Wealth, Wages, and Employment

Still Preliminary

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Introduction

- We want to analyze fluctuations in gross employment flows.
- They are informative over wage rigidity.
- In an environment where the joint distribution of employment, wages, and wealth, is determined and where
  - Workers are risk averse, so only use self-insurance.
  - Workers sometimes lose their jobs or quit or switch.
  - The economy aggregates into a modern economy (total wealth, labor shares, consumption/investment ratios)

Literature

- The steady state of this economy has as its core Aiyagari (1994) meets Merz (1995), Andolfatto (1996) meets Moen (1997).

- Related Lise (2013), Hornstein, Krusell, and Violante (2011), Krusell, Mukoyama, and Şahin (2010), Ravn and Sterk (2016, 2017), Den Haan, Rendahl, and Riegler (2015).

- Especially Eeckhout and Sepahsalari (2024), Chaumont and Shi (2022), Griffy (2021).

A Brief Look At Data: Relevant Volatility Properties in U.S.

	Mean Perc	St Dev Relt to Output	Correl w Output	Source
Average Wage	-	0.44-0.84	0.24-0.37	Haefke et al. (2013)
New Wage	-	0.68-1.09	0.79-0.83	Haefke et al. (2013)
Unemployment	4-6	4.84	-0.85	Campolmi and Gnocchi (2016)
Annual Quits	10-40	4.20	0.85	Brown et al. (2021)
Annual Switches	25-35	4.62	0.70	Fujita and Nakajima (2016)
Monthly FMP (J2J)	2.43	2.44	. 81	Qiu (2022)
Monthly FF (J2J)	2.13	2.96	.79	Qiu (2022)
Monthly MAR (J2J)	2.23	2.85	.80	Qiu (2022)
Consumption	75	0.78	0.86	NIPA
Investment	25	4.88	0.90	NIPA

FMP: Fujita et al. (2024).
FF: Fallick and Fleischman (2004).
MAR: Missing at Random. This is without adjustment.

A Brief Look At Data: U.S. Job Flows (Source Qiu (2022))

	Mean Perc	St Dev Relt to Output	Correl w Output	Source
Average Wage	-	0.44-0.84	0.24-0.37	Haefke et al. (2013)
New Wage	-	0.68-1.09	0.79-0.83	Haefke et al. (2013)
Wages of Hired OE		1.68	.44	Qiu (2022)
Wages of Hired UE		1.98	.33	Qiu (2022)
Wages of Hired JJ		1.42	.49	Qiu (2022)
Wages of HiredStayer		0.07	.04	Qiu (2022)

Ingredients of the Model

1. Take a basic Aiyagari (1994) model and make the job a choice with frictions: Trade-off between likelyhood and wages informed by wealth.
    - Workers Search
    - Workers Quit
    - Workers On the job search
2. We want to control:
    - Correlation between wages and wealth when
    - Wage Dispersion
3. Need to add two-sided noise (EVS) to generate useful wage dispersion and turnover.

Build the Theory Sequentially

1. Exogenous Job Destruction and Worker Quits. Built on top of Growth Model. (GE version of Eeckhout and Sepahsalari (2024): Not a lot of wage dispersion. Not a lot of job creation in expansions.

2. Add Endogenous Quits and On the Job Search Extreme value Shocks to the taste of quitting/searching/neither (Similar but not the same as in Chaumont and Shi (2022), not Block Recursive).

3. Add Aiming Application Shocks. Add EVS to the Utility of where to apply. Weakens the correlation between wages and wealth when hired.

4. Add Manager Posting Shocks. Gives full Support to Wages even in Business Cycles (again EVS).

- Jobs are created by firms (plants). A plant with capital plus a worker produce one unit of the good
  - Firms pay flow cost $\bar{c}$ to post a vacancy in market $\{w, \theta\}$.
  - Firms cannot change the wage afterwards (like a machine programmed to pay w)
  - Plants (and their capital) are destroyed at rate δ^f.
  - Workers quit exogenously at rate δ^h leaving firms idle.
- Households differ only in wealth and wages (if working).
- No state contingent claims, nor borrowing.
  - If employed, workers get w and save.
  - If unemployed, workers produce b and search in some market $\{w, \theta\}$.
- General equilibrium: Workers own firms.

Order of Events of 1: Exog Quits

1. Households enter the period with or without a job: $\{e, u\}$.
2. Production, payment of dividends and wages & Consumption : Employed produce z on the job. Unemployed produce b at home. They choose savings.
3. Firm Destruction and Exogenous Quits:
   Some Firms are destroyed (rate δ^f) They cannot search this period.
   Some workers quit their jobs for exogenous reasons δ^h.

   Total job destruction is δ.
4. Search: Firms and the unemployed choose wage w and tightness θ.
5. Job Matching : $M(V, U)$: Some vacancies meet some unemployed job searchers. A match becomes operational the following period. Job finding and job filling rates $\psi^h(\theta) = \frac{M(V,U)}{U}$, $\psi^f(\theta) = \frac{M(V,U)}{V}$.

Household Problem

- Individual state: wealth and wage
  - If employed: (a, w)
  - If unemployed: (a)
- Problem of the employed: (Standard)

$$V^e(a,w) = \max_{c,a'} u(c) + \beta \left[(1-\delta)V^e(a',w) + \delta V^u(a')\right]$$
$$\text{s.t.} \quad c + a' = a(1+r) + w, \quad a \geq 0$$

- Problem of the unemployed: Choose which wage to look for

$$V^u(a) = \max_{c,a',w} u(c) + \beta \left\{\psi^h[\theta(w)]\ V^e(a',w) + [1-\psi^h[\theta(w)]]\ V^u(a')\right\}$$
$$\text{s.t.} \quad c + a' = a(1+r) + b, \quad a \geq 0$$

$\theta(w)$ is an equilibrium object

- Standard Euler equation for savings

$$u_c = \beta (1 + r) \; E \{u'_c\}$$

  - Households with more wealth are able to insure better against unemployment risk.

- From wage applicants $\max_w \psi^h[\theta(w)] \; [V^e(a', w) - V^u(a')]$ so

$$\psi^h[\theta(w)] \; V^e_w(a', w) = \psi^h_\theta[\theta(w)] \; \theta_w(w) \; [V^u(a') - V^e(a', w)]$$

- Up to a certain level of wealth, richer households apply to higher wages. After that, it seems not. Consistent with theory

Firms Post vacancies at different wages & filling probabilities

- Value of a job with wage w: uses constant $\overline{k}$ capital that depreciates

$$\Omega(w) = z - \overline{k}\delta_k - w + \frac{1-\delta}{1+r}\Omega(w)$$

- Affine in w: $\Omega(w) = (z - \overline{k}\delta_k - w)\frac{1+r}{r+\delta}$

Block Recursivity Applies (firms can be ignorant of Eq)

- Value of creating a firm includes posting a vacancy: $\psi^f[\theta(w)]\ \ \Omega(w)$

- Free entry condition requires that for all offered wages

$$\bar{c} + \overline{k} = \psi^f[\theta(w)]\ \ \frac{\Omega(w)}{1+r} + [1 - \psi^f[\theta(w)]]\ \ \frac{\overline{k}(1-\delta_k)}{1+r},$$

- A stationary equilibrium is functions $\{V^e, V^u, \Omega, g\prime^e, g\prime^u, w^u, \theta\}$, an interest rate r, and a stationary distribution x over (a, w), s.t.

1. $\{V^e, V^u, g\prime^e, g\prime^u, w^u\}$ solve households' problems, $\{\Omega\}$ solves the firm's problem.

2. Zero profit condition holds for active markets

$$\bar{c} + \overline{k} = \psi^f[\theta(w)] \ \frac{\Omega(w)}{1+r}, \qquad \forall w \text{ that are offered}$$

3. An interest rate r clears the asset market

$$\int a \ dx = \int \Omega(w) \ dx.$$

2: On the Job Search and Quits: Time-line

1. Workers enter period with or without a job: V^e, V^u.
2. Production payment of dividends and wages & Consumption :
3. Exogenous Separation Only from Firms' side
4. Quitting? Searching? Neither?: Employed draw shocks $(\epsilon^e, \epsilon^u, \epsilon^s)$ and make decision to quit, search, or neither. Those who quit become u', those who search join the u, in case of finding a job become $\{e', w'\}$ but in case of no job finding remain e' with the same wage w and those who neither become e' with w. $\widehat{V}^E(a', w)$, is determined with respect to this stage.
5. Search : Potential firms decide whether to enter and if so, the market (w) at which to post a vacancy; u and s assess the value of all wage applying options, receive match specific shocks $\{\epsilon^{w'}\}$ and choose the wage level w' to apply. Those who successfully find jobs become e', otherwise u'.
6. $\widehat{V}^u(a')$, $\{\Omega^j(w)\}$ are determined with respect to this stage.
7. Match

- After saving, the employed choose whether to quit, search or neither

$$\widehat{V}^e(a', w) = \int \max\{V^e(a', w) + \epsilon^e, V^u(a') + \epsilon^u, V^s(a', w) + \epsilon^s\} dF^\epsilon$$

- The value of searching is

$$V^s(a', w) = \max_{w'} \left\{ \psi^h(w') \; V^e(a', w') + [1 - \psi^h(w')] \; V^e(a', w) \right\}$$

- Problem of the unemployed: Choose which wage to look for

$$V^u(a) = \max_{c, a', w} u(c) + \beta \left\{ \psi^h[\theta(w)] \; V^e(a', w) + [1 - \psi^h[\theta(w)]] \; V^u(a') \right\}$$

$$\text{s.t.} \quad c + a' = a(1 + r) + b, \quad a \geq 0$$

- Employed Households solve

$$V^e(a,w) = \max_{a' \geq 0} u[a(1+r) + w - a'] + \beta \left[\delta V^u(a') + (1-\delta)\widehat{V}^e(a',w)\right]$$

- With solution probabilities of quitting and of searching

$$q(a',w) = \frac{1}{1 + \exp(\alpha[V^e(a',w) - V^u(a')]) + \exp(\alpha[V^s(a',w) - V^u(a') + \mu^s])},$$
$$s(a',w) = \frac{1}{1 + \exp(\alpha[V^u(a') - V^s(a',w)]) + \exp(\alpha[V^e(a',w) - V^s(a',w) - \mu^s])}.$$

$\mu^s < 0$ is the mode of the shock ϵ^s which reflects the search cost.

- The rich pursue often other activities (leisure?)

- The value of the firm is

$$\Omega^{\mathbf{0}}(w) \quad = \quad (z - w - \delta^k k)\, Q^{\mathbf{1}}(w) + (1 - \delta - \delta_k)k\, Q^{\mathbf{0}}(w),$$

$$Q^{\mathbf{1}}(w) = 1 + \sum_{\tau=\mathbf{0}}^{\infty} \left[\left(\frac{1-\delta}{1+r} \right)^{\mathbf{1}+\tau} \prod_{i=\mathbf{0}}^{\tau} \ell^i(w) \right],$$

$$Q^{\mathbf{0}}(w) = \sum_{\tau=\mathbf{0}}^{\infty} \left[\left(\frac{1-\delta}{1+r} \right)^{\mathbf{1}+\tau} [1 - \ell^{\tau}(w)] \left(\prod_{i=\mathbf{0}}^{\tau-\mathbf{1}} \ell^i(w) \right) \right].$$

- Where the probability of keeping a worker after j periods is

$$\ell^j(w) = 1 - \int h(w;a)\, q[g^{e,j}(a,w), w]\, dx^u(a) -$$
$$\int h(w;a)\, s[w; g^{e,j}(a,w)] \left[\int \hat{h}[\widetilde{w}; g^{e,j}(a,w), w] \xi \phi^h(\widetilde{w})\, d(\widetilde{w}) \right] dx^u(a)$$

- Without knowing the wealth of the worker it is Not block recursive but Q^1 and Q^2 are sufficient.

3 and 4: Market Arriving Shocks

- The Model as is very delicate.
- Specific markets appear and disappear very easily.
- Particular bad for Business Cycles Analysis
- We add smoothing shocks on both sides They do not end in the market they hoped for (EVS that smooth out where to go to while still mostly going to the best markets)
    1. Aiming Application shocks for workers:
    2. Manager Posting shocks that make them offer all possible salaries. (Zero Profit Condition Still holds.)
- Still with mostly the "right" wages.

3: Worker Application Shocks: Time-line

1. Workers enter period with or without a job: V^e, V^u.
2. Production payment of dividends and wages & Consumption :
3. Exogenous Separation Only from Firms' side
4. Quitting? Searching? Neither?: Employed draw shocks $(\epsilon^e, \epsilon^u, \epsilon^s)$ and make decision to quit, search, or neither. Those who quit become u', those who search join the u, in case of finding a job become $\{e', w'\}$ but in case of no job finding remain e' with the same wage w and those who neither become e' with w. $\widehat{V}^E(a', w)$, is determined with respect to this stage.
5. Search : Job searchers assess the value of applying to each market $\theta(w')$. Apply Gumbel Shocks to the Utility of each market, which yields the probabilty of applying to each job for each worker type. Potential firms decide whether to enter and if so, the market (w) at which to post a vacancy; u and s assess the value of all wage applying options, receive match specific shocks $\{\epsilon^{w'}\}$ and choose the wage level w' to apply. Those who successfully find jobs become e', otherwise u'.
6. $\widehat{V}^u(a')$, $\{\Omega^j(w)\}$ are determined with respect to this stage.
7. Match

- The unemployed after saving solve and yield logit choice density of wage for wealth choice a':

$$\widehat{V}^u(a') = \left\{ \int \max_{w'} \left[\psi^h(w')\ V^e(a', w') + (1 - \psi^h(w'))\ V^u(a') + \epsilon^{w'} \right] \ dF^\epsilon \right\}$$

$$h^u(w'; a') = \frac{\exp\left\{ \alpha^w \left[\psi^h(w')\ V^e(a', w') + (1 - \psi^h(w'))\ V^u(a') \right] \right\}}{\int \exp\left\{ \alpha^w \left[\psi^h(\widetilde{w})\ V^e(a, \widetilde{w}) + (1 - \psi^h(\widetilde{w}))\ V^u(a') \right] \right\} \ d\widetilde{w}}$$

and $V^u(a) = \max_{a'} u[a(1 + r) + b - a'] + \beta\ \widehat{V}^u(a')$

- For searchers we get

$$V^s(a', w) = \left\{ \int \max_{w'} \left[\psi^h(w')\ V^e(a', w') + [1 - \psi^h(w')]\ V^e(a', w) + \epsilon^{w'} \right] \ dF^\epsilon \right\}$$

$$h^s(w'; a', w) = \frac{\exp\left\{ \alpha^w \left[\psi^h(w')\ V^e(a', w') + (1 - \psi^h(w'))\ V^u(a') \right] \right\}}{\int \exp\left\{ \alpha^w \left[\psi^h(\widetilde{w})\ V^e(a, \widetilde{w}) + (1 - \psi^h(\widetilde{w}))\ V^u(a') \right] \right\} \ d\widetilde{w}}$$

- The rest is the same.

4: Manager Vacancy Posting Shocks

- The value of a firm with newly hired worker at w is as before

$$\Omega^{\mathbf{0}}(w) = (z - w - \delta^k k)\ Q^{\mathbf{1}}(w) + (1 - \delta - \delta_k)k\ Q^{\mathbf{0}}(w),$$

where

and

$$Q^{\mathbf{1}}(w) = 1 + \sum_{\tau=\mathbf{0}}^{\infty} \left[\left(\frac{1-\delta}{1+r} \right)^{\mathbf{1}+\tau} \prod_{i=\mathbf{0}}^{\tau} \ell^i(w) \right],$$

$$Q^{\mathbf{0}}(w) = \sum_{\tau=\mathbf{0}}^{\infty} \left[\left(\frac{1-\delta}{1+r} \right)^{\mathbf{1}+\tau} [1 - \ell^{\tau}(w)] \left(\prod_{i=\mathbf{0}}^{\tau-\mathbf{1}} \ell^i(w) \right) \right].$$

- Managers get Gumbel shocks η^w to expected profits at w which yields

$$\widehat{\Omega} = \left\{ \int \max_w \left[\psi^f(w)\ \Omega^{\mathbf{0}}(w) + [1 - \psi^f(w)]\ (w) + \epsilon^{w'} \right] dF^{\epsilon} \right\}$$

$$h^s(w'; a', w) = \frac{\exp\left\{ \alpha^w \left[\psi^h(w')\ V^e(a', w') + (1 - \psi^h(w'))\ V^u(a') \right] \right\}}{\int \exp\left\{ \alpha^w \left[\psi^h(\widetilde{w})\ V^e(a, \widetilde{w}) + (1 - \psi^h(\widetilde{w}))\ V^u(a') \right] \right\} d\widetilde{w}}$$

- This gives the probabilities of where to post
- Prospective entrants understand the incompetence of their managers:

$$\bar{c} + \overline{k} = \frac{\widehat{\Omega}}{1+r}$$

A little Detail on Computation

- When we discretize the set of wages, solving the zero profit condition requires solving a system of equations:
  1. Entering Firms expect 0 profits:

$$(1+r)k+\bar{c}=\sum_j \Pi_j \left[\psi^f(w^j)\Omega(w^j)+(1-\psi^f(w^j))\Omega\right].$$

  2. Mass of Idle firms o and new firms x satisfy:

$$o=\sum_j \Pi^j \left\{\left(1-\psi^f(w_j)\right)\left((1-\delta^f)\left[o+\sum_\ell e^\ell \int_a q(a,w^\ell)dF(a)\right]+x\right)\right\}.$$

  3. Matching probability j is determined as a function of vacancies and unemployed:

$$\psi^f(w_j)=\frac{\iota^j}{\left\{(\iota^j)^\eta+\left[(o+x)\Pi^j\right]^\eta\right\}^{1/\eta}} j=1,\ldots,J.$$

  4. Probability of managers posting a vacancy in market j:

$$\Pi^j=\frac{1}{1+\sum_{k\neq j}\exp\left\{\alpha_F\left[\Omega^0(w_k)-\Omega^0(w_j)\right]\right\}} j=1,\ldots,J.$$

Managers posting choices that in turn have to be consistent with the numbers of entrants. Cesar add details

5: Firms Destruction Shocks: Time-line

1. Workers start period with or without a job: $V^e(a, w)$, $V^u(a)$. Firms start as $\Omega^j(w), \Omega$.
2. Production payment of dividends and wages & Consumption and investment:
3. Firms Get Profitability Shocks that determine their survival.
4. Quitting? Searching? Neither?: Employed draw shocks $(\epsilon^e, \epsilon^u, \epsilon^s)$ and make decision to quit, search, or neither. Those who quit become u', those who search join the u, in case of finding a job become $\{e', w'\}$ but in case of no job finding remain e' with the same wage w and those who neither become e' with w. $\widehat{V}^E(a', w)$, is determined with respect to this stage.
5. Search : Job searchers assess the value of applying to each market $\theta(w')$. Apply Gumbel Shocks to the Utility of each market, which yields the probabilty of applying to each job for each worker type. Potential firms decide whether to enter and if so, the market (w) at which to post a vacancy; u and s assess the value of all wage applying options, receive match specific shocks $\{\epsilon^{w'}\}$ and choose the wage level w' to apply. Those who successfully find jobs become e', otherwise u'.
6. $\widehat{V}^u(a')$, $\{\Omega^j(w)\}$ are determined with respect to this stage.
7. Match

Firms Profitability Shock: Instead of exogenous Destruction

- Each firm has a firm profitability shock ζ, say normally distributed. To survive, $\Omega^j(w) \geq \zeta$ which happens with probability

$$F^{\zeta}\left(\Omega^j(w) - z\right)$$

- We do not have here a serious microfoundation of what this shock is. It can be thouhght of related to depreciation, but it is important that the probability of destruction increases with the wage.

- The measure of firms destroyed add their capital to the amount depreciated.

7: Outside the Labor Force Time-line

1. Workers start period with or without a job: $V^e(a, w)$, $V^u(a)$. Firms start as $\Omega^j(w), \Omega$.
2. Production payment of dividends and wages & Consumption and investment:
3. Firms Get Profitability Shocks that determine their survival. $(\epsilon^e, \epsilon^u, \epsilon^s)$ and make decision to quit, search, or
4. Quitting? Searching? Neither?: Only for the Employed who draw shocks. Those who quit become u, those who search join the u, in case of finding a job become $\{e', w'\}$ but in case of no job finding remain e' with the same wage w and those who neither become e' with w. $\widehat{V}^E(a', w)$, is determined with respect to this stage.
5. Those that do not have a job decide whether to search for a job or not.
6. Search : Job searchers assess the value of applying to each market $\theta(w')$. Apply Gumbel Shocks to the Utility of each market, which yields the probabilty of applying to each job for each worker type. Potential firms decide whether to enter and if so, the market (w) at which to post a vacancy; u and s assess the value of all wage applying options, receive match specific shocks $\{\epsilon^{w'}\}$ and choose the wage level w' to apply. Those who successfully find jobs become e', otherwise u'.
7. $\widehat{V}^u(a')$, $\{\Omega^j(w)\}$ are determined with respect to this stage.
8. Match

Outside the Labor Force Model: Time-line

1. Workers enter period with or without a job: V^e, V^u.
2. Production payment of dividends and wages & Consumption :
3. Exogenous Separation
4. Quitting? Searching? Neither?: Only for the Employed
5. In the beginning of the period non Workers get a shock to the utility of either searching or not searching. They then choose whether to sit out and not search or to search. It is an extreme value shock. Workers get a utility injection equal to the expected utility of the maximum of those two shocks to get no bias in the value of working versus not. There may also be a Markov chain for workers that determines the value of b. High b are likely to be outside the labor force for periods on end.
6. Search
7. $\widehat{V}^u(a')$, $\{\Omega^j(w)\}$ are determined with respect to this stage.
8. Match

Plan II: Study Fluctuation Properties Related to Wage Rigidity

- Outside Steady State Employers commit to a wage schedule

$$w(z) = \phi \; z \; w$$

- We estimate the value of ϕ off the Business cycle Properties.

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Key Findings

- If wages are fully fixed and committed (Drastic Wage rigidity)
  - Both endogenous quits and on-the-job yield counter factual procyclical unemployment and massive on the job search.
  - Allowing the wage of an already formed job match to respond some to aggregate shocks corrects this.
  - Getting the right relative volatility of old and new wages and the amount of job-to-job moves and quits provides a way to measure wage rigidity.
- With partial wage rigidity the model fares reasonably well with the data. A few things still to improve. (Excessive Job-to-JOB transitions)