Wealth, Wages, and Employment: A Progress Report

More Inexistent than Preliminary

Per Krusell   Jinfeng Luo   José-Víctor Ríos-Rull
IIES   Penn   Penn, CAERP

Wharton Macro Finance Lunch
October 16, 2018

Introduction

- We want a real-world theory of the joint distribution of employment, wages, and wealth.
  - Workers are risk averse, only use self-insurance.
  - The employment and wage risk is endogenous.
  - The economy aggregates into a modern economy (total wealth, labor shares, consumption/investment ratios)
  - Business cycles can be studied.

- Such a framework does not exist in the literature.
  1. Requires heterogeneous agents.
  2. No (search-matching) closed form solutions possible.
  3. Wage formation? Nash bargaining not very promising:
     - A bargaining problem where wages become a(n increasing) function of worker wealth.
     - Not time-consistent and bargaining with commitment makes no sense.
     - Not numerically well-behaved.

- We offer a numerically tractable alternative: competitive job search with commitment to a wage while the job lasts.

LITERATURE

- At its core is Aiyagari (1994) meets Moen (1997).

- Developing empirically sound versions of these ideas compels us to
  - Add extreme value shocks to transform decision rules from functions into densities to weaken the correlation between states and choices.
  - Pose quits, on the job search, and explicit role for leisure so quitting is not only to search for better jobs
  - Use new potent tools to address the study of fluctuations in complicated economies Boppart, Krusell, and Mitman (2018)

- Related to 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 (2015), Chaumont and Shi (2017), Griffy (2017).

- The study of Business cycles including gross flows in and out of employment, unemployment and outside the labor force

- Policy analysis where now risk and employment are all responsive to policy.

TODAY: DISCUSS VARIOUS MODEL INGREDIENTS & FLUCTUATIONS

1. **Basic:** Exogenous Destruction, no Quits. Built on top of Growth Model. (GE versin of Eeckhout and Sepahsalari (2015): But No outside the labor force, not a lot of wage dispersion.

2. **Quits:** Higher wage dispersion may arise to keep workers longer. (Endogenous quits via extreme value shocks). But Wealth trumps wages and wage dispersion collapses.

3. **Aiming Shocks** Weakens but does not destroy the dependency of wages on wealth. Larger Wage Dispersion.

4. **Aiming and Quiting Shocks** Stronger Wage dispersion. **Fluctuations.** Procyclical quits.

5. **On the Job Search** workers may get outside offers and take them. (Some in Chaumont and Shi (2017)). **Fluctuations.** Excessive Quitting.

6. **On the Job Search with Multiple types** Workers differ in their value of leisure. Explicit role of Outside Labor Force.

- Jobs are created by firms (plants). A plant with capital plus a worker produce one (z) unit of the good.

    - Firms pay flow cost $\bar{c}$ to post a vacancy in market $\{w, \theta\}$. Cannot change wage afterwards.

    - Plants (and their capital) are destroyed at rate δ. Workers will not want to quit (for now).

- Households differ in wealth and wages (if working). There are no state contingent claims, nor borrowing.

    - If employed, workers get w and save.

    - If unemployed, workers produce b and search in some $\{w, \theta\}$.

- General equilibrium: Workers own firms.

Order of Events of Basic Model

1. Households enter the period with or without a job: $\{e, u\}$.

2. **Production & Consumption**: Employed produce z on the job. Unemployed produce b at home. They choose savings.

3. **Job Separation**: Some employed workers receive exogenous job destruction shocks at rate δ. They cannot search this period.

4. **Search**: Potential entrants and the unemployed choose wage w and market tightness θ.

5. **Job Matching** : Some vacancies meet some unemployed job searchers. A match becomes operational the following period. Job finding and job filling rates $\psi^h(\theta), \psi^f(\theta)$.

Basic Model: 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

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

  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

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

Basic Model: Stationary Equilibrium

- A stationary equilibrium is functions $\{V^e, V^u, \Omega, g'^e, g'^u, w^u, \theta\}$, an interest rate r, and a stationary distribution x over (a, w), s.t.

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

  2. Zero profit condition holds for active markets

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

  3. An interest rate r clears the asset market

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

Characterization of a worker's decisions

- Standard Euler equation for savings

- A F.O.C for wage applicants

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

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

- As a result they apply for higher wage jobs and we have dispersion

- A form of "Precautionary job search".
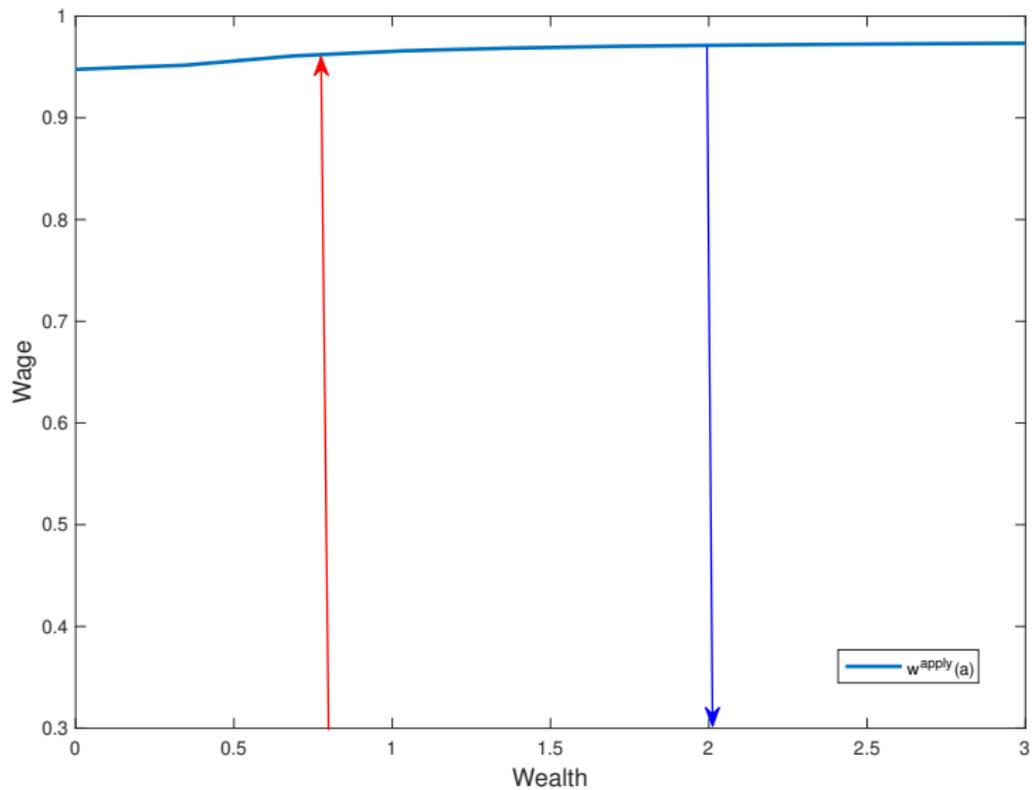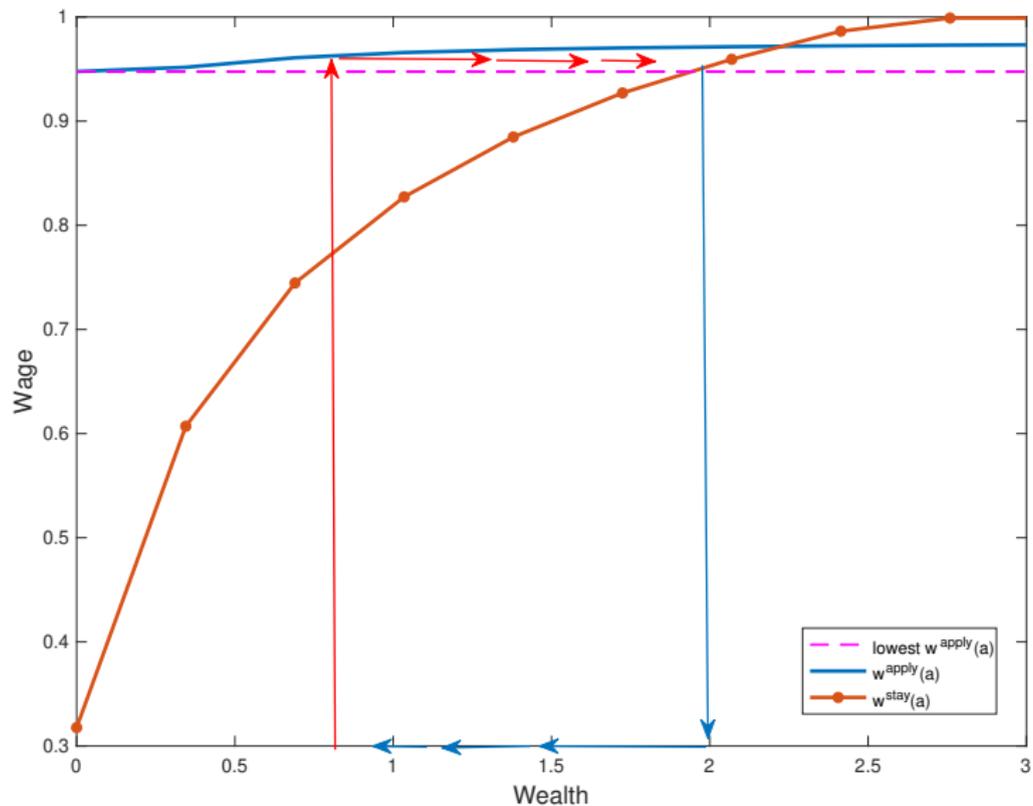
1. Very Easy to Comute Steady-State with key Properties

   i Risk-averse, only partially insured workers, endogenous unemployment

   ii Can be solved with aggregate shocks too

   iii Policy such as UI would both have insurance and incentive effects

   iv Wage dispersion small—wealth doesn't matter too much

   v $\cdots$ so almost like two-agent model (employed, unemployed) of Pissarides despite curved utility and savings

2. In the following we will examine whether more wage dispersion obtains under additional assumptions –given that frictional wage dispersion is considered large in the data

1. Temporary Shocks to the utility of working or not working: Some workers quit.

2. Adds a (smoothed) quitting motive so that higher wage workers quit less often: Firms may want to pay high wages to retain workers.

3. Conditional on wealth, high wage workers quit less often.

4. But Selection (correlation 1 between wage and wealth when hired) makes wealth trump wages and higher wages imply quit less often: Wage inequality collapses due to firms profit maximization.

1. Workers enters period with or without a job: $\{e, u\}$.

2. Production occurs and consumption/saving choice ensues:

3. Exogenous job/firm destruction happens.

4. Quitting: e draw shocks $\{\epsilon^e, \epsilon^u\}$ and make quitting decision. Job losers cannot search this period.

5. Search: New or Idle firms post vacancies. Choose $\{w, \theta\}$. Wealth is not observable. (Unlike Chaumont and Shi (2017)). Not Block Recursive (It does not matter yet).

6. Matches occur

QUITTING MODEL: WORKERS

- Workers receive i.i.d shocks $\{\epsilon^e, \epsilon^u\}$ to the utility of working or not the following period

- Value of the employed right before receiving those shocks:

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

  V^e and V^u are values after quitting decision as described before.

- If shocks are Type-I Extreme Value dbtn (Gumbel), then $\widehat{V}$ has a closed form and the ex-ante quitting probability $q(a, w)$ is

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

  higher $\alpha \to$ lower chance of quitting.

- Hence higher wages imply longer job durations. Firms could pay more to keep workers longer.

- Problem of the employed: just change $\widehat{V}^e$ for V^e

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

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

- Problem of the unemployed is like before

- Ω: Value of an idle firm, $\Omega^j(w)$: Value with with j-old worker. Free entry condition requires that for all offered wages

$$\bar{c} + \bar{k} = \frac{1}{1+r} \left\{ \psi^f[\theta(w)]\Omega^0(w) + [1 - \psi^f[\theta(w)]]\Omega \right\},$$

- Probability of retaining a worker with tenure j at wage w is $\ell^j(w)$.

  (One to one mapping between wealth and tenure)

$$\ell^j(w) = 1 - q^e[g^{e,j}(a, w), w]$$

  $g^{e,j}(a, w)$ savings rule of a $j - tenured$ worker that was hired with wealth a

- Firm's value

$$\Omega^j(w) = z - \bar{k}\delta^k - w + \frac{1-\delta}{1+r} \left\{ \ell^j(w)\Omega^{j+1}(w) + [1 - \ell^j(w)] \, \Omega \right\}$$

18

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

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

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

- New equilibrium objects $\{Q^0(w), Q^1(w)\}$. Rest is unchanged.

- While no longer strictly Block Recursive, it is effectively independent of the distribution.

- For the poorest, employment duration increases when wage goes up.
- Despite wage increases while output is fixed, firm value increases
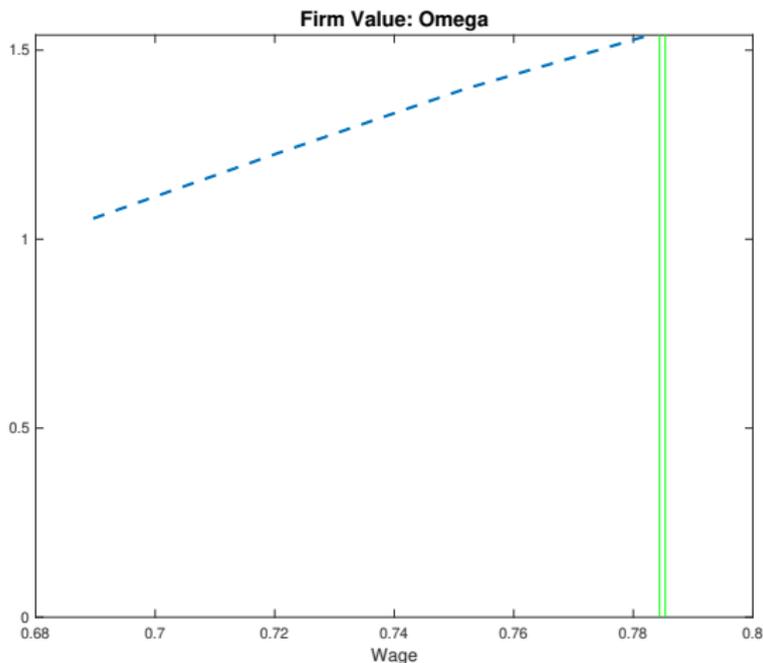

Firm Value: Omega

Value of the firm as wage varies: The Rich

- For the richest, employment duration increases but not fast enough.
- Firm value is decreasing in wages.

Firm Value: Omega
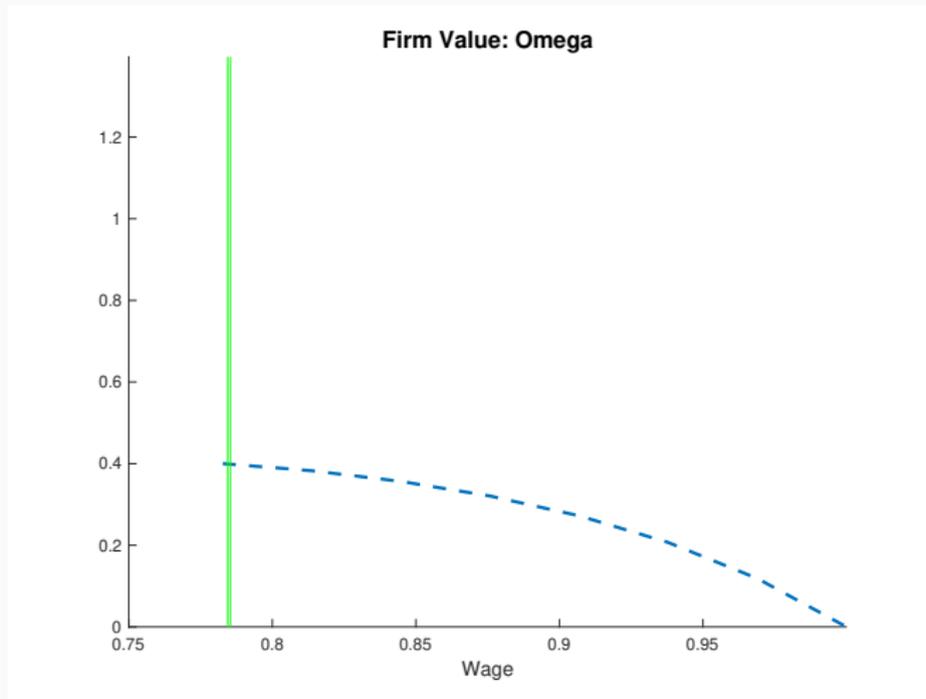
- Large drop from below to above equilibrium wages.
- In Equilibrium wage dispersion COLLAPSES due to selection.

Firm Value: Omega
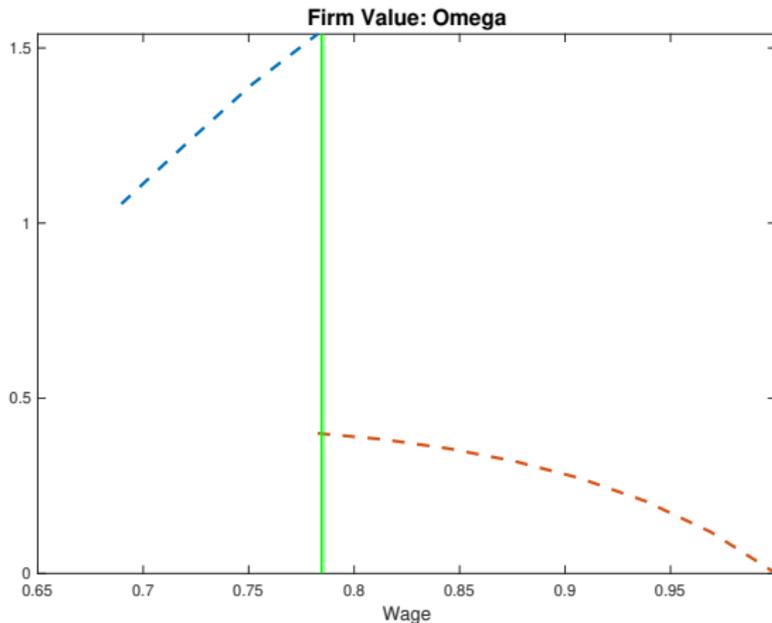
- Two forces shape the dispersion of wages

  - Agents quit less at higher paid jobs, which enlarge the spectrum of wages that firms are willing to pay (for a given range of vacancy filling probability).

  - However, by paying higher wages, firms attract workers with more wealth.

- Wealthy people quit more often, shrink employment duration.

- In equilibrium, the wage gap is narrow and the effect of wealth dominates.

- Need to weaken link between wages and wealth

1. Workers enter period with or without a job: {e,u}. V^e, V^u defined here.

2. Production & Consumption:

3. Exogenous Separation.

4. Quitting $\widehat{V}^e(a', w)$, determined here.

5. Search: Firms choose $\{w, \theta\}$. The unemployed asses the value of all wage applying options, receive match specific aiming shocks $\{\epsilon^{w'}\}$ and choose the wage level w' to apply. Those who successfully find jobs become e', otherwise become u'.

6. $\widehat{V}^u(a'), \{\Omega^j(w)\}$ are determined with respect to this stage.

7. Matching

- After saving, the unemployed problem is

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

- $h(w'; a')$ is now the logit choice density of wage for wealth level a'

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

- After saving, the employed choose whether to quit as before

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

$V^e(a, w)$ and $V^u(a)$ are as before beginning of period values.

- The employed solve

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

$$\text{s.t.} \quad c + a' = a(1 + r) + w$$

- The unemployed face the problem

$$V^u(a) = \max_{c, a' \geq 0} u(c) + \beta \widehat{V}^u(a')$$

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

- The value of the firm is again given like in the Quitting Model

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

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

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

- Except that now the probability of keeping a worker after j periods is

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

- Explicitly Not Block Recursive

- Higher wage dispersion

- Weaker but positive correlation between wage and wealth when hired

- Smooth firm problem: Firm value $\Omega^0(w)$ has no sharp drop due to composition

- Rich unemployed apply for higher wages (on average)

- But have more dispersion in its applications as utility differentials are lower

On the Job Search

On the Job Search Model: Time–line

1. Workers enter period with or without a job: V^e, V^u.
2. Production & Consumption:
3. Exogenous Separation
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 become u'.
6. $\widehat{V}^u(a'), \{\Omega^j(w)\}$ are determined with respect to this stage.
7. Match

- After saving, the unemployed problem is

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

- 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

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

- The 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.

- Households solve

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

$$V^u(a) = \max_{c, a' \geq 0} u[a(1 + r) + b - a'] + \beta \widehat{V}^u(a')$$

- The value of the firm is again given like in the Quitting Model

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

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

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

- Except that now the probability of keeping a worker after j periods is

$$\ell^j(w) = 1 - \int h(w; a) \, q[g^{e,j}(a, w), w] \, dx^u(a) -$$

$$\int h(w; a) \, s[w; g^{e,j}(a, w)] \left[\int \hat{h}[\widetilde{w}; g^{e,j}(a, w), w] \xi \phi^h(\widetilde{w}) \, d(\widetilde{w}) \right] \, dx^u(a)$$
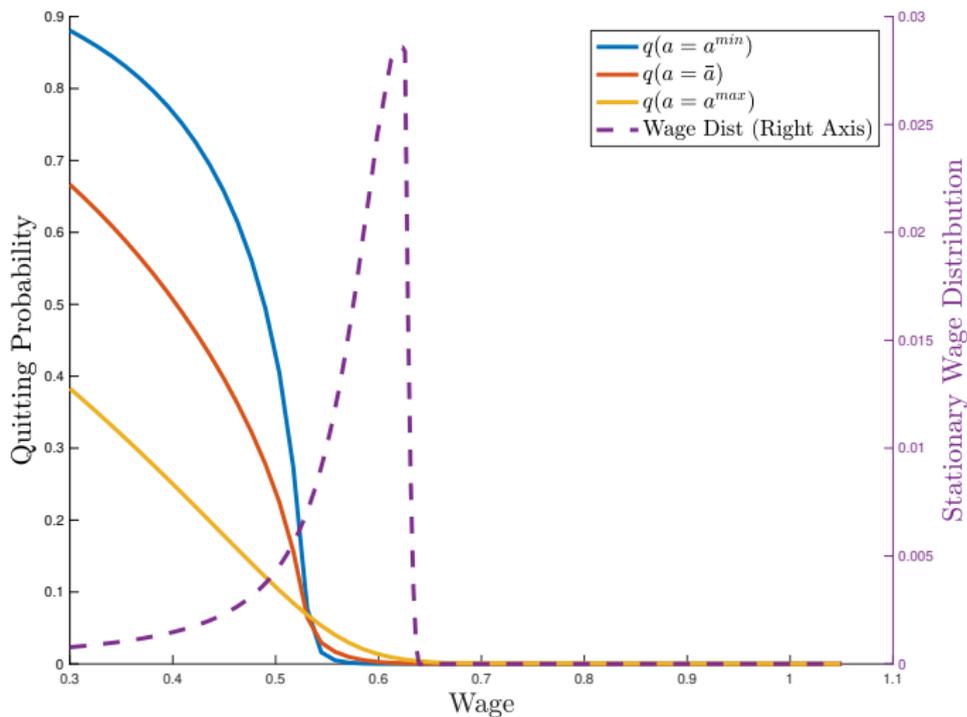
- The rich pursue often other activities (leisure?)
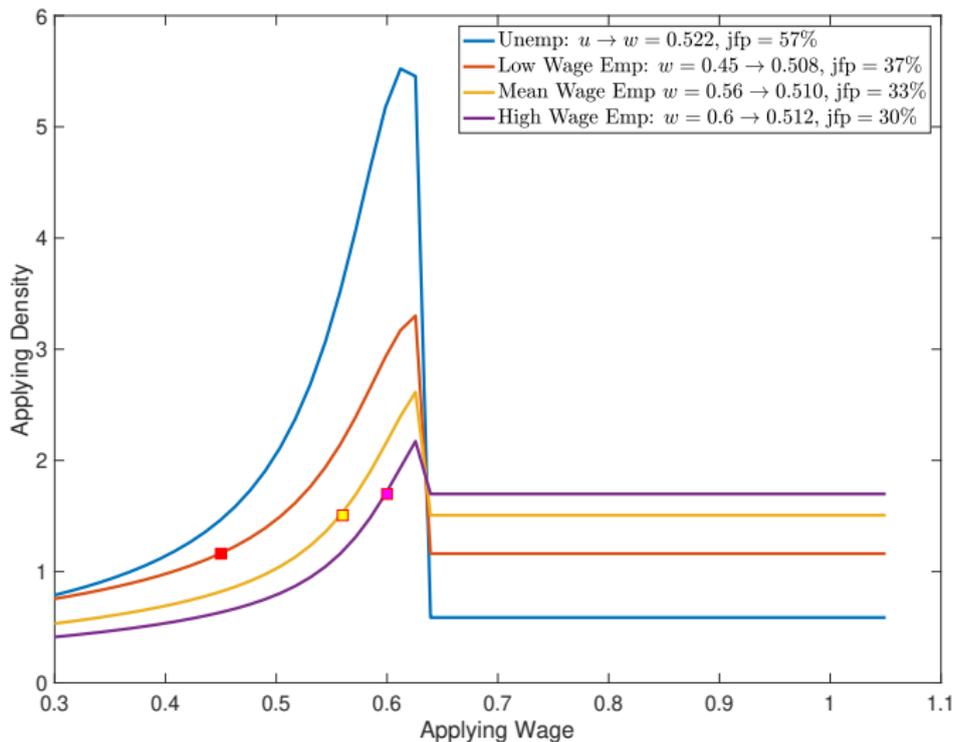
- The rich pursue often other activities (leisure?)

- Unemployed get jobs faster than searchers

- But $\cdots$ to higher wages

- Higher wage guys move more and to higher wages than lower wage

- But to lower wages than their own

- Excessive quitting in expansions: Easy to come back. Quit to take advantage of a *vacation* a temporary non working opportunity.

- We are redefining the role of extreme value shocks so that searching for almost impossible to find jobs is not rewarding (t)

- Extend to types differ in value of leisure: Outside labor force.

On the Job Search Model: Equilibrium Properties

- Some good Properties
    - Low wage workers move more often than high wage workers
    - Low wage workers move to lower wages than high wage workers

- Still some unattractive properties

    - Unemployed apply to higher wages than employed.
        - We think that it is an artifact of the way aiming shocks enter: too much wait in the application process and not in the outcome. We are now changing the process of how to implement these shocks.

    - There is excessive quitting in expansions because it is easy to come back. All quitting is to take advantage of a *vacation* a temporary non working opportunit.
        - We propose an extension where some quitting is due to a more permanent switch into a low attachment stage (retirement, schooling, parenting). Business cycles are less tempting to quite: A model of multiple types that differ in leisure valuation. Gives an explicit role to outside the labor force that is not purely temporary.

On the Job Search with Multiple Types

1. Household enters period t with or without a job: $V^{e,\eta}$, $V^{u,\eta}$.

2. Production & Consumption: u produce b at home, e produce z on the market; they then choose consumption today and wealth level tomorrow $\{c, a'\}$. Types differ in $u^{e,\eta}(c) = u(c) - \chi^{\eta}$

3. Separation:

4. Workers Change their type η according to $\Gamma_{\eta,\eta'}$.

5. Quitting? Searching? Neither?: $\widehat{V}^{e,\eta'}(a', w)$, is determined here.

6. Search: Cannot condition on η' (it is illegal). Firms enter, job searchers apply

7. Matching: $\widehat{V}^{u,\eta'}(a')$, $\{\Omega^j(w)\}$ are determined with respect to this stage.

- After saving, the unemployed problem is

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

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

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

- The value of searching is

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

- The probabilities of quitting and of searching are

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

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

- Household solves

$$V^{e,\eta}(a, w) = \max_{a' \geq 0} u[a(1 + r) + w - a'] - \chi^\eta + \beta \sum_{\eta'} \Gamma_{\eta\eta'}$$

$$\left[\delta V^{u,\eta'}(a') + (1 - \delta) \widehat{V}^{e,\eta'}(a', w) \right]$$

$$V^{u,\eta}(a) = \max_{w, a' \geq 0} u[a(1 + r) + b - a'] + \beta \sum_{\eta'} \Gamma_{\eta,\eta'} \ \widehat{V}^{u,\eta'}(a')$$

- The value of the firm is again given like in the Quitting Model

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

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

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

- Except that now the probability of keeping a worker after j periods is

$$\ell^j(w) = 1 - \int \sum_\eta \left\{ h(w; a)\, q\left[g^{e,j}(a, w), w\right] x^u(\eta) \right\} dx^u(a)$$

$$- \int \sum_\eta \left\{ h(w; a)\, s(w; g^{e,j}(a, w)) H(w; a) x^u(\eta) \right\} dx^u(a)$$

where $H(w; a) = \int \hat{h}(\widetilde{w}; g^{e,j}(a, w), w) \xi \phi^h(\widetilde{w})\, d\widetilde{w}$ and $x^u(\eta)$ is the stationary distribution of type η induced by $\Gamma_{\eta\eta'}$.

- Limited Comparable Results

- Right now we have five Economies

  1. No Aiming and Not Quitting The Benchmark

  2. No Aiming and Quitting Quitting is Small without Aiming

  3. Aiming and Not Quitting (Closed Economy) General Equilibrium

  4. An Aiming and Quitting Economy with the same interest rate

  5. An Aiming-Quitting & On the Job Search Economy (same r)

- Potential output is Normalized to 1.

Steady State Statistics of Various Economies

| $r = 1.28\%$ per quarter	No Aim & No Quitt	No Aim Quitt	Aim & No Quitt	Aim Quitt	Aim/Quitt OJS
Output	0.947	0.851	0.956	0.854	0.872
Avg Consumption	0.650	0.614	0.639	0.624	0.606
Avg Wage	0.639	0.626	0.604	0.577	0.563
Wage from Unemp	0.639	0.620	0.604	0.527	0.525
Std Wage	0.001	0.001	0.027	0.061	0.062
Mean-min Wage	1.005	1.000	1.385	1.925	1.878
Max-mean Wage	1.004	1.004	1.077	1.126	1.130
Avg Wealth	2.848	3.706	4.899	8.689	7.647
Stock Value	7.121	6.933	8.502	8.671	9.172
Cons-Wealth Ratio	0.228	0.166	0.130	0.072	0.079
Vacancies	0.055	0.085	0.121	0.185	0.189
Unemployment Rate	0.053	0.097	0.044	0.078	0.073
Non Emp Rate	0.053	0.149	0.044	0.146	0.128
Quitt Rate	–	0.053	–	0.068	0.054
Switching Rate	–	–	–	–	0.028
Newly Hired Unemp	0.029	0.070	0.029	0.083	0.072
Avg Unemp Duration	1.805	2.128	1.368	1.702	1.695
Avg Emp Duration	33.333	12.336	33.333	10.370	12.104
Std Consumption	0.027	0.032	0.031	0.036	0.034
Std Wealth	0.656	1.440	2.142	4.543	3.836
Max-mean Wealth	1.479	3.408	4.298	4.179	4.198

Aggregate Fluctuations

WHAT IS NEEDED?

- Two steps

  1. Compute the TRUE impulse response to an MIT Shock

  2. Use this path as a dynamic linear approximation to generate fluctuations (Boppart, Krusell, and Mitman (2018))

- The transition is a large but doable problem:

  - Firms need to know functions $\{Q_t^0(w), Q_t^1(w), \psi^f(w)\}$ at each stage (no block recursivity)

  - Households need to know $\phi_t^h(w)$ job finding probabilities every period.

  - Also need to know sequence of interest rates (not today)

- So it is a second order difference functional equation.

- Average wages don't move much but wages of new workers do!

- Newly hired Wage Distribution Shifts upward

- Quits are procyclical but excessive

- Employment moves more (not so much of Shimer puzzle)

Wage Path

Quitting Rate Path

Non-employment Rate Path
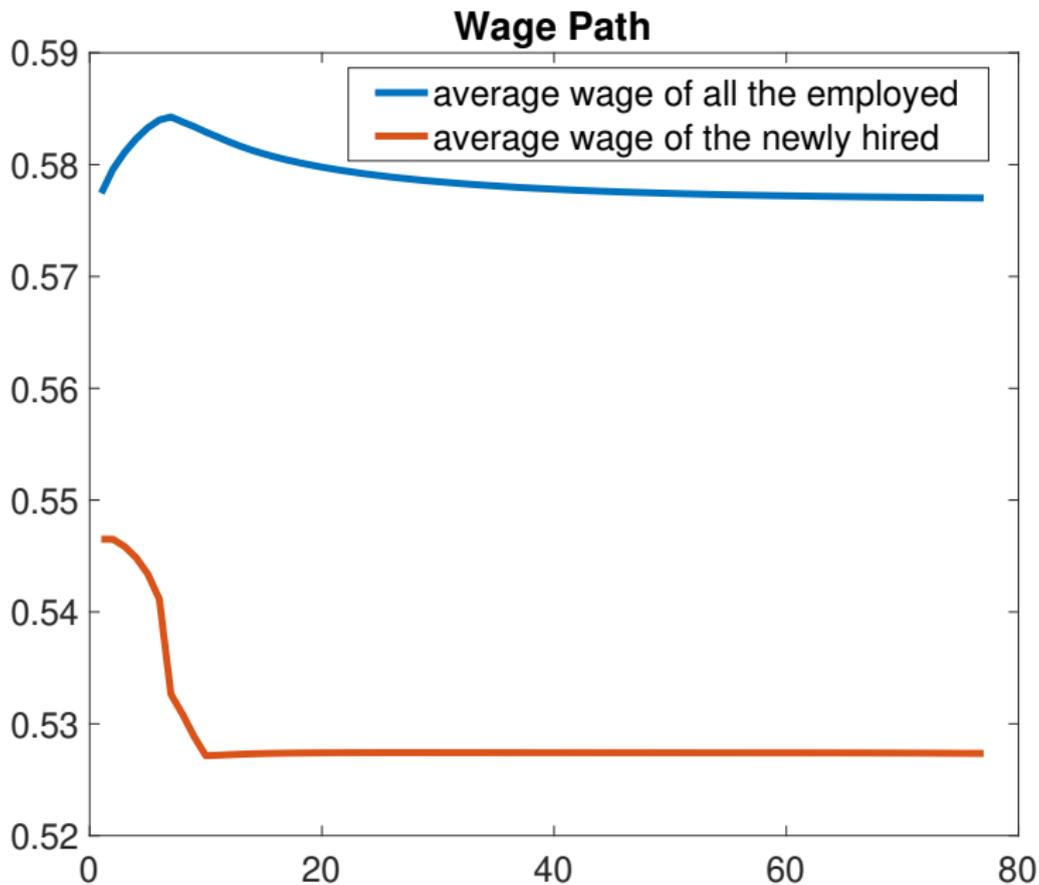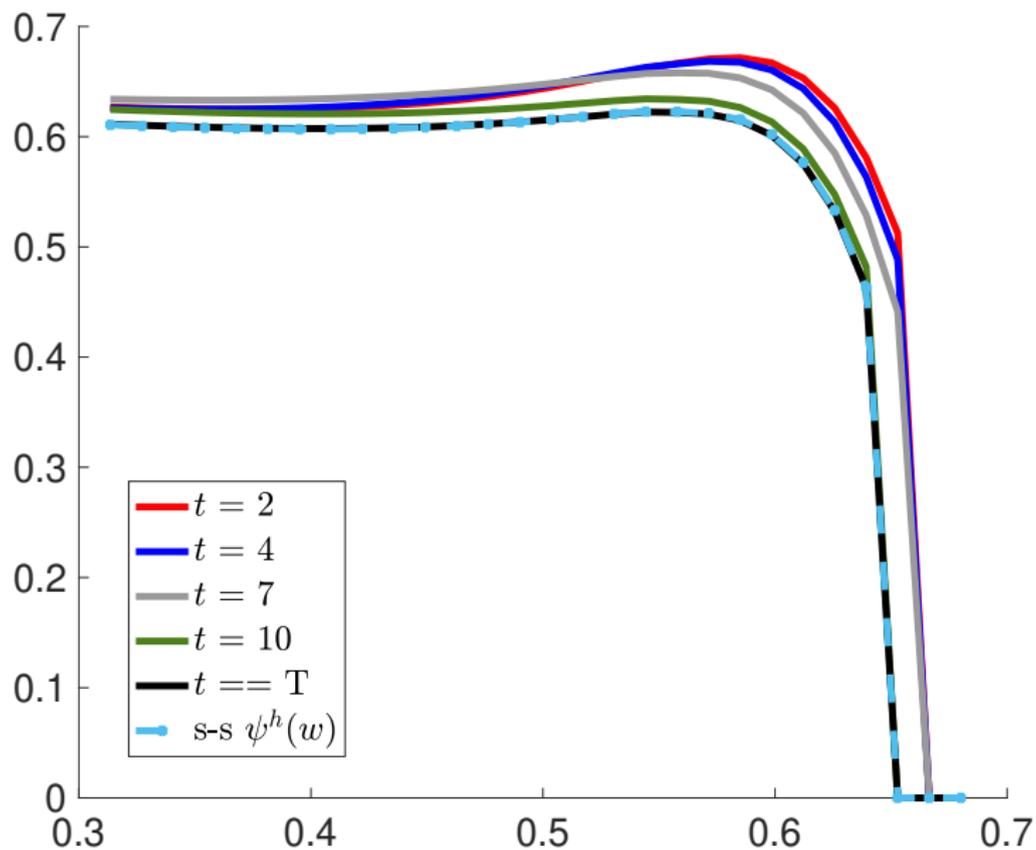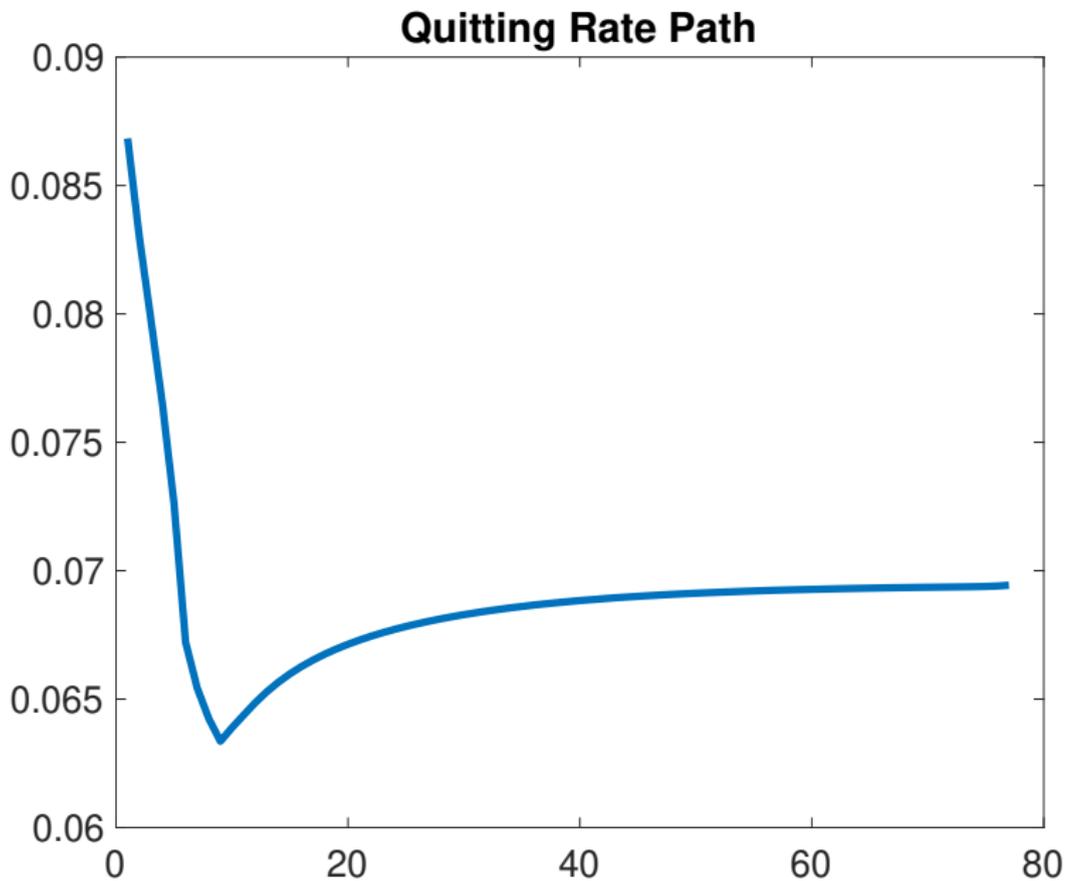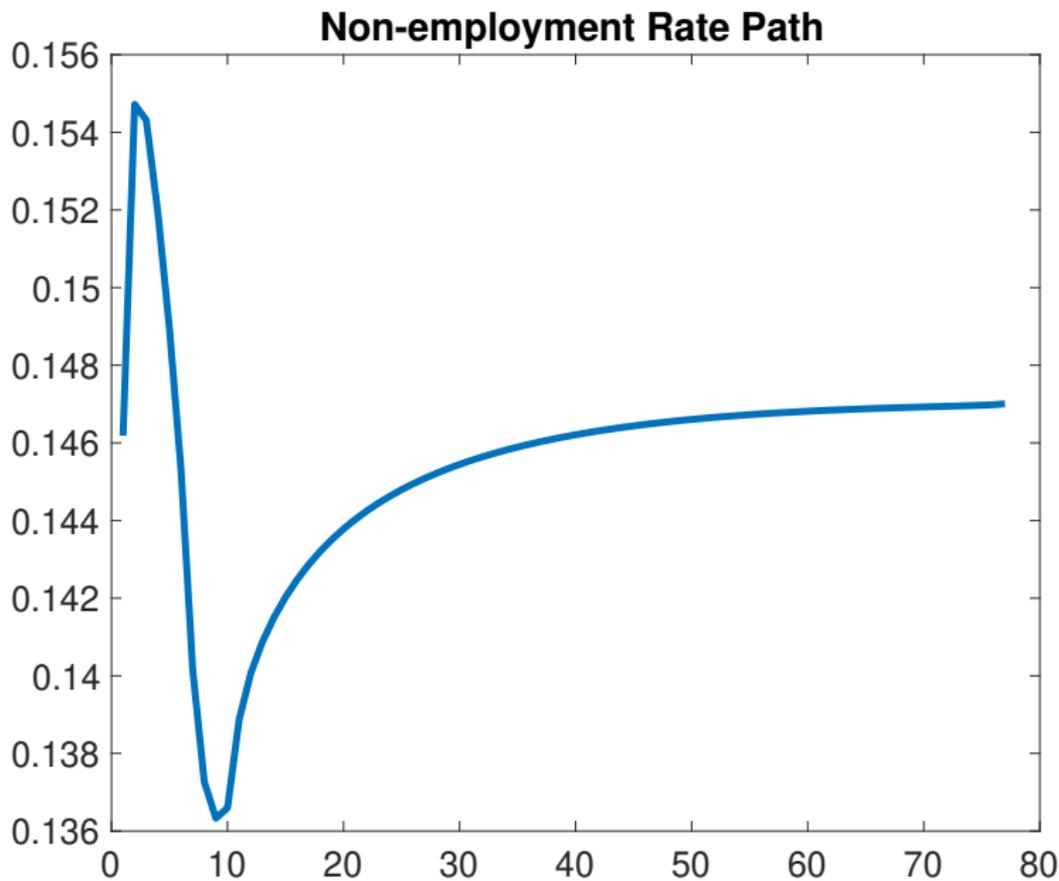
Business Cycle Behavior of On the Job Search

OJS Move Rate Path

Non-employment Rate Path

Non-employment Rate Path
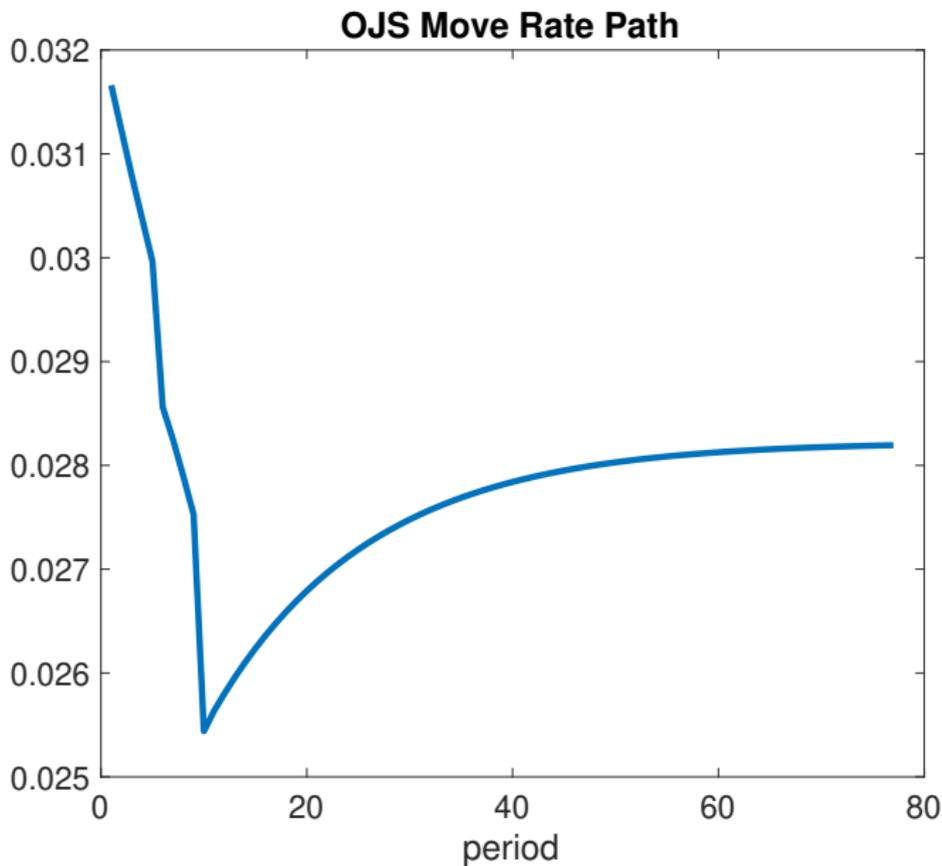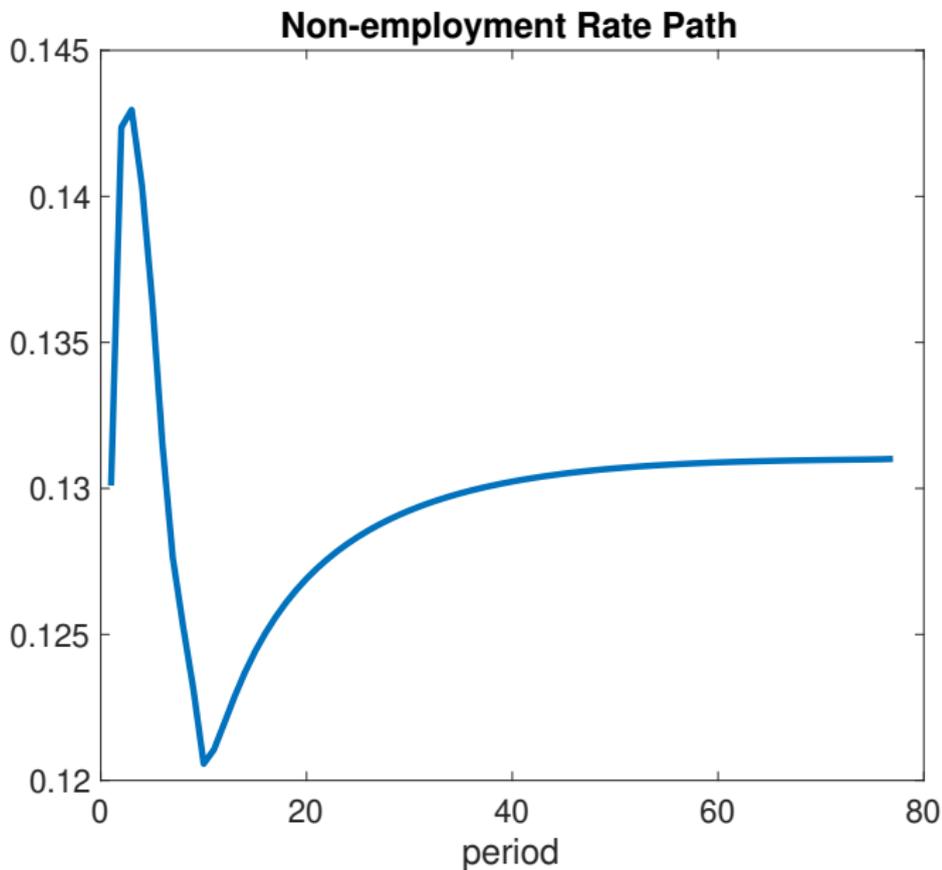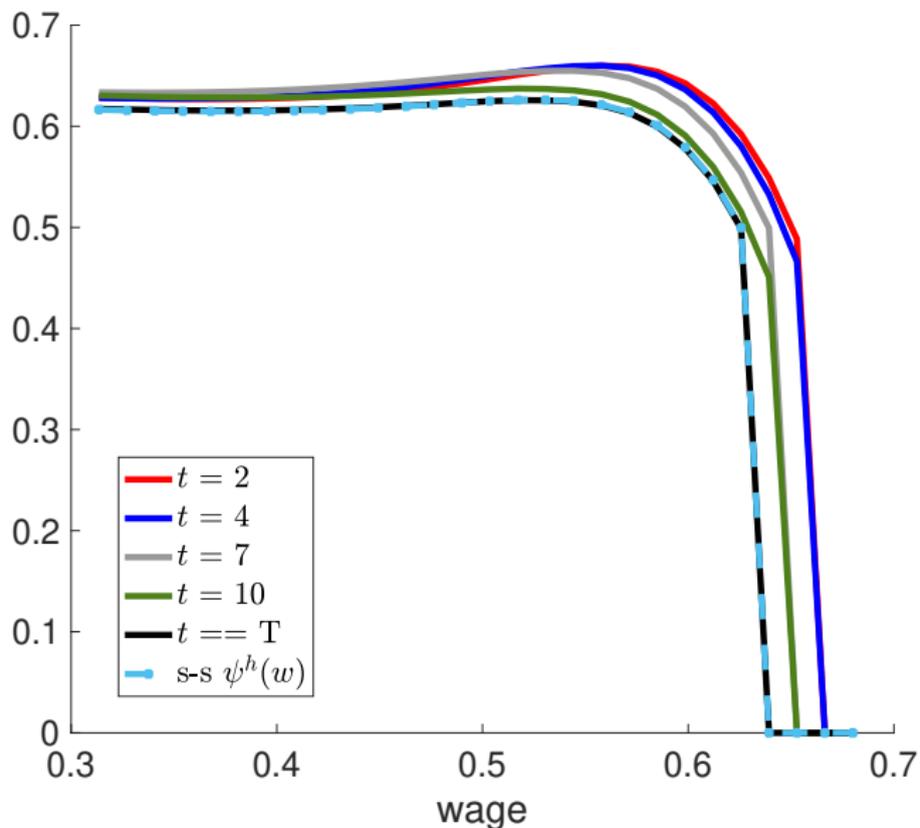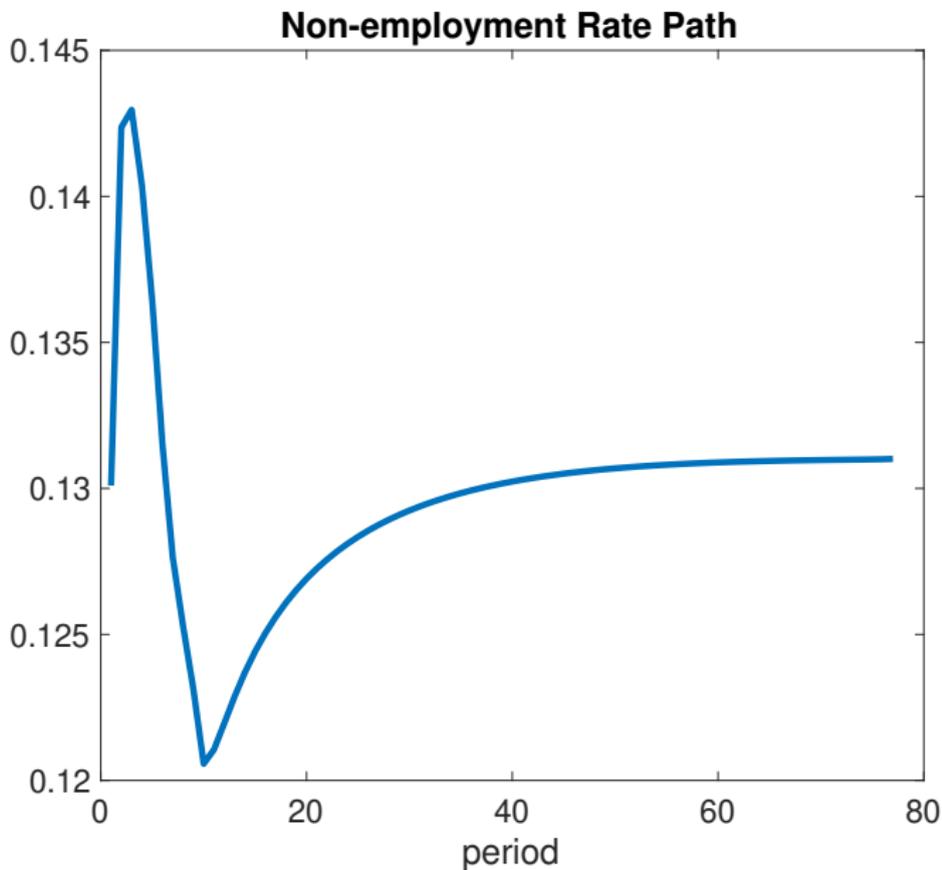
- Switches are Procyclical

- Average wages don't move much but wages of new workers do!

- Newly hired Wage Distribution Shifts upward

- Quits are procyclical but excessive

- But Employment moves down!!! (Excessive Quitting)

Conclusions

- Develop tools to get a joint theory of wages, employment and wealth that marry the two main branches of modern macro:
  1. Aiyagari models (output, consumption, investment, interest rates)
  2. Labor search models with job creation, turnover, wage determination, flows between employment, unemployment and outside the labor force.
  3. Add tools from Empirical Micro to soften wage-wealth correlations.

- Useful for business cycle analysis: We are getting procyclical
  - Quits
  - Employment after a lag
  - Investment and Consumption

- Exciting set of continuation projects:
  - Efficiency Wages, Endogenous Productivity (firms use different technologies with different costs of idleness)
  - Move towards more sophisticated life cycle movements that account for levels of labor market engagement.

References

Aiyagari, S. Rao. 1994. "Uninsured Idiosyncratic Risk and Aggregate Saving." *Quarterly Journal of Economics* 109 (3):659–684.

Boppart, Timo, Per Krusell, and Kurt Mitman. 2018. "Exploiting MIT shocks in heterogeneous-agent economies: the impulse response as a numerical derivative." *Journal of Economic Dynamics and Control* 89 (C):68–92. URL https://ideas.repec.org/a/eee/dyncon/v89y2018icp68-92.html.

Chaumont, Gaston and Shouyong Shi. 2017. "Wealth Accumulation, On the Job Search and Inequality." Https://ideas.repec.org/p/red/sed017/128.html.

Den Haan, Wouter, Pontus Rendahl, and Markus Riegler. 2015. "Unemployment (Fears) and Deflationary Spirals." CEPR Discussion Papers 10814, C.E.P.R. Discussion Papers. URL https://ideas.repec.org/p/cpr/ceprdp/10814.html.

Eeckhout, Jan and Alireza Sepahsalari. 2015. "Unemployment Risk and the Distribution of Assets." Unpublished Manuscript, UCL.

Griffy, Benjamin. 2017. "Borrowing Constraints, Search, and Life-Cycle Inequality." Unpublished Manuscript, UC Santa Barbara.

Hornstein, Andreas, Per Krusell, and Gianluca Violante. 2011. "Frictional Wage Dispersion in Search Models: A Quantitative Assessment." *American Economic Review* 101 (7):2873–2898.

Krusell, Per, Toshihiko Mukoyama, and Ayşegul Şahin. 2010. "Labour-Market Matching with Precautionary Savings and Aggregate Fluctuations." *Review of Economic Studies* 77 (4):1477–1507. URL https://ideas.repec.org/a/oup/restud/v77y2010i4p1477-1507.html.

Lise, Jeremy. 2013. "On-the-Job Search and Precautionary Savings." *The Review of Economic Studies* 80 (3):1086–1113. URL +http://dx.doi.org/10.1093/restud/rds042.

Moen, Espen R. 1997. "Competitive Search Equilibrium." *Journal of Political Economy* 105 (2):385–411.

Ravn, Morten O. and Vincent Sterk. 2016. "Macroeconomic Fluctuations with HANK & SAM: An Analytical Approach." Discussion Papers 1633, Centre for Macroeconomics (CFM). URL https://ideas.repec.org/p/cfm/wpaper/1633.html.

———. 2017. "Job uncertainty and deep recessions." *Journal of Monetary Economics* 90 (C):125–141. URL https://ideas.repec.org/a/eee/moneco/v90y2017icp125-141.html.