Observation unit: employer-employee matches generated under a given probationary period contract

Key variables:

- Histogram of layoffs by tenure (Y): outcome variable
- Probationary period length (PP): intervention variable that imposes a discontinuity in firing costs at a particular tenure (within 3 months)
- Tenure required for unemployment insurance (UI): at 6 months workers are eligible for unemployment insurance, affecting the histogram of layoffs by tenure
- Tenure required for mediation meetings (MM): at 12 months workers that are fired have a mediation meeting, affecting the histogram of layoffs by tenure
- Union strength relative to employers (US): the stronger the union is relative to the employer, the shorter the probationary period
- Recruitment practices (RP): the shorter the probationary period, the higher the incentive for the employers to improve recruitment practices, thereby affecting the quality of hired employees and monitoring intensity
- Quality of applicants (QA): the better the pool of applicants, the higher quality of individuals available for hiring
- Quality of hires (QH): the better the hires, the less likely they will be fired during the probationary period
- Scope for learning-by-doing (LD): the more room there is for a worker to learn a job with time, the lower the bar set by employers when deciding whether to fire a recent hire, thereby making recruitment practices more important
- Monitoring intensity (MI): the shorter the probationary period and the worse the recruitment practices, the more intense the employer will monitor recent hires, thereby affecting the timing of firing decisions by the firm
- Location, time, and occupation (S): related to units of observation—can generate backdoor paths (not in Figure 1 for simplicity)

Identification:

1. The backdoor criterion is satisfied without any conditioning.

2. The key assumption is that that union strength is unrelated to the quality of applicants and workers hired, monitoring intensity and recruitment practices of employers, as well as the scope of learning-by-doing of the job.

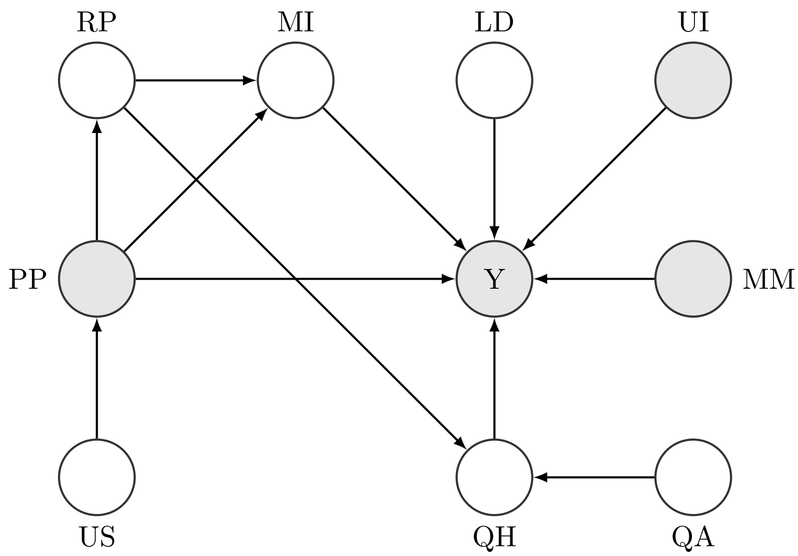
    - Unions do not participate in hiring decisions. However, there may be certain skill types that prefer to work in jobs with stronger unions. But it seems reasonable to say that people don't chooses their occupation and region of employment based on union strength. In turn, the quality of workers is unlikely to affect how strong the union is. If any of these assumptions are violated, there is no identification since PP→RP→QH.
    - Unions do not directly participate in the recruitment process. They may participate indirectly through recommendations of peers. Unions may also have a say on how intensely workers are monitored. But to the extent that unions care more about their senior members than recent hires, this should have no effect on our question of interest. Reverse causation from recruitment practices and monitoring intensity to union strength is unlikely. If any of these assumptions fail, there is no identification since PP→MI and PP→RP.
    - Unions cannot affect the scope for learning-by-doing, since the latter is particular to a job. It is possible that occupations determine both union strength and learning-by-doing. Were these assumptions to be violated, I would have to control for LD.

3. Each observation unit is in a (region, occupation, time period) triple. Each of these variables has a direct impact on:

    - Y, QA, and QH: through shocks in the economy affecting regions and occupations differently over time
    - PP: through the collective bargaining agreement
    - US: through historical and economic circumstances of organized labor for an occupation in a region

    → identification must account for these **observed** factors

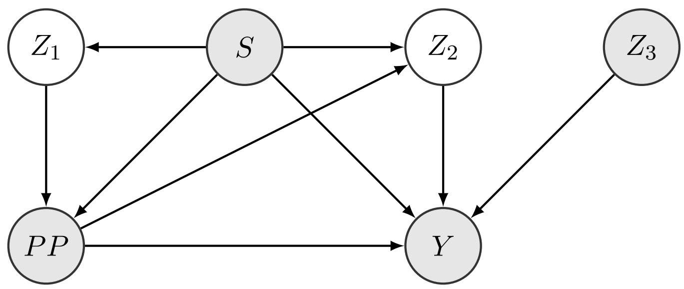
Figure 1: Causal Graph



Concerns:

- The fact that region-occupation-year (S) creates backdoor paths need not be too problematic. In fact controlling for these observed variables blocks all backdoor paths (see Figure 2).
- However, the issue is that collective bargaining agreements are defined at the region-occupation-year level. Hence there will be little variation in PP for some given S.
- Therefore, a way forward would be to exploit some form of quasi-experimental variation in the observational data. In particular, I would like to explore how the discontinuities in the firing cost schedule of firms generate specific shapes in the histogram of layoffs by tenure, e.g., bunching at the end of the probationary period.
- Such an approach requires a model that looks into firm's decisions to terminate matches. This causal graph will essentially go into the economic behavior of how PP, UI, and MM affect Y.
- The usefulness of the previous causal graph is that it informs me that estimates for each region-occupation-year triple should be separate.

Figure 2: Simplified Causal Graph (incuding Region-Occupation-Year)



Economic Model:

(i) Outcome Model

In this model, firms learn about match quality over time through Bayesian updating. Firms then solve a dynamic optimization problem where their choice variable is whether to keep the current match (retain the worker) or draw a new one (fire the worker and hire another one). Considering the empirical setting in questions, firms maximize the present discounted value of profits through match termination decisions facing a nonlinear firing cost contract and uncertainty about match quality.

Suppose that the economy consists of multiple risk-neutral, single-job, forward-looking firms $j \in \mathbb{J}$ operating over an infinite discrete time period $t \in [0, 1, 2, ...]$. Each firm enters the model at $t = 0$ with its single vacancy filled by some agent $i \in \mathbb{I}$ earning a fixed monthly wage w corresponding to the vacancy in question. Matching and wage setting considerations are ignored for this simple version of the model. Assume that the firm's only factor of production is labor and that it faces constant returns to scale. Workers assume a passive role throughout the model, while firms make firing decisions. Since firms are assumed to employ one worker at a time, the rest of this section will simply focus on a single match (i, j).

At each time period t, the firm decides on a value for the choice variable

$$d_t = \begin{cases} 1 & \text{fire the current worker and draw a new match} \\ 0 & \text{keep the current worker and reconsider next period} \end{cases}$$

The state variables that influence the binary control d_t are twofold: worker tenure (t) and beliefs about match quality (y_t). Tenure indicates how many periods the current worker has been employed at the firm in question, and therefore affects the firing cost schedule as well as the time for learning about match quality. This state variable is observed by both the firm and the econometrician. On the other hand, match quality is observed by neither the econometrician nor the firm. However, each period the firm observes signals $\xi_t \sim G(\cdot)$ with mean equal to the true match quality y_*. Based on the sequence of signals received and their priors about the distribution of match quality in the relevant population, firms make inferences about match quality at each tenure y_t.

The firm's objective is to choose the sequence $\{d_t\}_{t=0}^{\infty}$ that maximizes discounted expected profits while facing a given employment contract k with firing cost nonlinearities $C_k(w, \tau_t)$ and uncertainty about match quality determined by some density $h_t(y)$. The infinite horizon problem takes the following form:

$$\max_{\{d_t\}} \mathbb{E} \sum_{t=0}^{\infty} \beta^t \pi(d_t; w, \xi_t, t)$$

where

$$\pi(d_t; w, \xi_t, t) = R(w, \xi_t) - C_k(w, t) \cdot \mathbb{1}\{d_t = 1\}$$

Both the probationary period stipulated in the employment contract k and the active legislation on firing fines introduce discontinuities in slopes and levels to the firing cost schedule $C_k(w, t)$. Meanwhile, the function $R(w, \xi_t)$ captures the revenue that the firm realizes in period t with the signal produced by the worker net of wage payments and other fixed labor costs. The timing of events within a period is such that this revenue is unaffected by the firm's firing decision. That is, within period t the timing of events are:

1. Firm receives signal $\xi_t \sim G(\cdot)$ with mean y_*
2. Revenue is generated $R(w, \xi_t)$
3. Firm updates beliefs about match quality y_t and $h_t(y)$
4. Firm makes firing decision d_t

Following the Bellman Principle of Optimality, define the choice-specific value functions $\tilde{V}(d; y, t)$ for current firing decisions as follows

$$\begin{aligned}\tilde{V}(1; y, t) =& [R(w, \xi) - C_k(w, t)] + \beta \mathbb{E}_{h_0}[V(y', 0)] \\ \tilde{V}(0; y, t) =& [R(w, \xi)] + \beta \mathbb{E}_{h_t}[V(y', t + 1)]\end{aligned}$$

where $V(y, t) = \max\{\tilde{V}(1; y, t), \tilde{V}(0; y, t)\}$ denotes the value to the firm upon choosing the optimal policy. The reason for V being a function of beliefs about match quality y_t and tenure t only holds when updated beliefs about match quality depend only on those variables (as is the case when match quality and worker signals are normally distributed). Note that the density functions over which expectations are taken are different in each choice-specific value function. This captures the notion that when a worker is fired, the random variable for match quality of some new unobserved worker has a density (h_0) that is different from that of the current worker that has been observed t periods (h_t).

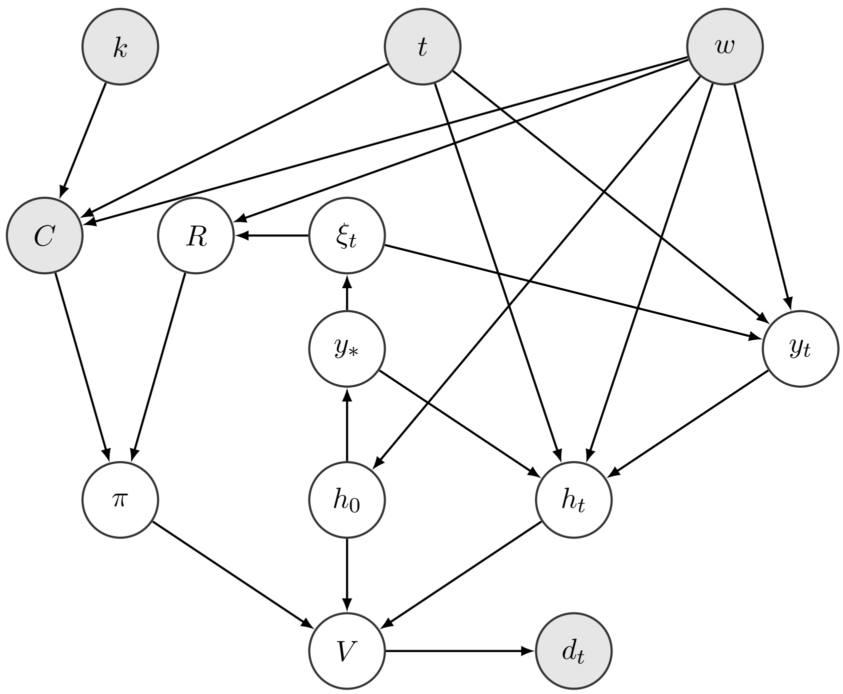
(ii) Causal Graph

Observation unit: employer-employee matches generated under a given probationary period contract in a specific region-occupation-year triple where the employer has no previous experience at that occupation or firm

Key variables:

- Contract (k): includes probationary period length, unemployment insurance, and mediation meeting cutoffs
- Tenure (t): number of periods the employee has been at the firm
- Wage (w): average monthly wage paid to the employee
- Firing cost (C): cost of firing employee
- Revenue (R): revenue generated by the employee
- Profit (π): profits made by the employer
- Pool quality (h_0): density of quality among the pool of potential workers (known to the employer)
- Match quality (y_*): true quality of a given match (unknown to the employer)
- Signal (ξ_t): signal sent by employee about the true match quality
- Expected match quality (y_t): the expected value of worker's quality as estimated by the employer
- Match beliefs (h_t): the employer's beliefs about the worker's quality
- Value function (V): object for solving firing dceision problem
- Firing decision (d_t): employer's optimal firing decisions

Figure 3: Causal Graph of Economic Model



(iii) Parametrization

A time period in the model will denote 3 days. This is because tenure is recorded in months (of 30 days) up to one decimal place. Thus, the monthly wages in the data map into period wages of $w/10$. Assume the simple linear revenue function $R(w, \xi) = \xi - w/10$. That is, treat signals as profit shocks and set revenue equal to the period's signal minus per period wages. Institutional knowledge gives us the form for the firing cost schedule given some probationary period length T_k and firing fines f, i.e.,

$$C_k(w,t) = \mathbb{1}\{t \leq T_k\}[0.5(T_k - t)w/10] + \mathbb{1}\{t > T_k\}[(1+b)w + f(t+10)w/10]$$

In other words, prior to the probationary period the worker is fired immediately and the firm must pay half of the remaining wages due in the probationary period. After the probationary period, the worker is notified of the separation and the firm must still pay an entire month of wages including benefits b, as well as firing fines proportional to the monthly wages accrued up to the advanced notice month $t+1$. In the case of a 3 month experience contract under present day job security legislation, $T_k = 30$ (90 days), $b = 0.358$, and $f = 1/300$.

Assume that match quality is continuous and normally distributed within each group of vacancies with the same wage, i.e., $Y_* \sim \mathcal{N}(y_0 + \frac{w}{10}, \sigma_0^2)$. The reason for varying the mean by wage is that it would be too restrictive to impose normality on productivity for the entire population. In addition, firm priors coincide with the true distribution of match quality. That is, the density h_0 is that of a normal with mean $y_0 + \frac{w}{10}$ and variance σ_0^2. Moreover, I assume that the signals about match quality are also normally distributed, i.e. $\xi_t \sim \mathcal{N}(y_*, \sigma_*^2)$, where y_* is the realized quality of a given match and σ_*^2 is constant across matches. Given that the conjugate prior of a normal likelihood is also normal, firms' beliefs over match quality have a closed form. In particular, employing a Kalman filter provides the following updated beliefs about permanent unobserved quality for some realized match at tenure t

$$\begin{aligned} y_t &= \left(y_{t-1} + \frac{w}{10}\right)\left[\frac{(t-1)\sigma_0^2 + \sigma_*^2}{t\sigma_0^2 + \sigma_*^2}\right] + \left(\frac{\sigma_0^2}{t\sigma_0^2 + \sigma_*^2}\right)\xi_t \\ \sigma_t^2 &= \frac{\sigma_0^2\sigma_*^2}{t\sigma_0^2 + \sigma_*^2} \end{aligned}$$

This results in y_t and t fully describing the firm's knowledge about match quality—hence their role as the state variables in the model. Also note that we can now specify the density $h_t = f(y_{t+1}|y_t)$. By using the closed form for y_{t+1}, conditioning on y_t, and recalling that $\xi_{t+1} \sim \mathcal{N}(y_*, \sigma_*^2)$, we again obtain a normal $\mathcal{N}(\mu, s^2)$ where

$$\mu = \left[\frac{\sigma_0^2}{(t+1)\sigma_0^2 + \sigma_*^2}\right] y_* + \left[\frac{t\sigma_0^2 + \sigma_*^2}{(t+1)\sigma_0^2 + \sigma_*^2}\right] \left(y_t + \frac{w}{10}\right)$$
$$s^2 = \left(\frac{\sigma_0^2}{(t+1)\sigma_0^2 + \sigma_*^2}\right)^{1/2} \sigma_*^2$$

To wrap up this simple model, I fix the discounting factor β to 0.95. This means that in this simple version of the model there are only 3 parameters to estimate:

1. Two parameters determining firms' priors y_0 and σ_0^2
2. One parameter dictating the signal generating process σ_*^2

Given any value of these parameters, the firm's problem can be solved with a value function iteration (VFI) algorithm.