?
    - This category of theories tries to explain why the queue of unemployed workers knocking on the doors of firms looking for jobs would not push wages down to reabsorb those workers
    - Broadly speaking, there are several sets of explanations here, of which we consider only a few:
      - Minimum wages
      - Union bargaining behavior
      - Contracts (in short run)
      - Efficiency wages
    - We will study Shapiro-Stiglitz model of efficiency wages in detail as a representative from this group of models

- o Search theories
    - ▪ Emphasize the process of two-sided job search
    - ▪ Matching models such as the one we study in class examines how workers and jobs are matched up with one another
    - ▪ Can also model the search process more explicitly
    - ▪ We usually assume that people do not move job to job without a spell in unemployment, which is false
        - • NY Fed blog post: ~20% of employed people actively searched and applied for another job.
        - • How important is this to our theories?
        - • It is probably true that it is *easier* to search when one is not employed
        - • It is probably also true that a spell of unemployment makes one a less attractive job candidate
- Cyclical unemployment
    - o Basically we usually rely on something analogous to **Okun's Law** to explain the connection between the output gap and the natural unemployment rate
        - ▪ Okun argued in the 1970s that 3% higher output corresponded to about 1% point lower unemployment
        - ▪ Most evidence suggests that the number now is closer to 2%

Generic Efficiency-Wage Models

- Basic idea of efficiency wages: Raising a worker's wage makes her more productive
    - o More effort
        - ▪ To keep job?
        - ▪ Why doesn't firm make effort a condition of employment and pay lower wages?
    - o Improved applicant pool
    - o Happier workers might be more productive
    - o Higher wage might increase health (in developing countries)
- Basic models
    - o Simple model of effort: $e = e(w)$
    - o More complex model: $e = e(w, w_a, u)$
        - ▪ Firm must offer a higher wage than other firms (w_a) in order to get higher effort, for given level of unemployment rate
   - ▪ Could be simplified to $e = e(w - w_a, u)$
- Productivity effect

- o $Y = F(eL)$

- o $\Pi = F(eL) - wL$

- o   Max Π:

    - ▪ $\dfrac{\partial \Pi}{\partial L} = eF'(eL) - w = 0$

    - ▪ $\dfrac{\partial \Pi}{\partial w} = LF'(eL)\dfrac{\partial e}{\partial w} - L = 0$

- o   Solve together to get: $\dfrac{\partial e}{\partial w}\dfrac{w}{e} = 1$: Set wage at level where elasticity of effort with respect to wage is unity

- o   Then $F'(eL) = \dfrac{w}{e}$ determines L

- Increase in MPL would lead to higher L but not higher w
    - o   This is strongly consistent with data in a way that the RBC model does not explain
    - o   However, if w_a or u changed, then the optimal wage would respond
    - o   This is one justification for the "wage adjustment equation" that Romer uses from time to time in place of assuming that the wage clears the labor market
- Can *all* firms pay an efficiency wage?
    - o   If all firms are symmetric, then all end up paying the same wage, so no individual firm pays a wage higher than others ($w = w_a$)
    - o   But driving up wage leads to a persistent excess supply of labor and unemployment, which keeps workers working hard out of fear of becoming unemployed: "Unemployment as a worker-discipline device"

Shapiro-Stiglitz Model

Basic setup

- Shapiro-Stiglitz model tries to get inside the e function to model workers' decisions about how hard to work
    - o   Application of dynamic programming: mathematical technique that macroeconomics use a lot
- A worker can be in any of three states:
    - o E means she is working hard
    - o S means she is shirking
    - o U means she is unemployed
- We analyze movement between states in continuous time

- o Hazard rate = instantaneous probability (per year) of moving into or out of a state
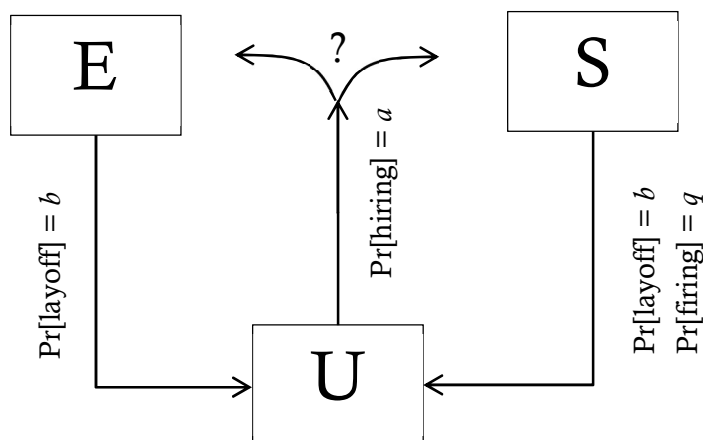
- o Employed worker chooses whether to be in E or S
- o q is the penalty for shirking in terms of a probability of getting caught and fired
    - In world of perfect monitoring of worker performance, firms can fire workers immediately and $q \to \infty$
    - If it is totally impossible for firms to monitor workers, then $q = 0$
- Instantaneous probabilities of moving:
    - o Movement can happen at any moment, but probabilities are still expressed in "per period" rate
    - o Intuition based on frequency of layoff opportunities:
        - Suppose the period is one year
        - If one can only be laid off at end of year, then probability of still being employed after a year is $(1-b)^1$
        - If one can be laid off at middle or end of year, then $\left(1-\frac{1}{2}b\right)^2$
        - If one can be laid off at end of any quarter: $\left(1-\frac{1}{4}b\right)^4$
        - If at end of any month: $\left(1-\frac{1}{12}b\right)^{12}$
        - If any day: $\left(1-\frac{1}{365}b\right)^{365}$
        - As opportunities for layoffs become continuous: $\lim_{n \to \infty}\left(1-\frac{1}{n}b\right)^n = e^{-b}$
    - o Probability that someone starting in E is still in E after Δt is $e^{-b\Delta t}$
    - o Probability that someone starting in S is still in S after Δt is $e^{-(b+q)\Delta t}$

- o   Probability that someone starting in U is still in U after Δt is $e^{-a\Delta t}$
- Working utility: $U = \int_0^\infty e^{-\rho t} u(t) dt$, with $u(t) = w(t) - \bar{e}$ if employed and working,

  $u(t) = w(t)$ if employed and shirking, and $u(t) = 0$ if unemployed
- Firm's profit with $L(t)$ working hard and $S(t)$ shirking is

  $\Pi(t) = F\left(\bar{e}L(t)\right) - w(t)\left[L(t) + S(t)\right]$

Dynamic programming

- Fundamental underlying equation of dynamic programming is the Bellman equation, which relates to the lifetime expected utility of someone who is currently in state i:

  $$V_i(0) = \lim_{\Delta t \to 0} V_i(\Delta t) \equiv \lim_{\Delta t \to 0}\left\{\int_{t=0}^{\Delta t} u(t \mid \text{state at } 0 = i) dt + e^{-\rho\Delta t} E\left[V(\Delta t \mid \text{state at } 0 = i)\right]\right\}$$

- For state E, the Bellman equation is

  $$V_E(\Delta t) = \int_{t=0}^{\Delta t} e^{-\rho t}\left[e^{-bt}(w - \bar{e}) + (1 - e^{-bt})(0)\right] dt$$
  $$+ e^{-\rho\Delta t}\left[e^{-b\Delta t} V_E(\Delta t) + (1 - e^{-b\Delta t}) V_U(\Delta t)\right]$$

  - o   Interpretation of expressions:
    - ▪ Integral is utility gained over t between time 0 and Δt
      - • Bracketed sum is expected utility at t given probabilities of being employed and unemployed
        - o   Discount factor in front
        - o e^{-bt} is probability that worker is still E at t given E at 0
        - o $(w - \bar{e})$ is utility gained at each moment in state E
        - o $(1 - e^{-bt})$ is probability of having been laid off before t
        - o   (0) is the utility obtained at t if unemployed (laid off)
    - ▪ Discount factor in front of second bracketed term discounts for period 0 to Δt
      - • Bracketed term is expected value of utility over rest of life given E at time 0:
        - o $e^{-b\Delta t}$ is probability still employed at Δt
        - o $V_E(\Delta t)$ is discounted rest-of-life value of utility at time Δt if still in state E
        - o $(1 - e^{-b\Delta t})$ is probability that worker has moved to U by Δt
        - o $V_U(\Delta t)$ is discounted rest-of-life value of utility at time Δt if in state U

o   Evaluating the definite integral:

$$\int_{t=0}^{\Delta t} e^{-(\rho+b)t}\left(w-\overline{e}\right)dt = \left[-\frac{\left(w-\overline{e}\right)}{\rho+b}e^{-(\rho+b)\Delta t}\right] - \left[-\frac{\left(w-\overline{e}\right)}{\rho+b}e^{-(\rho+b)0}\right]$$

$$= \left[-\frac{w-\overline{e}}{\rho+b}e^{-(\rho+b)\Delta t}\right] + \frac{w-\overline{e}}{\rho+b} = \left(1-e^{-(\rho+b)\Delta t}\right)\frac{w-\overline{e}}{\rho+b}$$

o   Substituting into Bellman equation:

$$V_E\left(\Delta t\right) = \frac{w-\overline{e}}{\rho+b}\left(1-e^{-(\rho+b)\Delta t}\right) + e^{\rho\Delta t}\left[e^{-b\Delta t}V_E\left(\Delta t\right) + \left(1-e^{-b\Delta t}\right)V_U\left(\Delta t\right)\right]$$

o   Bringing the V_E terms to the left-hand side:

$$V_E\left(\Delta t\right)\left(1-e^{-(\rho+b)\Delta t}\right) = \frac{w-\overline{e}}{\rho+b}\left(1-e^{-(\rho+b)\Delta t}\right) + e^{\rho\Delta t}\left(1-e^{-b\Delta t}\right)V_U\left(\Delta t\right)$$

$$V_E\left(\Delta t\right) = \frac{w-\overline{e}}{\rho+b} + \frac{e^{-\rho\Delta t}\left(1-e^{-b\Delta t}\right)}{1-e^{-(\rho+b)\Delta t}}V_U\left(\Delta t\right)$$

o   Taking the limit as $\Delta t \to 0$, both the numerator and denominator of the expression in front of V_U go to zero.

   ▪   Applying L'Hôpital's Rule, we can show that

$$\lim_{\Delta t \to 0}\frac{e^{-\rho\Delta t}\left(1-e^{-b\Delta t}\right)}{1-e^{-(\rho+b)\Delta t}} = \lim_{\Delta t \to 0}\frac{-\rho e^{-\rho\Delta t} - \left(-\rho-b\right)e^{-(\rho+b)\Delta t}}{\left(\rho+b\right)e^{-(\rho+b)\Delta t}} = \frac{b}{\rho+b}$$

o   Thus, $V_E = \dfrac{w-\overline{e}+bV_U}{\rho+b}$, or

$$\left(\rho+b\right)V_E = \left(w-\overline{e}\right)+bV_U$$

$$\rho V_E = \left(w-\overline{e}\right)+b\left(V_U-V_E\right)$$

o   This last equation has a useful interpretation that we will apply to get the values of the other states without all the math:

   ▪   The left-hand side is the "utility return on being in state E"

      •   This is the discount rate ρ times that capital value of being in state E

      •   Analogous to multiplying an interest rate (of return) times the capital value of an asset to get an annual flow of returns

   ▪   The first term on the right is the "dividend" earned while in state E

      •   Each instant that the individual is in E he or she gets $w-\overline{e}$

   ▪   The last term on the right is the "expected capital gain" from being in state E

      •   Probability of changing state is b

      •   Change in capital value if state is changed is $V_U - V_E < 0$

- • Expected change in value is the product of the probability of changing state times the change in value if you do change state
- Can apply the "utility return" method to get V_S and V_U (or you can do the lengthy derivation if you want):
  - $\rho V_S = w + (b+q)(V_U - V_S)$
  - $\rho V_U = 0 + a(V_E - V_U)$, assuming that the individual works rather than shirks with hired.
    - ▪ (It doesn't matter, because we are going to set $V_E = V_S$ as a condition for equilibrium anyway.)
- Summarizing the key relationships:

$$\rho V_E = (w - \overline{e}) + b(V_U - V_E)$$
$$\rho V_S = w + (b+q)(V_U - V_S)$$
$$\rho V_U = a(V_E - V_U)$$

Decision-making and equilibrium

- **No shirking**
  - Firm will always pay a wage high enough to keep workers from shirking, because if workers shirk then the firm incurs wage cost but gets no output
  - Assume that workers work if and only if $V_E \geq V_S$, in other words, they work if the values are equal
  - Setting $\rho V_E = \rho V_S$,

$$w - \overline{e} - b(V_E - V_U) = w - (b+q)(V_E - V_U)$$
$$V_E - V_U = \frac{\overline{e}}{q} > 0.$$

  - ▪ Firms set wage high enough that working is more desirable than being unemployed, so workers have something to lose if they are fired or laid off
  - Solving for the wage from the ρV_E equation:

$$w = \overline{e} + \rho V_E + b(V_E - V_U)$$
$$= \overline{e} + (b+\rho)(V_E - V_U) + \rho V_U$$
$$= \overline{e} + (b+\rho+a)(V_E - V_U), \text{ because } \rho V_U = a(V_E - V_U)$$
$$w = \overline{e} + (a+b+\rho)\frac{\overline{e}}{q}.$$

  - ▪ Wage that firms must set to assure no shirking depends on disutility of working hard ($\overline{e}$), probability of being caught shirking (q), probability of being rehired if unemployed (a), and b and ρ.
- **Equilibrium**

- o In steady state with constant unemployment rate, flow of workers from E to U must balance flow from U to E:
  - If there are N firms and each one hires L workers, then total employment is NL
  - Suppose that the total labor force is fixed at $\bar{L}$
  - Number unemployed is $\bar{L} - NL$
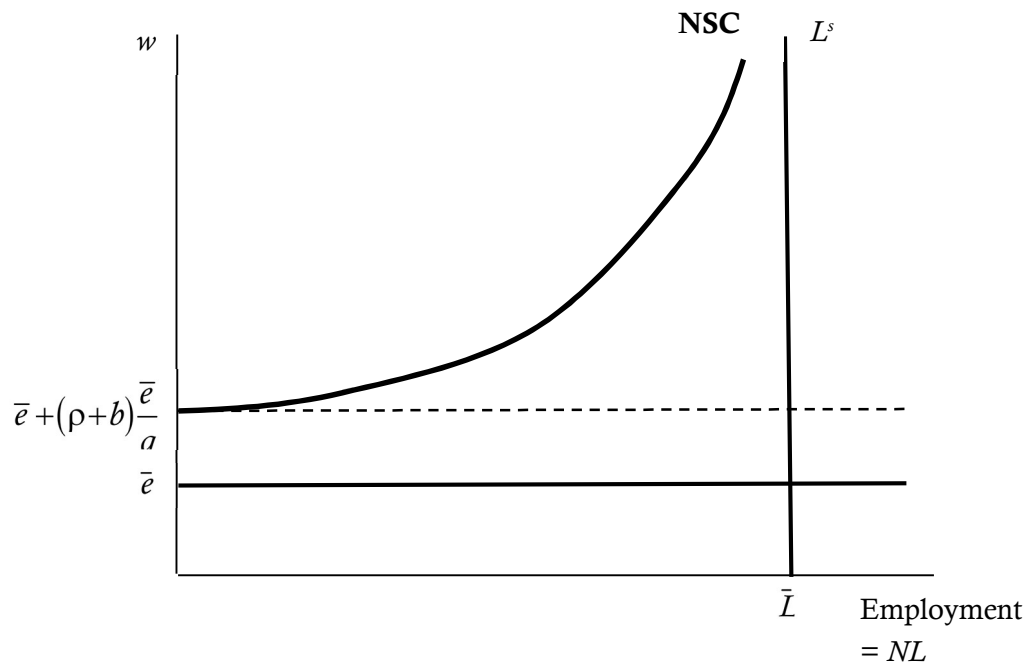 - Balancing flows are $bNL = a(\bar{L} - NL)$, so

    $$a = \frac{bNL}{\bar{L} - NL} \text{ and}$$

    $$a + b = \frac{\bar{L}}{\bar{L} - NL}b = \frac{1}{u}b, \text{ where } u \text{ is the unemployment rate}$$

- o Substituting into the no-shirking wage,

  $$w = \bar{e} + \left(\rho + \frac{\bar{L}}{\bar{L} - NL}b\right)\frac{\bar{e}}{q} \text{ is the \textbf{no-shirking condition}}$$

  - Firms must pay a wage at least equal to this level in order to avoid shirking
  - Can be written as $w = \alpha + \beta\frac{1}{u}$, which is a rectangular hyperbola in the unemployment rate
  - Graphing w against NL gives:

- o Effects of parameters on NSC:

  $\bar{e} \uparrow \Rightarrow \text{NSC} \uparrow$

  $\bar{L} \uparrow \Rightarrow \text{NSC} \rightarrow$

  $b \uparrow \Rightarrow \text{NSC} \nwarrow$

  $q \uparrow \Rightarrow \text{NSC} \downarrow$

- o $q \rightarrow \infty$ means that shirkers get caught immediately and NSC becomes backward

  L at $\bar{e}$ and $\bar{L}$:

  - Workers all work if wage is greater than or equal to $\bar{e}$

- o With finite q, the NSC is like a supply curve for labor, telling firms how much they must (collectively) pay in order to get a certain number of workers to work hard

- **Labor demand**

  - o For individual firm, $\Pi = F[\bar{e}L] - wL$

  - o Profit-maximization: $\dfrac{\partial \Pi}{\partial L} = \bar{e}F'[\bar{e}L] - w = 0$, given the w on the NSC

  - o Labor-demand curve for each of N firms comes from $F'[\bar{e}L] = \dfrac{w}{\bar{e}}$, which is

    declining in L, so labor demand curve slopes downward as usual

    - Having to offer a higher efficiency wage means it is only profitable to hire a smaller number of workers
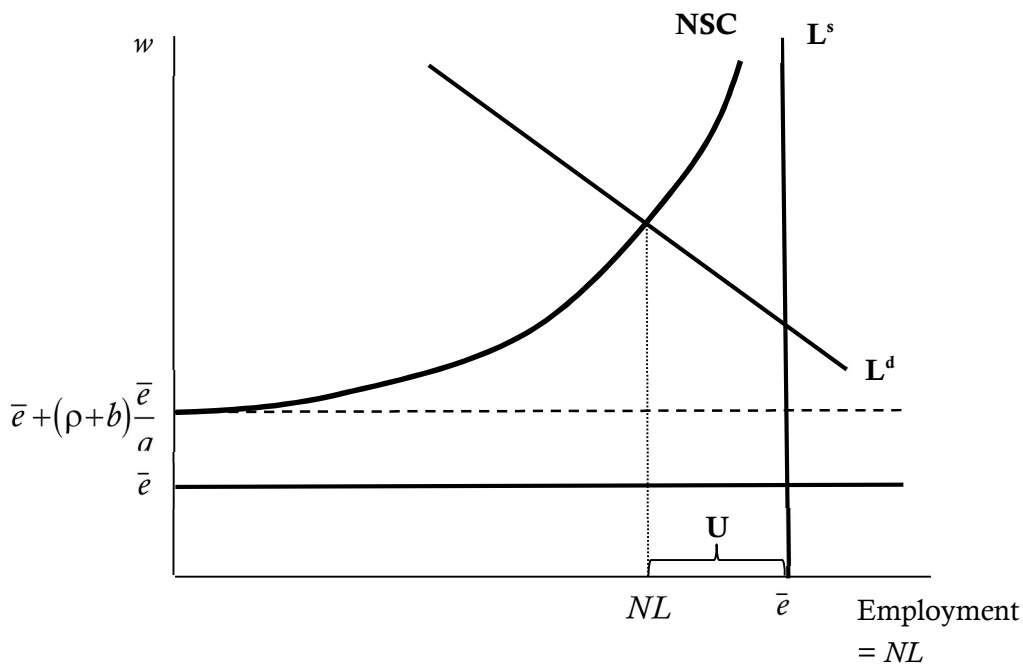
- If firms had perfect information about shirkers so $q = \infty$, then equilibrium occurs at full employment, where $L^d = L^s$
- With monitoring costs, equilibrium occurs where L^d = NSC and unemployment is the gap $\bar{L} - NL$
- Title of paper: "Unemployment as a worker discipline device"
- No firm pays higher wage than any other, so efficiency wage in aggregate means working hard because getting fired mean being unemployed (not going to a lower-wage firm)

Issues

- **Bonding**
  - How about having employee post a bond a hiring that is forfeited if he shirks?
  - This would allow firms to hire the entire labor force at the equilibrium wage (no unemployment)
  - Enforcement might be difficult: firm has incentive to claim shirking and seize bond, even if worker is not shirking
  - Workers might not be sufficiently liquid to pay up front
  - We see this to some extent in structure of labor compensation
    - Delayed vesting of retirement plans: Some worker benefits are not earned until worker has completed a certain number of years
    - Rising wage scale over time
      - More senior workers may not be more productive, but by offering higher wages to them it encourages workers to avoid firing (and quitting)
- **Costs of monitoring**
  - One can imagine a model in which firms choose between paying an efficiency wage and incurring costs of monitoring more closely
  - A decline in monitoring costs (due to better surveillance techniques, perhaps) would lower wage and increase employment
    - Could this help explain blue-collar wage stagnation since 1980s?

Search and Matching Model

Basic model setup

- Workers and jobs are heterogeneous
  - Matching is a time-consuming process involving matching vacant job with unemployed worker
- Workers can either be employed/working or unemployed/searching:

-      o   There is mass one of workers with fraction E employed and U unemployed:
  $$E + U = 1$$
- In this version of the model, workers' utility is just earnings. There is no effect on utility from a "good match" with a job.
  - o   When a worker is employed, he or she produces output at constant flow rate y and earns a wage of $w(t)$
  - o   When a worker is unemployed, he or she receives a benefit of $b > 0$ (either unemployment benefit payments or leisure utility, or both)
- Firms have a pool of jobs, some of which (F) are filled and some of which (V) are vacant
- A firm incurs a constant flow cost $c < y$ of maintaining a job, whether it is vacant or filled
  - o   This is a simplification, but think about all of the overhead personnel costs of keeping track of employees and the search costs of hiring for a new one
  - o   We just assume that they are the same (for simplicity)
  - o $\Pi(t) = y - w(t) - c$ for each filled job
    - ▪   There is no productivity bonus for a "good fit" with worker
    - ▪   This (along with lack of utility benefit) means that we can't really do any welfare analysis using this version of the model
    - ▪   Better matching will decrease unemployment, which is presumably beneficial, but we do not account for "better job matches"
  - o $\Pi(t) = -c$ for each vacant job
  - o   Vacancies/jobs are costless to create (but expensive to maintain)
- Both workers and firms have a discount rate of r
- Matching function matches members of the pool of unemployed workers with members of the pool of vacant jobs:
  $$M(t) = M[U(t), V(t)], \text{ with } M_U > 0, M_V > 0$$
- Employment matches end (through retirement, firm contraction, etc.) at a constant rate λ, so
  $$\dot{E}(t) = M[U(t), V(t)] - \lambda E(t)$$

Matching function

- Matching function is like a production function, but it need not have constant returns to scale:
  - o   Thick-market effects may make it easier for workers/jobs to find one another if there are many out there: increasing returns to scale
  - o   Congestion effects might make it more difficult to find one another if job-search resources are congested: decreasing returns to scale

- We assume CRTS and Cobb-Douglas marching function:

  $M\big[U(t),V(t)\big]=k\big[U(t)\big]^{1-\gamma}\big[V(t)\big]^{\gamma}$, with k being an index of the efficiency of job search

  o The **job-finding rate** $a(t)$ (same as Shapiro-Stiglitz a) is the rate at which unemployed workers find jobs: $M\big[U(t),V(t)\big]/U(t)$

    - With CRTS:

    $$a(t)=m\big[\theta(t)\big],\ \text{with}\ \theta(t)\equiv\frac{V(t)}{U(t)}\ \text{and}\ m\big[\theta(t)\big]\equiv M\big(1,\theta(t)\big)$$

    - θ is an indicator of labor market looseness: higher θ means more job vacancies or fewer unemployed workers, making it easier for workers to find jobs

    - With Cobb-Douglas: $a(t)=m\big[\theta(t)\big]=k\theta^{\gamma}$

  o The **job-filling rate** $\alpha(t)$ is the rate at which vacant jobs are filled: $M\big[U(t),V(t)\big]/V(t)$

    - With Cobb-Douglas: $\alpha(t)=\dfrac{m\big[\theta(t)\big]}{\theta(t)}=k\theta^{\gamma-1}$

- **Nash bargaining**
  o There is no "market wage" because each individual and job are unique
  o The wage is set to divide up the mutual gains from making the match, with share ϕ going to the worker and $(1-\phi)$ going to the firm
  o The value of ϕ will depend on institutions in the economy (and could depend on market conditions)

Decision-making

- Dynamic programming:
  o What is the value to worker of being in state E or in state U?
  o What is the value to firm of having filled job F or vacant job V?
  o Here, we consider the possibility that the economy may not always be in the steady state, so there can be a change in the value V_i over time, which adds (if positive) to the benefit of being in that state (like a capital gain)
- For the worker:

$$rV_E(t)=w(t)+\dot{V}_E(t)-\lambda\big[V_E(t)-V_U(t)\big]$$
$$rV_U(t)=b+\dot{V}_U(t)+a(t)\big[V_E(t)-V_U(t)\big]$$

- For the firm:

$$rV_F(t) = \left[y - w(t) - c\right] + \dot{V}_F(t) - \lambda\left[V_F(t) - V_V(t)\right]$$

$$rV_V(t) = -c + \dot{V}_V(t) + \alpha(t)\left[V_F(t) - V_V(t)\right]$$

Equilibrium conditions

- In the steady state, all of the $\dot{V}$ terms are zero, so we will now neglect them
- Also, in steady state, both a and α are constant
- **Evolution of number unemployed** is $\dot{E}(t) = \left[U(t)\right]^{1-\gamma}\left[V(t)\right]^{\gamma} - \lambda E(t)$ and must be zero in steady-state
- **Nash bargaining**:
    - Suppose that the total gain from match is X, of which worker gets ϕX and firm gets $(1 - \phi)X$
    - $\begin{aligned}(V_E - V_U) &= \phi X \\ (V_F - V_V) &= (1-\phi)X\end{aligned}$, so $X = \dfrac{V_E(t) - V_U(t)}{\phi} = \dfrac{V_F(t) - V_V(t)}{1-\phi}$

    and $V_E(t) - V_U(t) = \dfrac{\phi}{1-\phi}\left[V_F(t) - V_V(t)\right]$

- **Vacancies are costless to create**: $V_V(t) = 0$

Solution

- Solve model in terms of E and V_V
- Subtracting V_U from V_E yields

$$r\left[V_E(t) - V_U(t)\right] = w(t) - b - (\lambda + a(t))\left[V_E(t) - V_U(t)\right], \text{ or}$$

$$V_E - V_U = \frac{w - b}{a + \lambda + r}$$

- Doing the same to V_F and V_V gives

$$V_F - V_V = \frac{y - w}{\alpha + \lambda + r}$$

- From the Nash bargaining condition:

$$\frac{w - b}{a + \lambda + r} = \frac{\phi}{1 - \phi}\frac{y - w}{\alpha + \lambda + r},$$

$$w = b + \frac{(a + \lambda + r)\phi}{\phi a + (1-\phi)\alpha + \lambda + r}(y - b)$$

    - As a benchmark example, suppose that $b = 0$ (no unemployment benefits), $a = \alpha$ (job-finding rate = job-filling rate), and $\phi = \frac{1}{2}$ (bargaining shares are equal)

- In this case, $w = \dfrac{(a + \lambda + r)\frac{1}{2}}{a + \lambda + r} y = \frac{1}{2} y.$

  - Workers get half of their product and firms get half

  o Higher ϕ means workers get higher wage
  o Higher b means workers get higher wage
  o Higher a or lower α means workers get higher wage

- Value of vacancy:

$$rV_V = -c + \alpha \left[V_F - V_V \right]$$

$$= -c + \alpha \frac{y - w}{\alpha + \lambda + r}$$

$$= -c + \frac{(1-\phi)\alpha}{\phi a + (1-\phi)\alpha + \lambda + r} (y - b)$$

- $\dot{E} = 0 \Rightarrow M[U,V] \equiv aU \equiv a(1-E) = \lambda E$, so

$$a = \frac{\lambda E}{1 - E}$$, which is increasing in E

- $\lambda E = M(U,V) = kU^{1-\gamma}V^{\gamma} = k(1-E)^{1-\gamma}V^{\gamma}$, so

$$V = k^{-\frac{1}{\gamma}}(\lambda E)^{\frac{1}{\gamma}}(1-E)^{\frac{\gamma-1}{\gamma}}$$
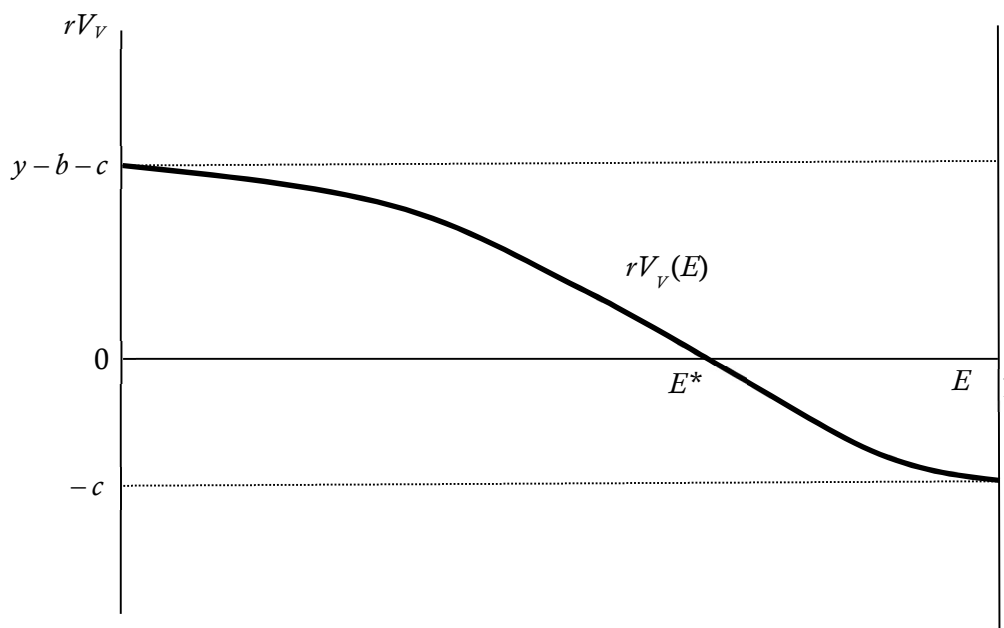
$$\alpha = M/V = k^{\frac{1}{\gamma}}(\lambda E)^{\frac{\gamma-1}{\gamma}}(1-E)^{\frac{1-\gamma}{\gamma}}$$

α is decreasing in E because $\gamma < 1$

- Free creation of vacancies implies that $V_V = 0$ in steady state, so

$$rV_V = -c + \frac{(1-\phi)\alpha(E)}{\phi a(E) + (1-\phi)\alpha(E) + \lambda + r}(y - b) = 0$$

  o When $E = 1$, $\alpha = 0$ (it takes forever to fill a vacancy because there are no unemployed workers)

    - $rV_V = -c$ because the flow of returns on vacancy are perpetually the cost of maintaining it

  o When $E \to 0$, $a = 0$ and $\alpha \to \infty$, so big fraction approaches one and

  $$rV_V = y - (b + c)$$

- o Curve of rV_V as a function of E has shape shown above.
- Equilibrium occurs where value of additional vacancies is exactly zero, at E^*
- Effects of changes in parameters:

$y \uparrow \Rightarrow rV_V$ curve shifts $\uparrow$

$k \uparrow \Rightarrow rV_V$ curve shifts $\nearrow$

$b \uparrow \Rightarrow rV_V$ curve shifts $\downarrow$

Applications

- Sectoral shifts
    - o When the economy is undergoing a lot of structural shifts from one industry/region to another, k may fall as matching becomes harder
    - o This would raise equilibrium unemployment in the model
- Active labor-market policies
    - o Scandinavian countries have had good success with policies to facilitate job matching
    - o This would be an increase in efficiency of matching so k increases
    - o (U.S. effectiveness not so good)
- Not again the absence of strong welfare criteria in this model
    - o Not accounting for utility or productivity of improved matches makes it difficult to assess policy implications of, for example, unemployment benefits

Natural Unemployment: Empirical Evidence

- Based on Nickel and Siebert's papers in 1997 *JEP*
- Economists have been studying the high natural unemployment rate in Europe intensively since about 1990
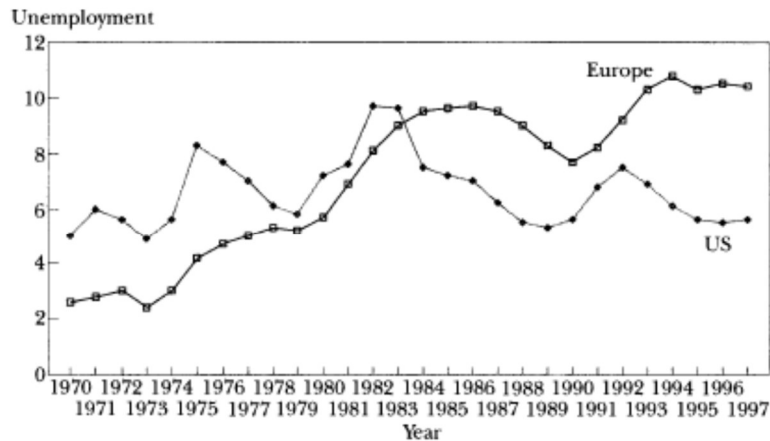
- There is no single, simple explanation
    - For example, Spain and Portugal have quite similar institutions, but Spanish unemployment is twice as high
    - European institutions were similar in 1960s when unemployment was very low
- Candidates that are usually discussed
    - Employment protection
        - Firms that can't fire won't hire
    - Collective bargaining coverage
    - Generous unemployment benefits
    - Tax wedge
    - Lack of wage flexibility
        - Is European unemployment the mirror image of US wage stagnation?
        - In U.S., low-skill wages have fallen; in Europe, low-skill employment has stagnated
    - General lack of "flexible labor market"
        - Low churn
        - Low mobility
- Exceptions to the rule
    - Netherlands undertook flexible labor-market reforms that dropped unemployment a lot
    - Germany is now doing better, although absorption of East increased natural rate
    - Sweden has used active labor-market policies effectively