Course in Heterogeneity: Econ 081

VI: Wealth, Wages, and Employment

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Based on joint work with Per Krusell and Jinfeng Luo

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  - Business cycles can be studied. In particular, we want to study employment flows jointly with the other standard objects.
- The most sophisticated version compares well with fluctuations data.

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- Developing empirically sound versions of these ideas compels us to
  - Add extreme value shocks as a form of accommodating quits and on the job search as choices.
  - Use new potent tools to address the study of fluctuations in complicated economies Boppart, Krusell, and Mitman (2018)

What are the uses?

- The study of Business cycles including gross flows in and out of employment, unemployment and outside the labor force
- Policy analysis where now risk, employment, wealth (including its distribution) and wages are all responsive to policy.
- Get some insights into the extent of wage rigidity
- Life-Cycle versions of these ideas (under construction) will allow us to assess how age dependent policies fare.

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tions from two types of shocks

1. No Quits: Exogenous Destruction, no Quits. Built on top of Growth Model. (GE version of Eeckhout and Sepahsalari (2015)): Not a lot of wage dispersion. Not a lot of job creation in expansions.

- Employers commit both to either a wage or a wage schedule $w(z)$ that depends on the aggregate shock.

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5. All of the Above

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- With partial wage rigidity the model fares reasonably well with the data. A few things still to improve. (Excessive Job-to-JOB transitions)
- Similar behavior to that in the Shimer/Hagedorn-Manowski debate. Here we can try to move towards an accommodation of both points of view.

Relevant Properties in U.S. Data

	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&Gnocchi (2016)
Annual Quits (All)	10-40	4.20	0.85	Brown et al. (2017)
Annual Switches	25-35	4.62	0.70	Fujita&Nakajima (2016)
Consumption	75	0.78	0.86	NIPA
Investment	25	4.88	0.90	NIPA

2 Model 1: No (Endogenous) Quits Model

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- General equilibrium: Workers own firms.

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   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.

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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 $\psi^h(\theta) = \frac{M(V,U)}{U}$, $\psi^f(\theta) = \frac{M(V,U)}{V}$.

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  - If unemployed: (a)
- Problem of the employed: (Standard)

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

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

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- 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

Firms Post vacancies: Choose wages & filling probabilities

- Value of wage-w job: uses constant $\overline{k}$ capital that depreciates at rate δ^k ($\Omega = \overline{k}$)

$$\Omega(w) = z - \overline{k}\delta^k - w + \frac{1-\delta^f}{1+r}\left[(1-\delta^h)\,\Omega(w) + \delta^h\,\Omega\right]$$

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Block Recursivity Applies (firms can be ignorant of Eq)

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- Value of creating a firm: $\psi^f[\theta(w)]\;\;\Omega(w) + [1-\psi^f[\theta(w)]]\;\Omega$

- Free entry condition requires that for all offered wages

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

No (Endog) Quits 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.

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  3. An interest rate r clears the asset market

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

Characterization of a worker's decisions

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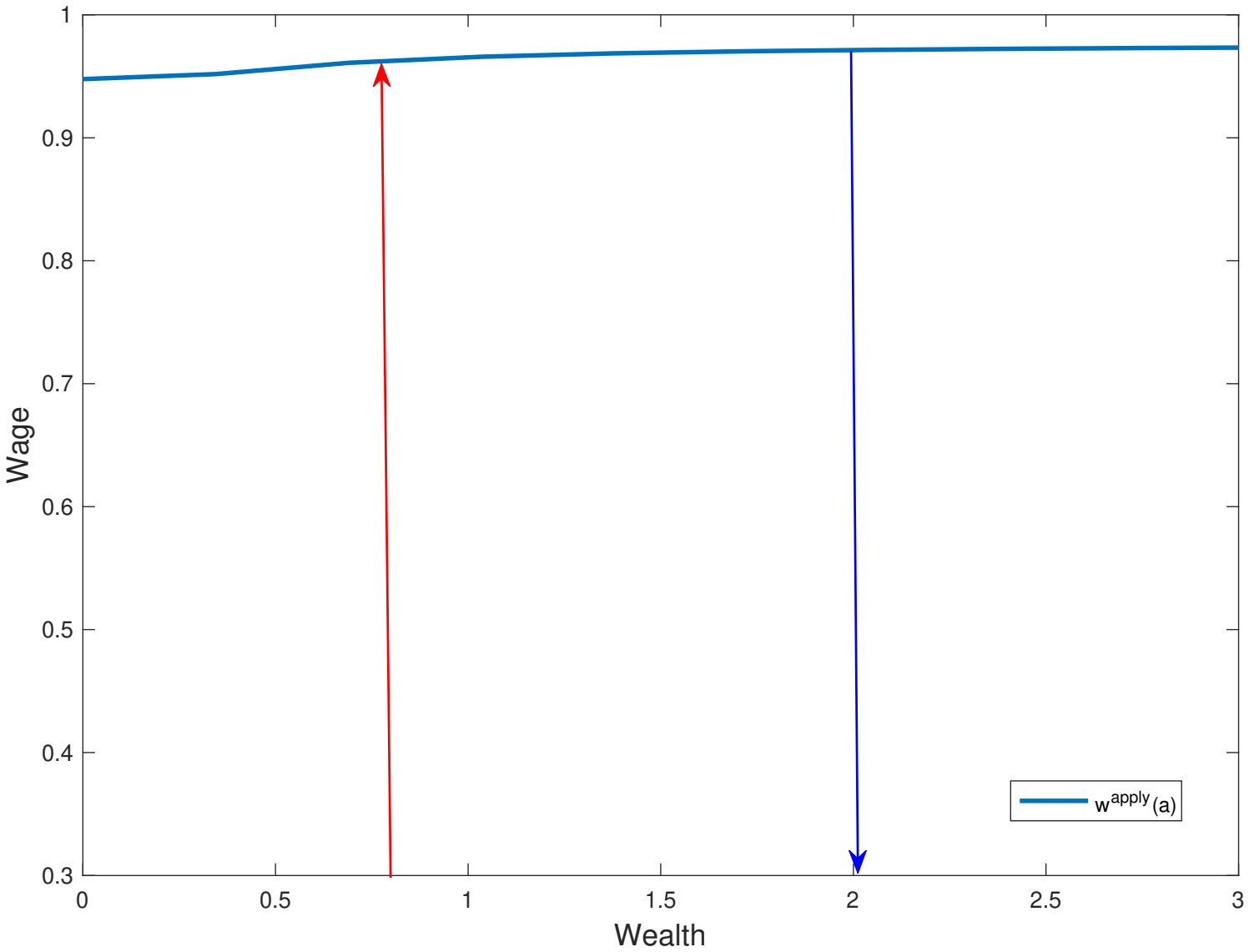
- Households with more wealth are able to insure better against unemployment risk.

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

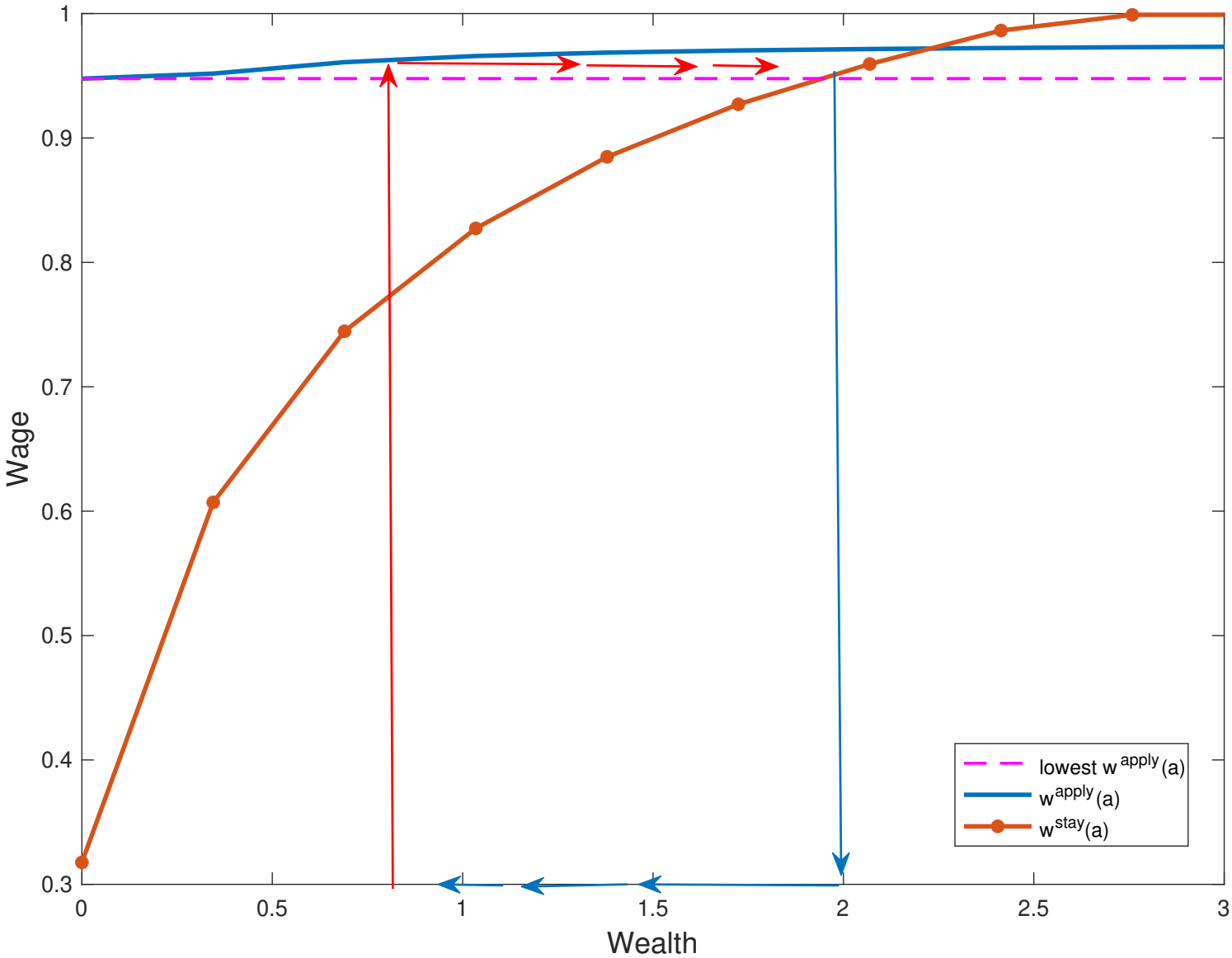
How does the Model Work

Worker's wage application decision



How does the Model Work

Worker's saving decision



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- Low unemployment volatility

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

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   - iii Policy such as UI would both have insurance and incentive effects
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   - v $\cdots$ so almost like two-agent model (employed, unemployed) of Pissarides despite curved utility and savings

2. In the following we examine the implications of a quitting choice

3 Endogenous Quits

Endogenous Quits: Beauty of Extreme Value Shocks

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- Conditional on wealth, high wage workers quit less often.
- But Selection (correlation 1 between wage and wealth when hired) makes wealth trump wages and those with higher wages have higher wealth which makes them quite more often: Wage inequality collapses.
- We end up with a model with little wage dispersion but with endogenous quits that respond to the cycle.

Quitting Model: Time-line

1. Workers enter 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.
   - u draw shocks $\{\epsilon_1^u, \epsilon_2^u\}$. No decision but same expected means.

5. Search: New or Idle firms post vacancies. Choose $\{w, \theta\}$.
   Wealth is not observable. (Unlike Chaumont and Shi (2017)).
   Yet it is still Block Recursive

6. Matches occur

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

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

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

Quitting Model: Workers Problem

- 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 except that there is an added term $E\{\max[\epsilon_1^u, \epsilon_2^u]\}$

So that there is no additional option value to a job.

Quitting Model: Value of the firm

- $\Omega^j(w)$: Value with with j-tenured worker.
  Free entry condition requires that for all offered wages

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

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- Probability of retaining a worker with tenure j at wage w is $\ell^j(w)$.
  (One to one mapping between wealth and tenure)

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- Firm's value

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

Quitting Model: Solving forward for the Value of the firm

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

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

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- New equilibrium objects $\{Q^0(w), Q^1(w)\}$. Rest is unchanged.
- It is Block Recursive because wealth can be inferred from w and j. (No need to index contracts by wealth (as in Chaumont and Shi (2017))).

Do we get More Wage Dispersion?

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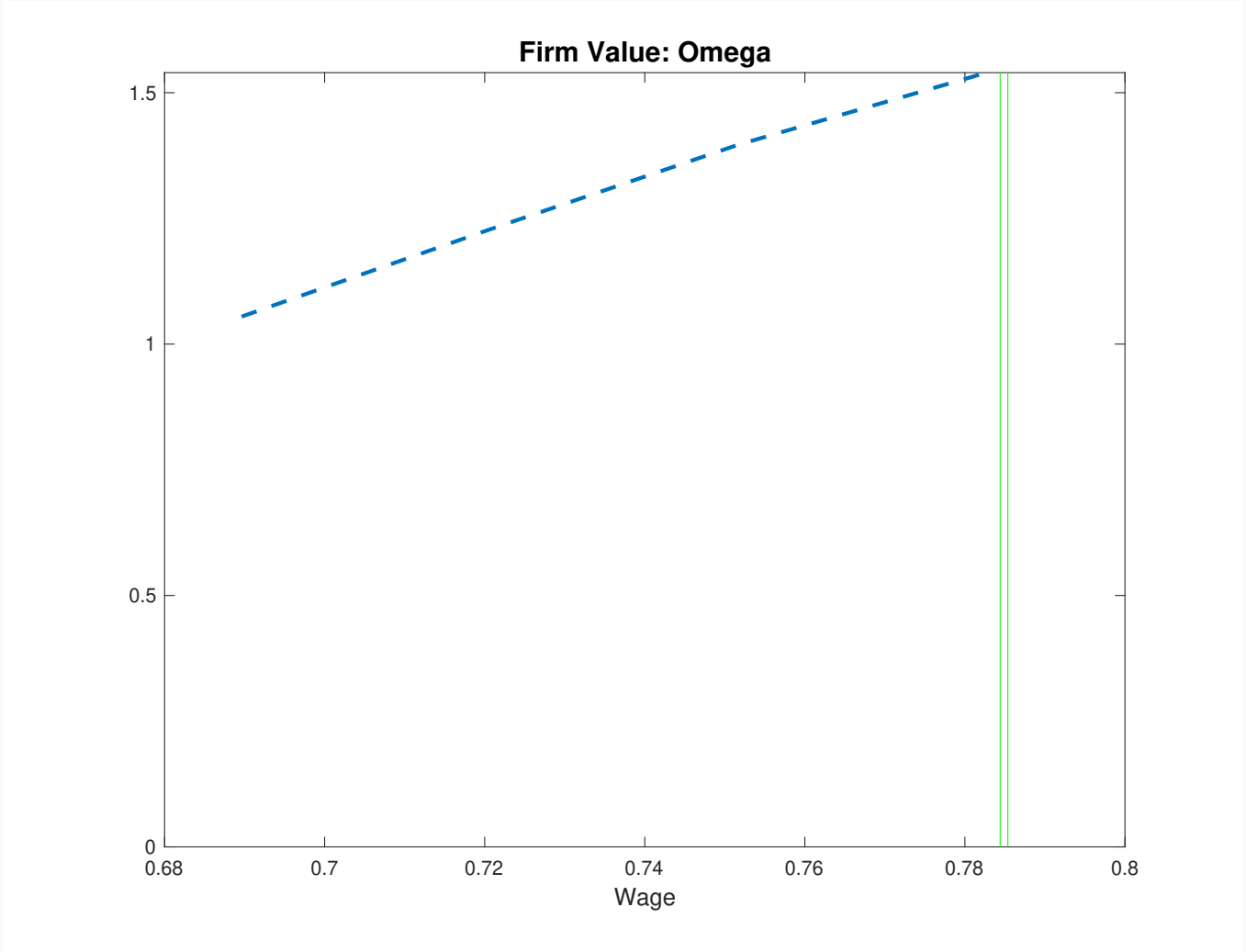
- **BUT** we will see a problem

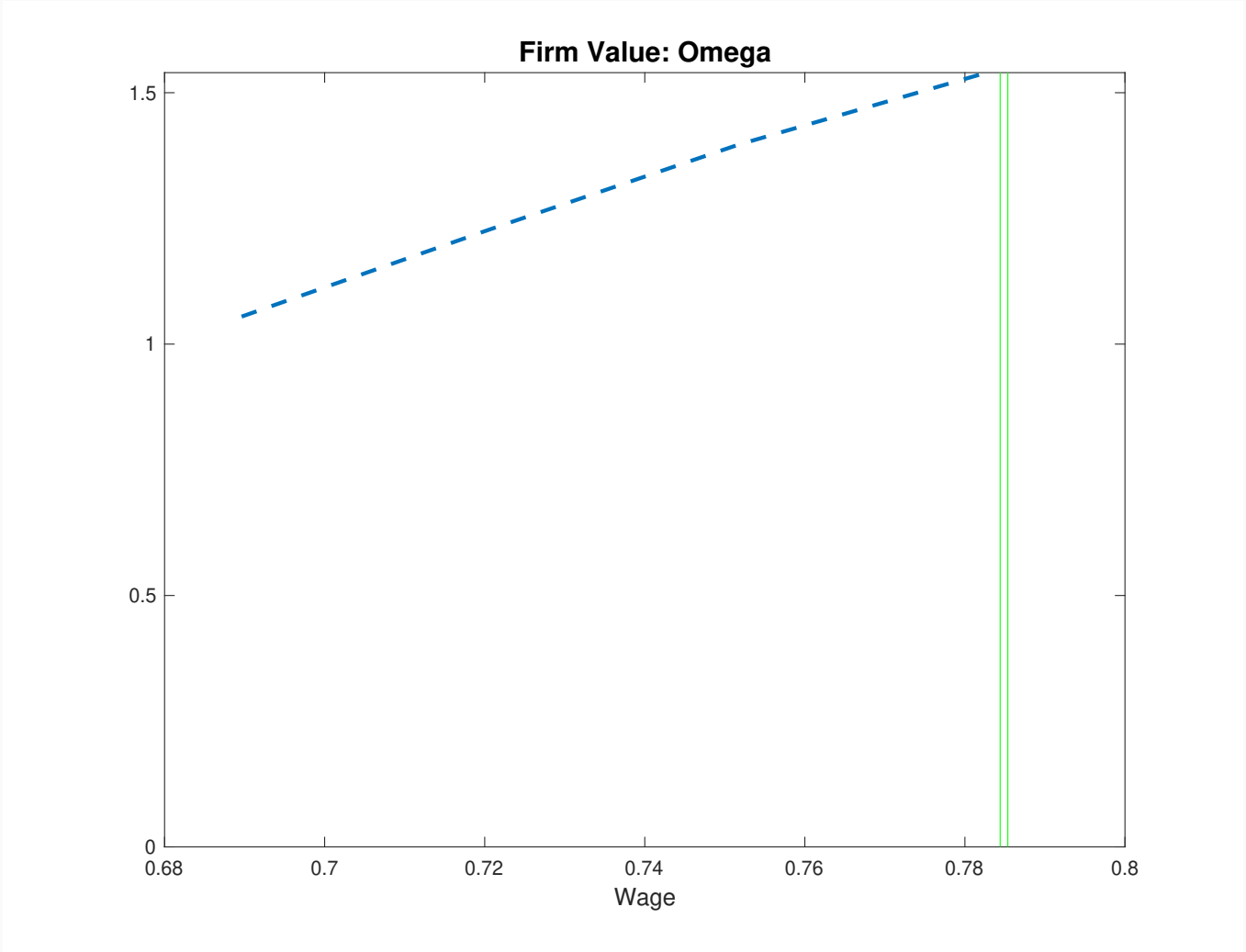
Value of the firm as wage varies: The Poor

- For the poorest, employment duration increases when wage goes up.



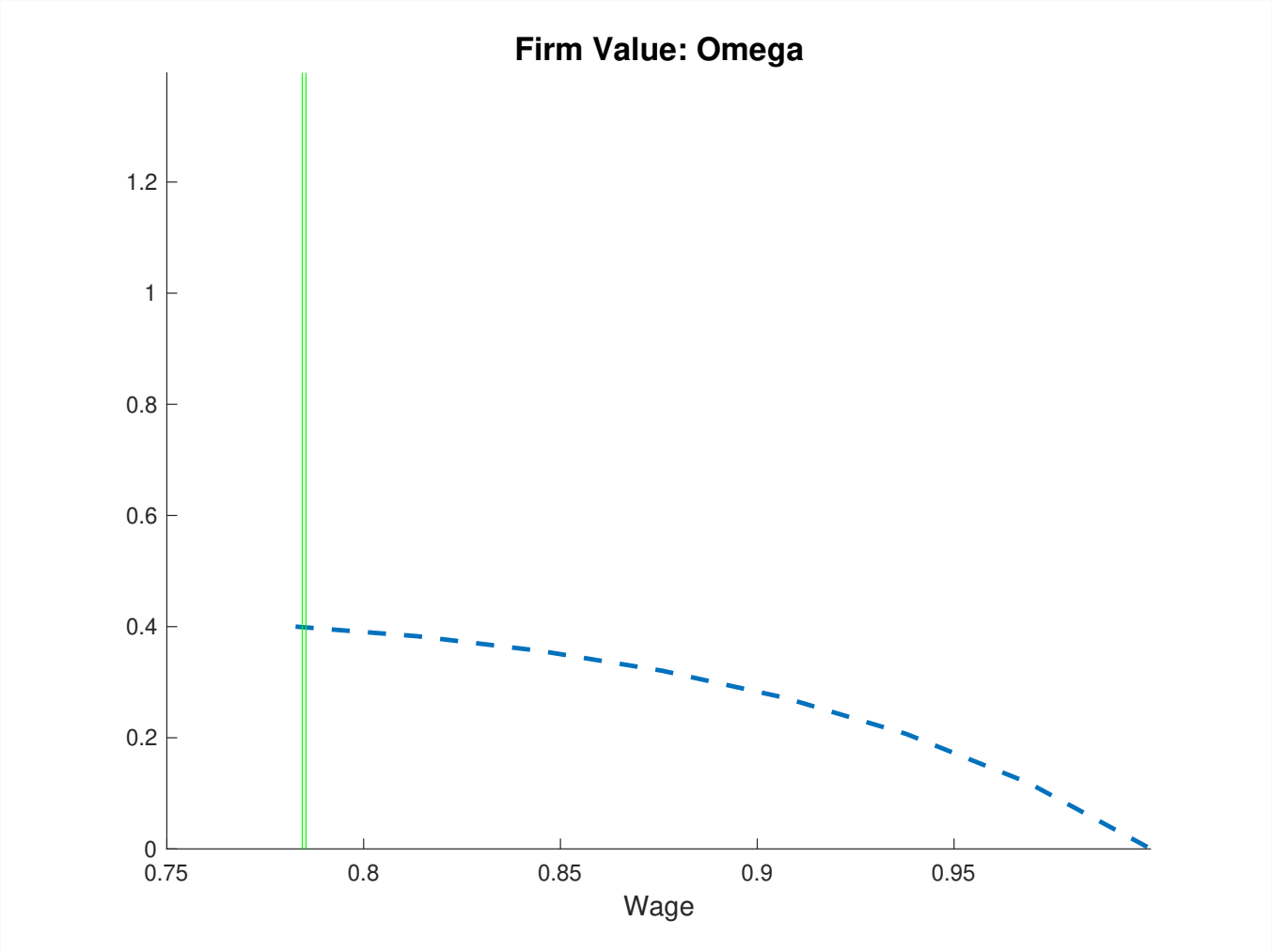
Value of the firm as wage varies: The Poor

- For the poorest, employment duration increases when wage goes up.
- Firms value is increasing in the wage



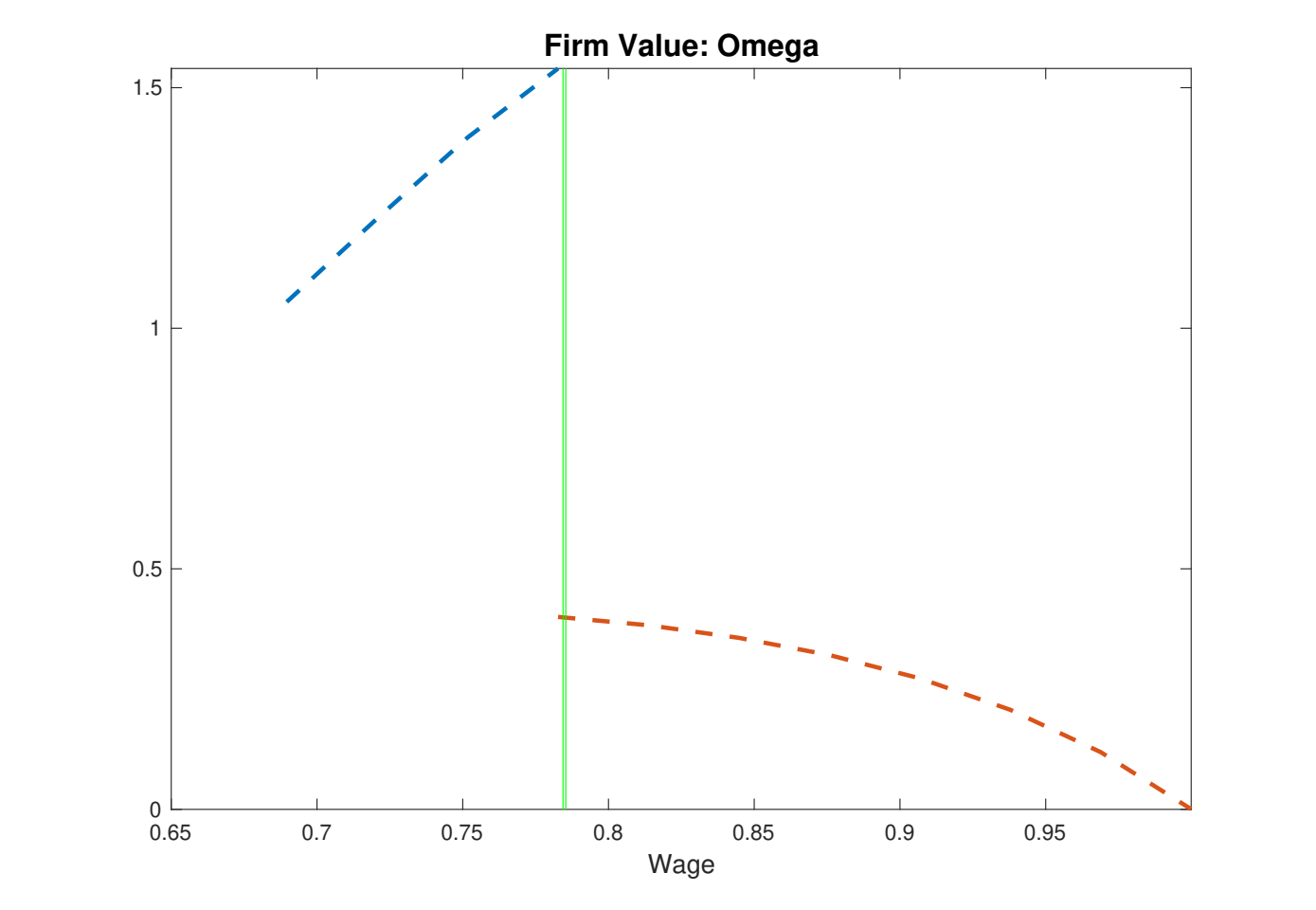
Value of the firm as wage varies: The Rich

- For the richest, employment duration increases but not fast enough.
- Firm value is slowly decreasing in wages (less than static profits).



Value of the firm: Accounting for Worker Selection

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



- Related to the Diamond dispersion paradox but for very different reasons.

Effect of Quitting: The Mechanism

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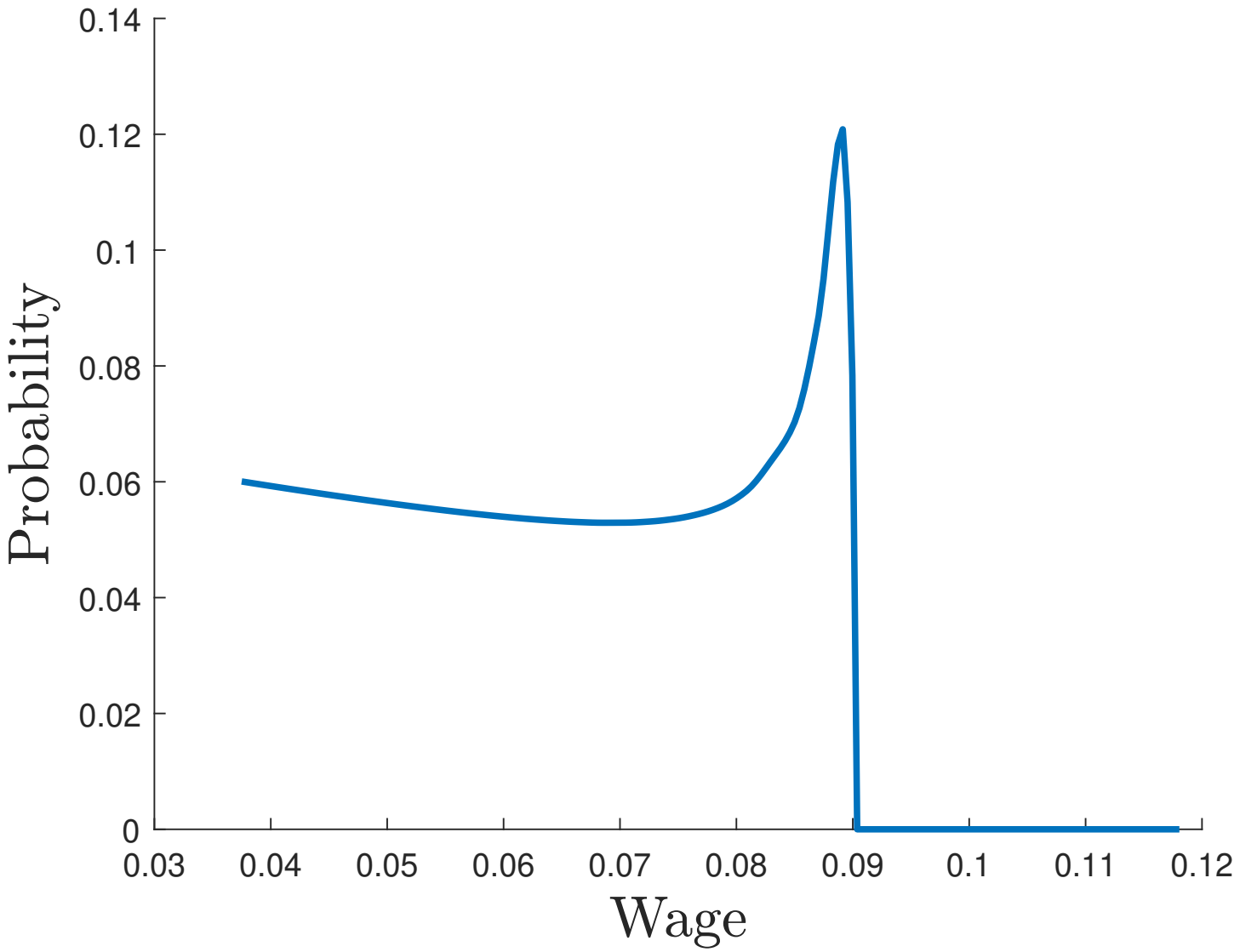
    - However, by paying higher wages, firms attract workers with more wealth.
- Wealthy people quit more often, shrink employment duration.
- In equilibrium, the wage gap is narrow (disappears?) and the effect of wealth dominates.

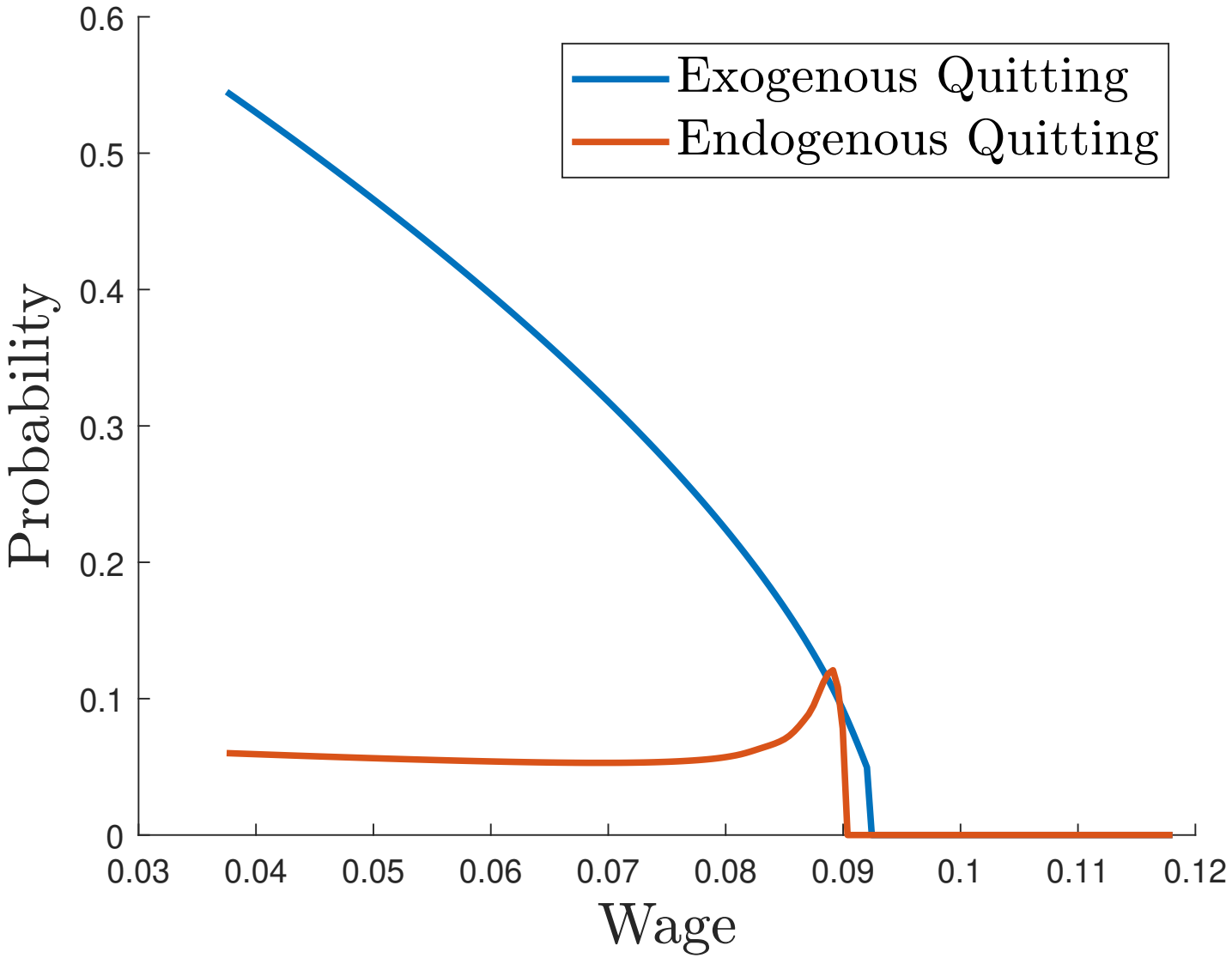
Value of the firm: Zero profit Job Finding Probability

- Increasing in Wage (up to Grid calculation): Unique wage.



Quitting Makes a Big Difference

- Job finding prob with Endo



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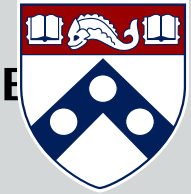
- Correlation 1 between Wealth when starting to work and wage

A Detour on How to Improve the Correlation Between We and Wages



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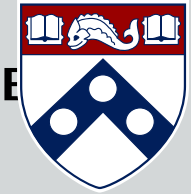

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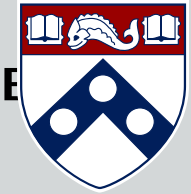

- Pose *aiming* (extreme value) shocks).
- This reduces the correlation between wages and wealth when first hired.
- It will have many uses, we think.

4 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

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

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

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- The value of searching is

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

On the Job Search: Household choices

- 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.

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$\mu^s < 0$ 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

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

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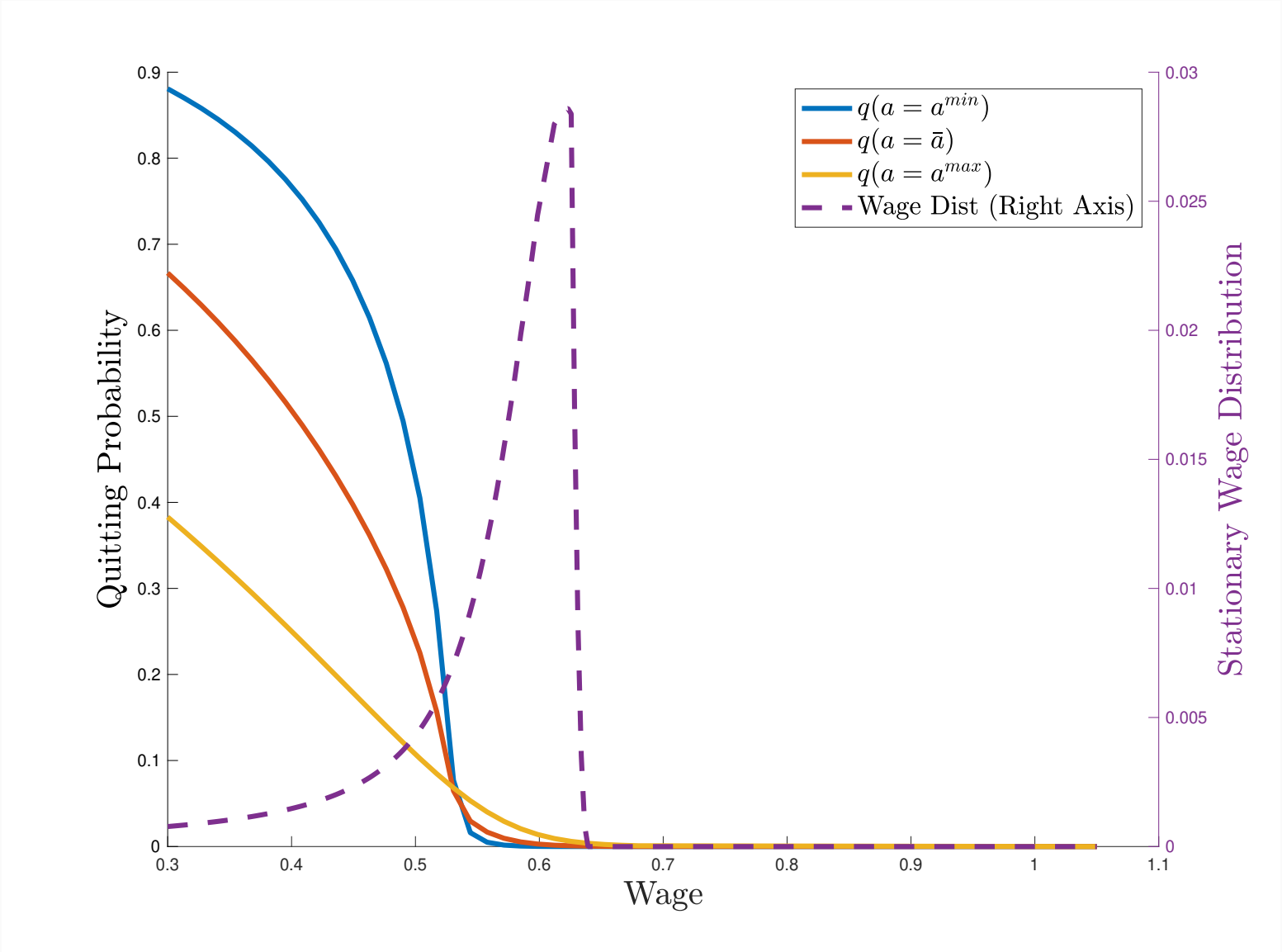
- Except that now the probability of keeping a worker after j periods is

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

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

OJS Quitting Probabilities, Various wealths & Wage Densi



- The rich pursue often other activities (leisure?)

5 Outside the Labor Force

Outside the Labor Force Model: Time-line

1. Workers enter period with or without a job: V^e, V^u.
2. 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.
3. Production & Consumption:
4. Exogenous Separation
5. Quitting? Searching? Neither?:
6. Search
7. $\widehat{V}^u(a'), \{\Omega^j(w)\}$ are determined with respect to this stage.
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Various Economies with added Life Cycle (live 50 years)

- Provides a mechanism for having poor agents

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  4. Endogenous Quitting and On-the-job Search

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  5. ... and some agents do not want to work
- Today we will only look at the Economy with Endogenous quitting and On-the-Job-Search (4)

6 Quantitative Analysis: Steady States

Parameter Values

Definition	Value in Yearly Units

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y	productivity on the job	1

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c^v	job posting cost	0.03
y	productivity on the job	1
b/w	productivity at home	0.4

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δ^f	firm destruction rate	2.88%
δ^k	capital maintenance rate	6.38%
δ^h	total worker quitting rate	8.56%
c^v	job posting cost	0.03
y	productivity on the job	1
b/w	productivity at home	0.4
σ	risk aversion	2

Parameter Values

	Definition	Value in Yearly Units
r	interest rate	3%
K	fixed capital required	3
δ^f	firm destruction rate	2.88%
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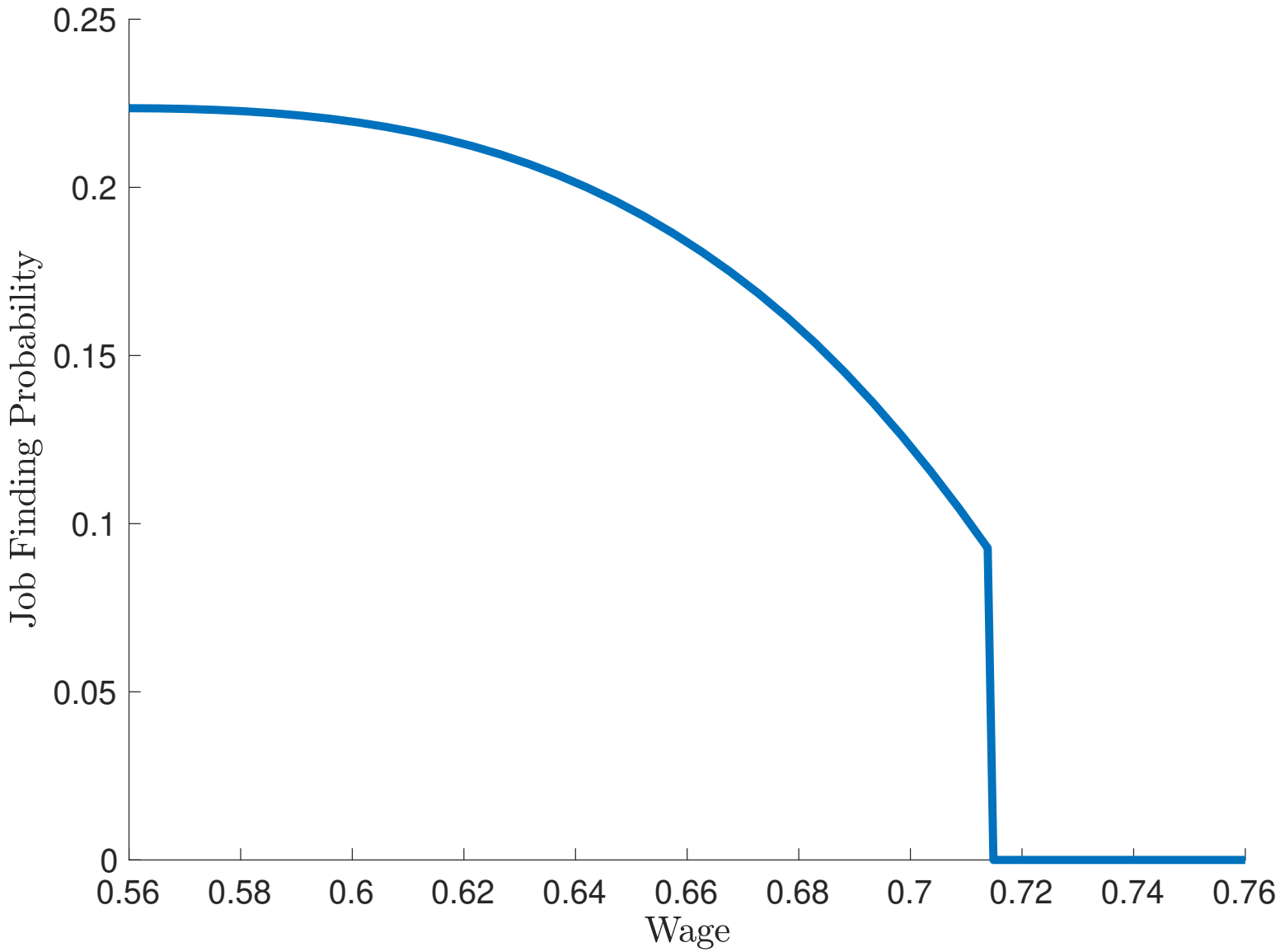
• We also explore a lower on the job search economy ()high value of leisure economy $b/w \sim 0.75$

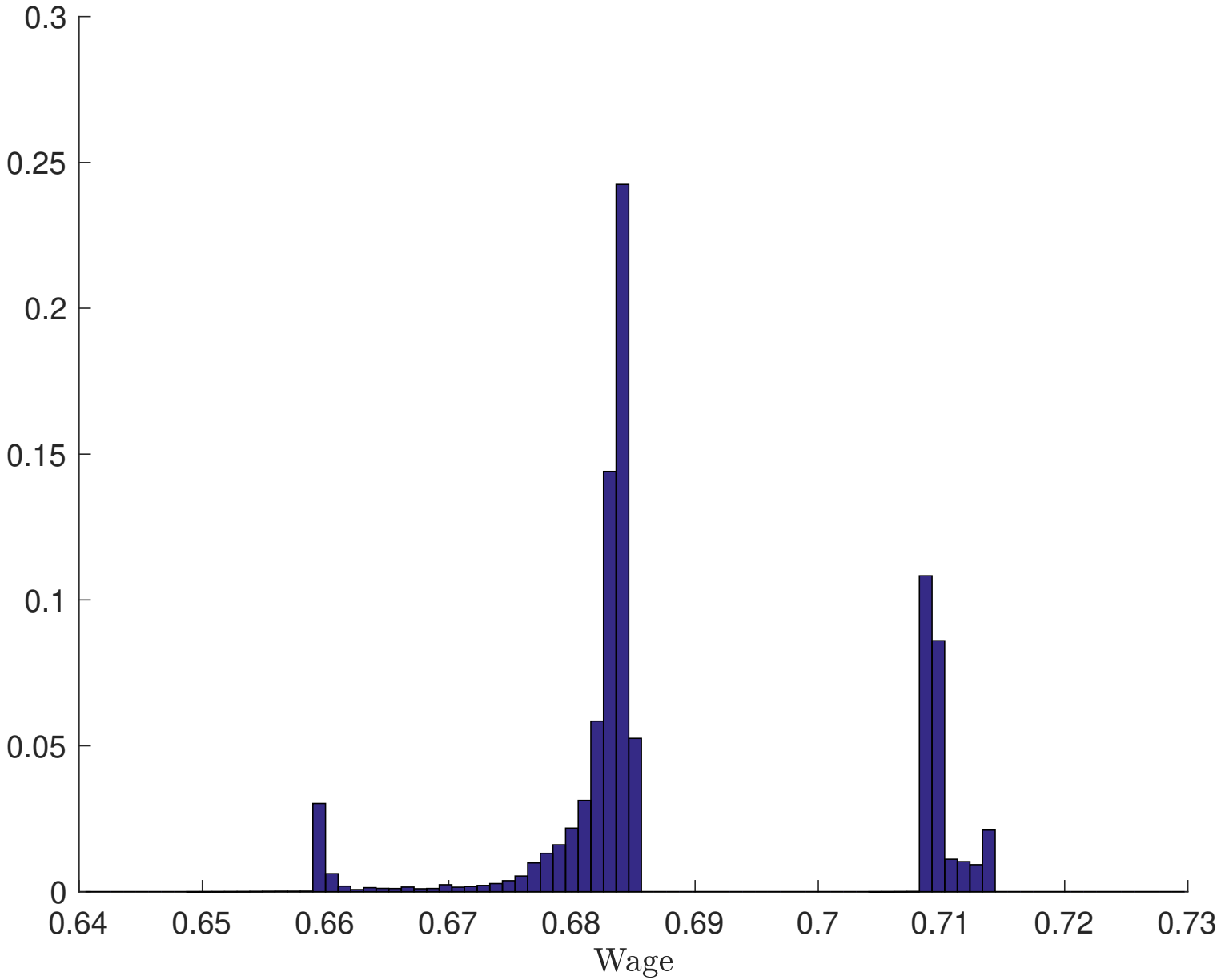
Steady State Allocations in Yearly Units: Endog Quits & C

interest rate	0.030
avg consumption	0.651
avg wage	0.689
avg wealth	3.041
stock market value	2.953
avg labor income	0.654
consumption to wealth ratio	0.225
labor income to wealth ratio	0.215
quit ratio	0.090
unemployment rate	0.097
job losers	0.117
wage of newly hired unemp	0.677
std consumption	0.011
std wage	0.002
std wealth	3.606
mean-min consumption	2.051
mean-min wage	1.058
UE transition	0.125
total vacancy	0.578
avg unemp duration	0.773
avg emp duration	7.228
avg job duration	1.898
OJS move rate	0.395

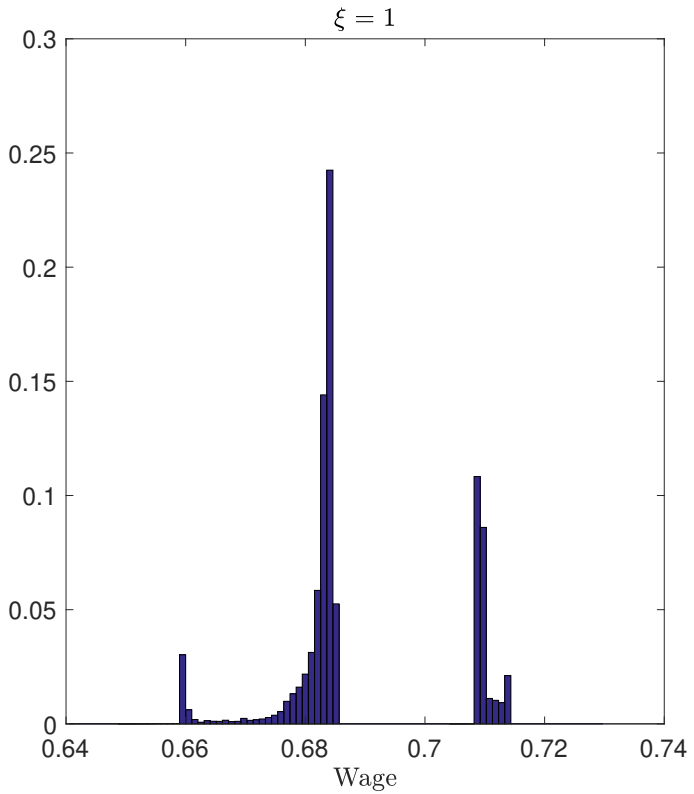
Job Finding Probability Curves

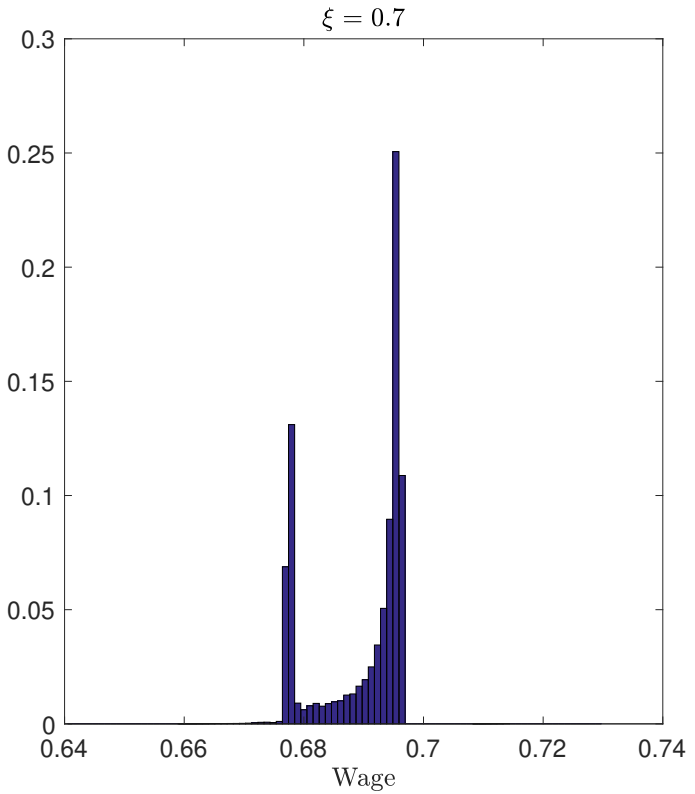


Wage Distributions: Baseline

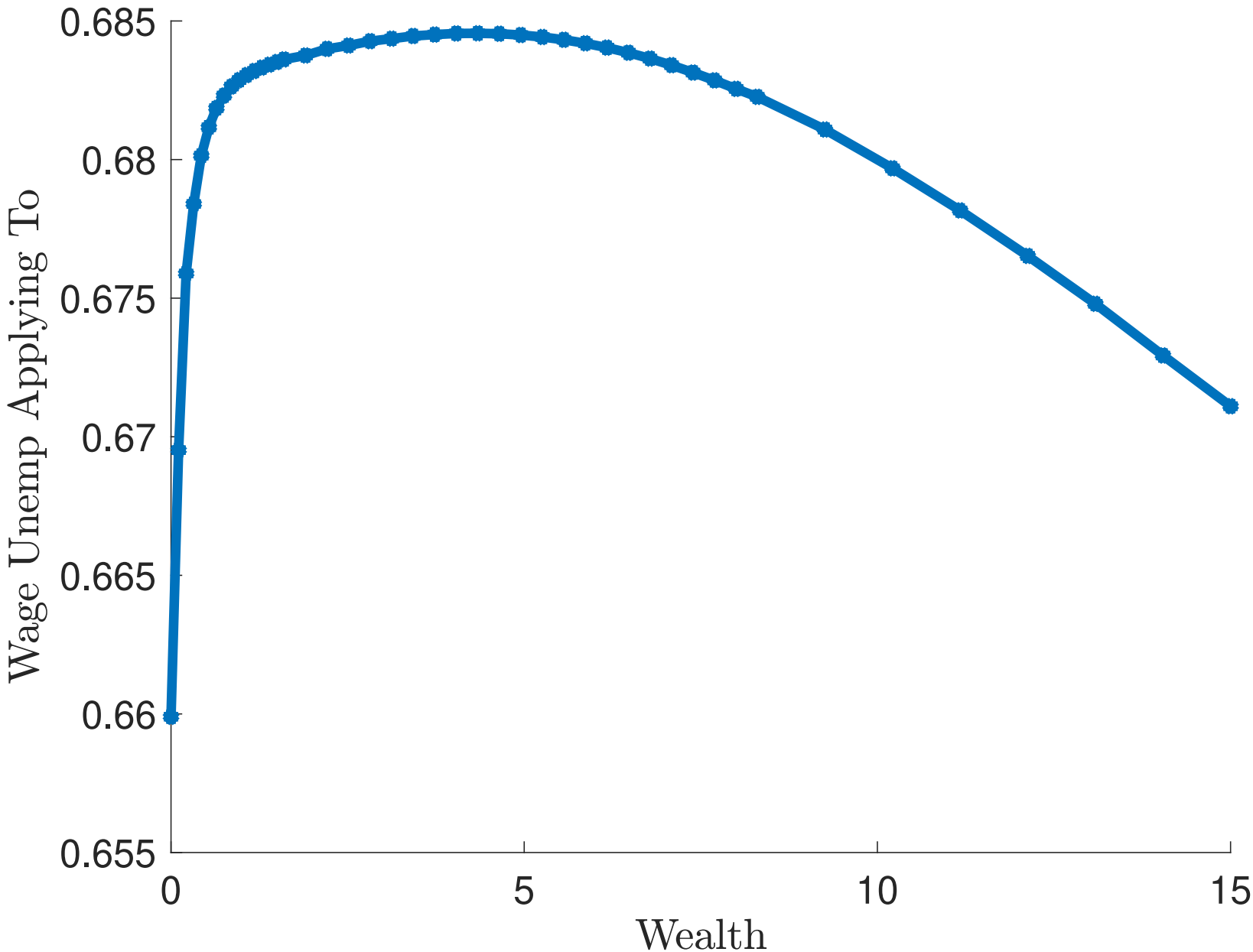


Wage Distributions: Comparing with lower OJS

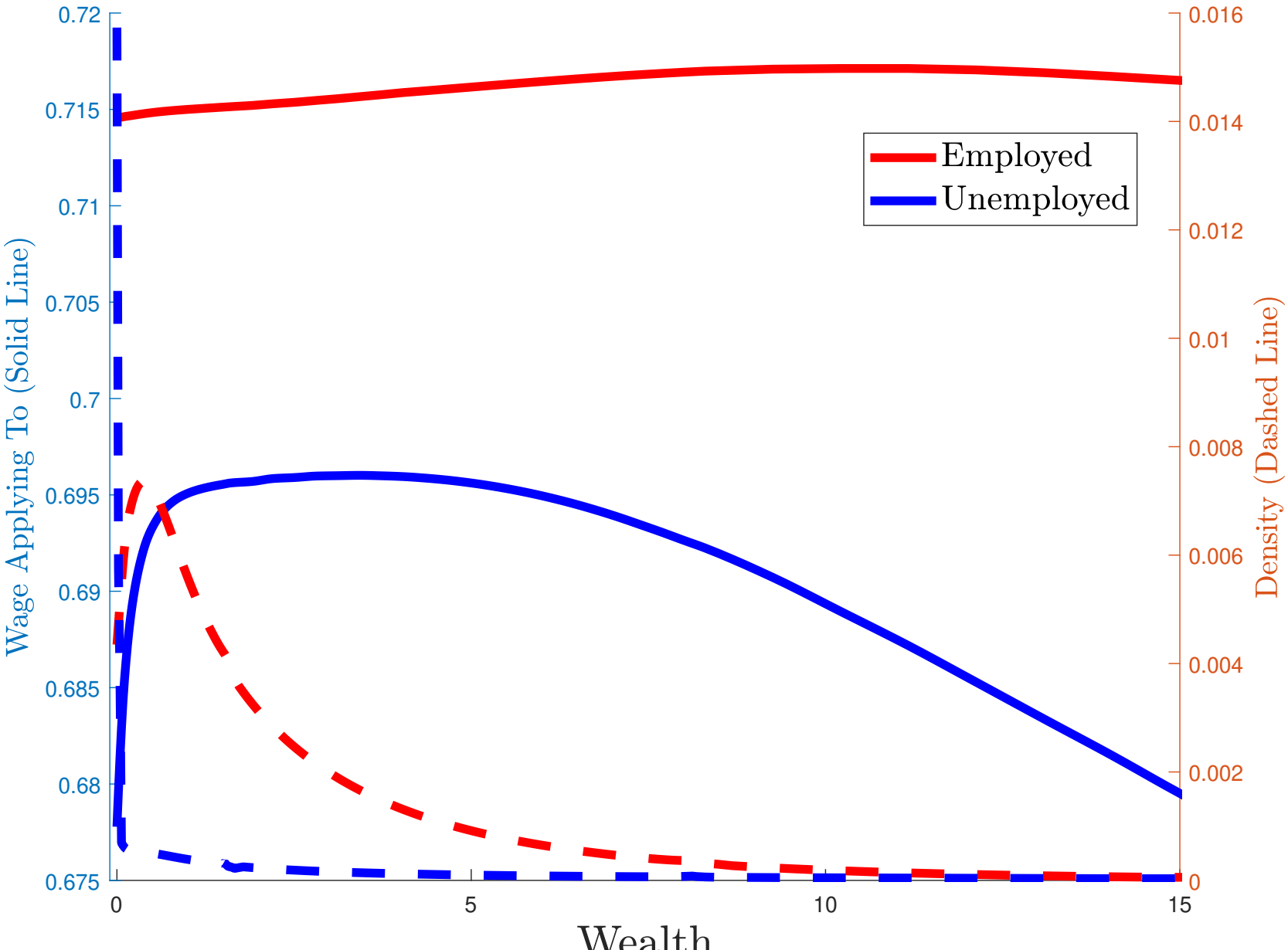




Wage Applications of the Unemployed by Wealth



Wage Applications of U and $\overline{w}$ and densities of all



7 Aggregate Fluctuations

Introduce Aggregate Shocks

- We examine the model responses to two type of shocks

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  1. Productivity shocks z_t: Output = EmpRate $\times$ $(1 + z_t)$

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  - To allow the wage of an already formed job match to respond to z_t shocks directly (by 50%) (but not to d_t shocks)

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  1. Productivity shocks z_t: Output = EmpRate $\times (1 + z_t)$
  2. Firm destruction shocks d_t: Firm Destruction Rate = $\delta^f \times (1 - d_t)$
- We introduce a wage peg assumption:
  - To allow the wage of an already formed job match to respond to z_t shocks directly (by 50%) (but not to d_t shocks)
  - If wages were completely rigid there would be massive quits: counterfactual.

1% Productivity Shock ($\rho = .95$) [IRF]

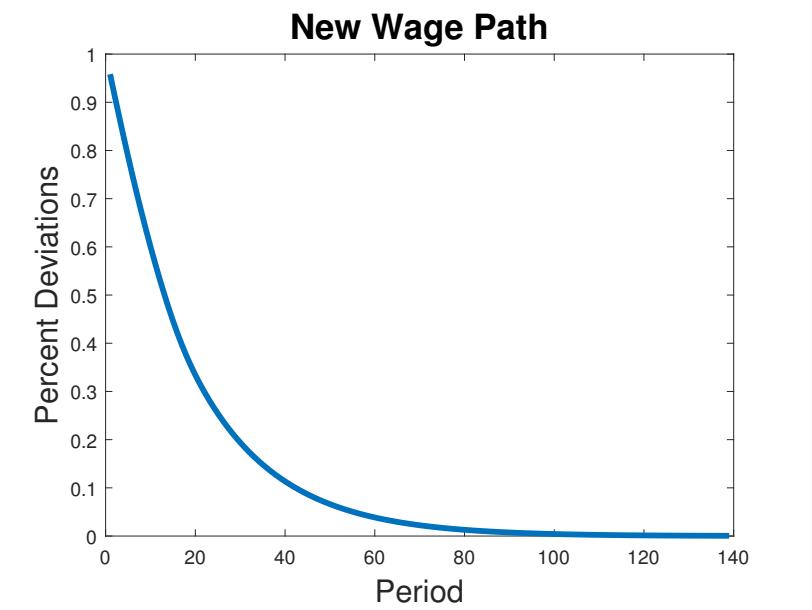

Figure 1: Wages

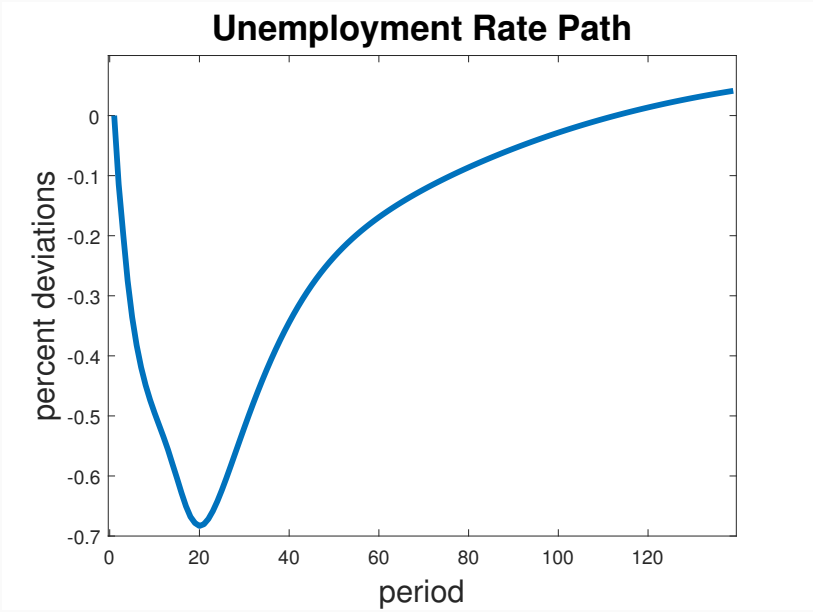

Figure 2: Unemployment Rate

- Non-trivial response of wage and unemployment

1% Productivity Shock ($\rho = .95$) IRF

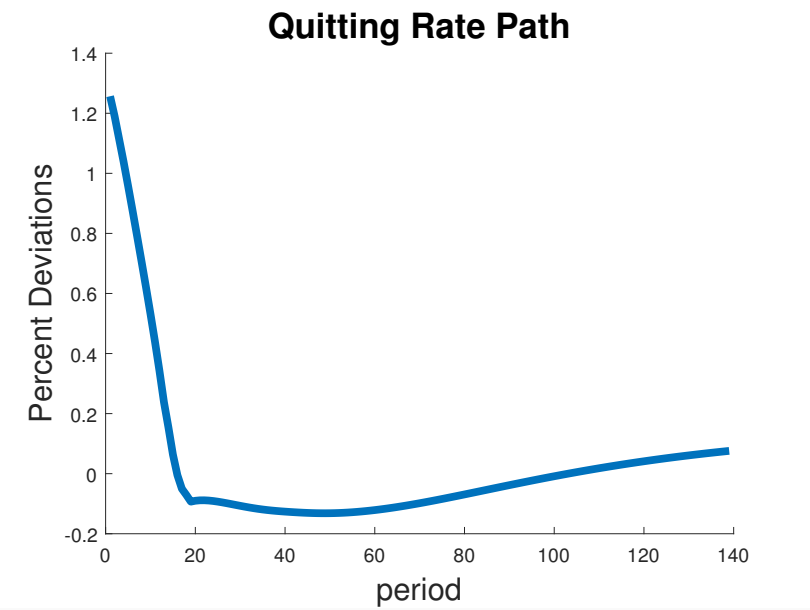

Figure 3: Quits

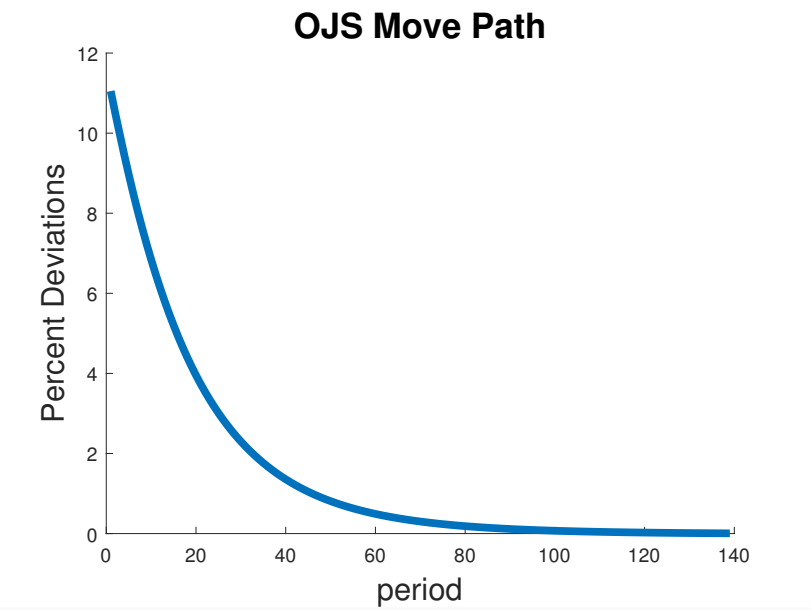

Figure 4: Job-to-job Moves

- Quits are mildly responsive to the shock
- While on-the-job moves are much more responsive: (perhaps too much)

1% Delta Shock ($\rho = .95$)

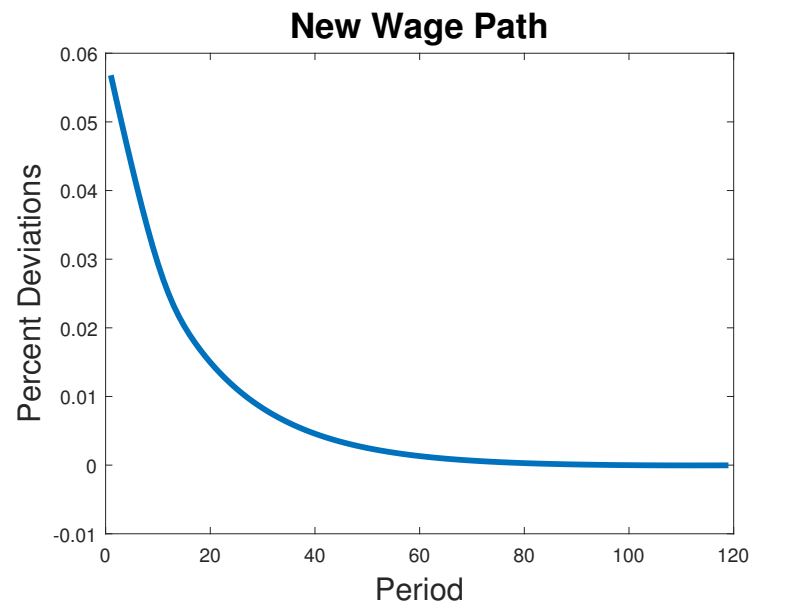

Figure 5: Wages

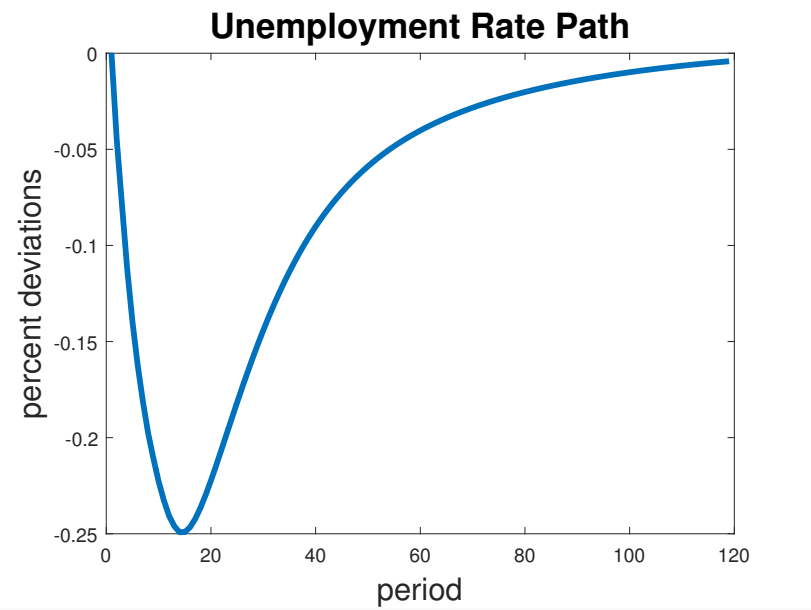

Figure 6: Unemployment Rate

- Again 1% delta shock = 0.36 base points
- Large response of wage and unemployment to the delta shock
- Note wage is not pegged to the delta shock

M4: 1% Delta Shock ($\rho = .95$)

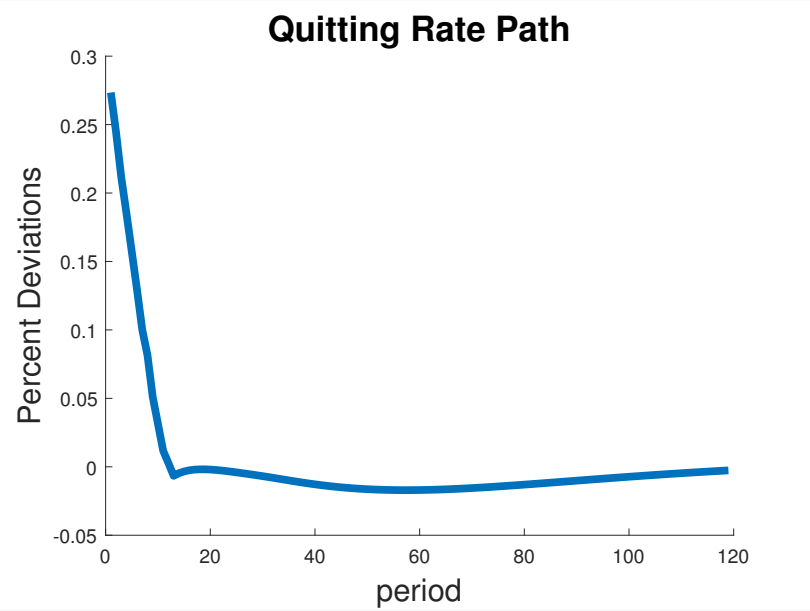

Figure 7: Quits

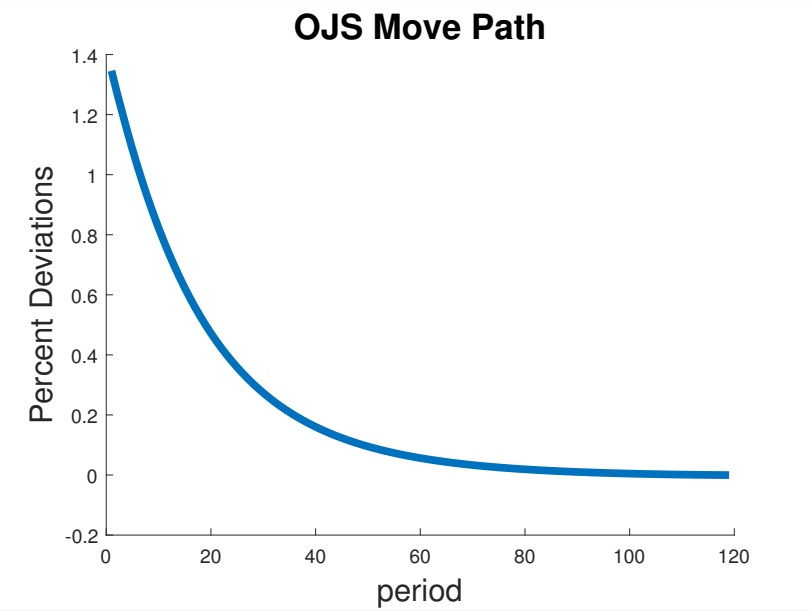

Figure 8: Job-to-job Moves

- But too much volatility for job-to-job transitions relative to output

Summary, On-the-job Search and Quits

- Pro-cyclical average wages, new wages, and employment, qutting, and job-to-job transitions
- Clear responses of new wages and employment
- Quitting mildly respnds to both shocks
- Job-to-job transitions move too much with both shocks

Assessing Performance in terms of standard HP-filtered moments

- 1st order data moments are from standard database: CPS, JOLTS, LEHD and NIPA.

- 2nd order data moments are from Haefke, Sonntag, and Van Rens (2013), Campolmi and Gnocchi (2016), Brown et al. (2017) and Fujita and Nakajima (2016).

Productivity Shock: Relative Volatility

- Only Productivity Shock: $\rho = 0.95$

	Model	Data
Output	1	1

Productivity Shock: Relative Volatility

- Only Productivity Shock: $\rho = 0.95$

	Model	Data
Output	1	1
Average Wage	0.51	0.44-0.84

Productivity Shock: Relative Volatility

- Only Productivity Shock: $\rho = 0.95$

	Model	Data
Output	1	1
Average Wage	0.51	0.44-0.84
New Wage	0.95	0.68-1.09

Productivity Shock: Relative Volatility

- Only Productivity Shock: $\rho = 0.95$

	Model	Data
Output	1	1
Average Wage	0.51	0.44-0.84
New Wage	0.95	0.68-1.09
Unemployment	0.35	4.84

Productivity Shock: Relative Volatility

- Only Productivity Shock: $\rho = 0.95$

	Model	Data
Output	1	1
Average Wage	0.51	0.44-0.84
New Wage	0.95	0.68-1.09
Unemployment	0.35	4.84
Quits + OJS moves	8.94	4.2

Productivity Shock: Relative Volatility

- Only Productivity Shock: $\rho = 0.95$

	Model	Data
Output	1	1
Average Wage	0.51	0.44-0.84
New Wage	0.95	0.68-1.09
Unemployment	0.35	4.84
Quits + OJS moves	8.94	4.2
OJS moves	10.66	4.62

Table 1: Standard Deviation Relative to Output: Only Productivity Shock

Productivity Shock: Relative Volatility

- Only Productivity Shock: $\rho = 0.95$

	Model	Data
Output	1	1
Average Wage	0.51	0.44-0.84
New Wage	0.95	0.68-1.09
Unemployment	0.35	4.84
Quits + OJS moves	8.94	4.2
OJS moves	10.66	4.62

Table 1: Standard Deviation Relative to Output: Only Productivity Shock

- Unemployment moves too little and Quits and OJS moves too much

Productivity Shock: Correlation

- Only Productivity Shock: $\rho = 0.95$

	Model	Data
Output	1	1

Productivity Shock: Correlation

- Only Productivity Shock: $\rho = 0.95$

	Model	Data
Output	1	1
Average Wage	1.00	0.24-0.37

Productivity Shock: Correlation

- Only Productivity Shock: $\rho = 0.95$

	Model	Data
Output	1	1
Average Wage	1.00	0.24-0.37
New Wage	1.00	0.79-0.83

Productivity Shock: Correlation

- Only Productivity Shock: $\rho = 0.95$

	Model	Data
Output	1	1
Average Wage	1.00	0.24-0.37
New Wage	1.00	0.79-0.83
Unemployment	-0.48	-0.85

Productivity Shock: Correlation

- Only Productivity Shock: $\rho = 0.95$

	Model	Data
Output	1	1
Average Wage	1.00	0.24-0.37
New Wage	1.00	0.79-0.83
Unemployment	-0.48	-0.85
Quits + OJS moves	0.99	0.85

Productivity Shock: Correlation

- Only Productivity Shock: $\rho = 0.95$

	Model	Data
Output	1	1
Average Wage	1.00	0.24-0.37
New Wage	1.00	0.79-0.83
Unemployment	-0.48	-0.85
Quits + OJS moves	0.99	0.85
OJS moves	0.99	0.70

Table 2: Correlation with Contemprary Output: Only Productivity Shock

Productivity Shock: Correlation

- Only Productivity Shock: $\rho = 0.95$

	Model	Data
Output	1	1
Average Wage	1.00	0.24-0.37
New Wage	1.00	0.79-0.83
Unemployment	-0.48	-0.85
Quits + OJS moves	0.99	0.85
OJS moves	0.99	0.70

Table 2: Correlation with Contemprary Output: Only Productivity Shock

- Correlations are on the spot

Delta Shock: Relative Volatility

	Model	Data
Output	1	1

Delta Shock: Relative Volatility

	Model	Data
Output	1	1
Average Wage	0.09	0.44-0.84

Delta Shock: Relative Volatility

	Model	Data
Output	1	1
Average Wage	0.09	0.44-0.84
New Wage	2.02	0.68-1.09

Delta Shock: Relative Volatility

	Model	Data
Output	1	1
Average Wage	0.09	0.44-0.84
New Wage	2.02	0.68-1.09
Unemployment	4.70	4.84

Delta Shock: Relative Volatility

	Model	Data
Output	1	1
Average Wage	0.09	0.44-0.84
New Wage	2.02	0.68-1.09
Unemployment	4.70	4.84
Quits + OJS moves	41.66	4.2

Delta Shock: Relative Volatility

	Model	Data
Output	1	1
Average Wage	0.09	0.44-0.84
New Wage	2.02	0.68-1.09
Unemployment	4.70	4.84
Quits + OJS moves	41.66	4.2
OJS moves	49.36	4.62

Table 3: Standard Deviation Relative to Output: Only Delta Shock

Delta Shock: Relative Volatility

	Model	Data
Output	1	1
Average Wage	0.09	0.44-0.84
New Wage	2.02	0.68-1.09
Unemployment	4.70	4.84
Quits + OJS moves	41.66	4.2
OJS moves	49.36	4.62

Table 3: Standard Deviation Relative to Output: Only Delta Shock

- Now Unemployment is good but moves are excessive

Delta Shock: Relative Volatility

	Model	Data
Output	1	1
Average Wage	0.09	0.44-0.84
New Wage	2.02	0.68-1.09
Unemployment	4.70	4.84
Quits + OJS moves	41.66	4.2
OJS moves	49.36	4.62

Table 3: Standard Deviation Relative to Output: Only Delta Shock

- Now Unemployment is good but moves are excessive
- Note that relative to output, productivity is very important so employment cannot do that much, but this shock makes employment the only culprit so it has to move a lot

Delta Shock: Correlation

- Only Delta Shock: $\rho = 0.95$

	Model	Data
Output	1	1

Delta Shock: Correlation

- Only Delta Shock: $\rho = 0.95$

	Model	Data
Output	1	1
Average Wage	0.13	0.24-0.37

Delta Shock: Correlation

- Only Delta Shock: $\rho = 0.95$

	Model	Data
Output	1	1
Average Wage	0.13	0.24-0.37
New Wage	0.31	0.79-0.83

Delta Shock: Correlation

- Only Delta Shock: $\rho = 0.95$

	Model	Data
Output	1	1
Average Wage	0.13	0.24-0.37
New Wage	0.31	0.79-0.83
Unemployment	-0.99	-0.85

Delta Shock: Correlation

- Only Delta Shock: $\rho = 0.95$

	Model	Data
Output	1	1
Average Wage	0.13	0.24-0.37
New Wage	0.31	0.79-0.83
Unemployment	-0.99	-0.85
Quits + OJS moves	0.40	0.85

Delta Shock: Correlation

- Only Delta Shock: $\rho = 0.95$

	Model	Data
Output	1	1
Average Wage	0.13	0.24-0.37
New Wage	0.31	0.79-0.83
Unemployment	-0.99	-0.85
Quits + OJS moves	0.40	0.85
OJS moves	0.42	0.70

Table 4: Correlation with Contemprary Output: Only Delta Shock

Both Shocks: Relative Volatility Very correlated

- Interact productivity shock and delta shock
  - High Correlation of shocks = 0.95
  - Relative Std of shocks: each shock contributes roughly equal to output volatility

	Model	Data
Output	1	1

Both Shocks: Relative Volatility Very correlated

- Interact productivity shock and delta shock
  - High Correlation of shocks = 0.95
  - Relative Std of shocks: each shock contributes roughly equal to output volatility

	Model	Data
Output	1	1
Average Wage	0.49	0.44-0.84

Both Shocks: Relative Volatility Very correlated

- Interact productivity shock and delta shock
  - High Correlation of shocks = 0.95
  - Relative Std of shocks: each shock contributes roughly equal to output volatility

	Model	Data
Output	1	1
Average Wage	0.49	0.44-0.84
New Wage	1.38	0.68-1.09

Both Shocks: Relative Volatility Very correlated

- Interact productivity shock and delta shock
  - High Correlation of shocks = 0.95
  - Relative Std of shocks: each shock contributes roughly equal to output volatility

	Model	Data
Output	1	1
Average Wage	0.49	0.44-0.84
New Wage	1.38	0.68-1.09
Unemployment	3.02	4.84

Both Shocks: Relative Volatility Very correlated

- Interact productivity shock and delta shock
  - High Correlation of shocks = 0.95
  - Relative Std of shocks: each shock contributes roughly equal to output volatility

	Model	Data
Output	1	1
Average Wage	0.49	0.44-0.84
New Wage	1.38	0.68-1.09
Unemployment	3.02	4.84
Quits + OJS moves	25.77	4.2

Both Shocks: Relative Volatility Very correlated

- Interact productivity shock and delta shock
  - High Correlation of shocks = 0.95
  - Relative Std of shocks: each shock contributes roughly equal to output volatility

	Model	Data
Output	1	1
Average Wage	0.49	0.44-0.84
New Wage	1.38	0.68-1.09
Unemployment	3.02	4.84
Quits + OJS moves	25.77	4.2
OJS moves	30.53	4.62

Table 5: Standard Deviation Relative to Output: Both Shocks

Both Shocks: Correlation

- Interact productivity shock and delta shock
  - High Correlation of shocks = 0.95
  - Relative Std of shocks: each shock contributes roughly equal to output volatility

	Model	Data
Output	1	1

Both Shocks: Correlation

- Interact productivity shock and delta shock
  - High Correlation of shocks = 0.95
  - Relative Std of shocks: each shock contributes roughly equal to output volatility

	Model	Data
Output	1	1
Average Wage	0.77	0.24-0.37

Both Shocks: Correlation

- Interact productivity shock and delta shock
  - High Correlation of shocks = 0.95
  - Relative Std of shocks: each shock contributes roughly equal to output volatility

	Model	Data
Output	1	1
Average Wage	0.77	0.24-0.37
New Wage	0.50	0.79-0.83

Both Shocks: Correlation

- Interact productivity shock and delta shock
  - High Correlation of shocks = 0.95
  - Relative Std of shocks: each shock contributes roughly equal to output volatility

	Model	Data
Output	1	1
Average Wage	0.77	0.24-0.37
New Wage	0.50	0.79-0.83
Unemployment	-0.37	-0.85

Both Shocks: Correlation

- Interact productivity shock and delta shock
  - High Correlation of shocks = 0.95
  - Relative Std of shocks: each shock contributes roughly equal to output volatility

	Model	Data
Output	1	1
Average Wage	0.77	0.24-0.37
New Wage	0.50	0.79-0.83
Unemployment	-0.37	-0.85
Quits + OJS moves	0.28	0.85

Both Shocks: Correlation

- Interact productivity shock and delta shock
  - High Correlation of shocks = 0.95
  - Relative Std of shocks: each shock contributes roughly equal to output volatility

	Model	Data
Output	1	1
Average Wage	0.77	0.24-0.37
New Wage	0.50	0.79-0.83
Unemployment	-0.37	-0.85
Quits + OJS moves	0.28	0.85
OJS moves	0.29	0.70

Table 6: Correlation with Contemprary Output: Both Shocks

Both Shocks: Relative Volatility Uncorrelated

- Interact productivity shock and delta shock
  - Low Correlation of shocks = 0
  - Relative Std of shocks: each shock contributes roughly equal to output volatility

	Model	Data
Output	1	1

Both Shocks: Relative Volatility Uncorrelated

- Interact productivity shock and delta shock
  - Low Correlation of shocks = 0
  - Relative Std of shocks: each shock contributes roughly equal to output volatility

	Model	Data
Output	1	1
Average Wage	0.40	0.44-0.84

Both Shocks: Relative Volatility Uncorrelated

- Interact productivity shock and delta shock
  - Low Correlation of shocks = 0
  - Relative Std of shocks: each shock contributes roughly equal to output volatility

	Model	Data
Output	1	1
Average Wage	0.40	0.44-0.84
New Wage	1.35	0.68-1.09

Both Shocks: Relative Volatility Uncorrelated

- Interact productivity shock and delta shock
  - Low Correlation of shocks = 0
  - Relative Std of shocks: each shock contributes roughly equal to output volatility

	Model	Data
Output	1	1
Average Wage	0.40	0.44-0.84
New Wage	1.35	0.68-1.09
Unemployment	2.59	4.84

Both Shocks: Relative Volatility Uncorrelated

- Interact productivity shock and delta shock
  - Low Correlation of shocks = 0
  - Relative Std of shocks: each shock contributes roughly equal to output volatility

	Model	Data
Output	1	1
Average Wage	0.40	0.44-0.84
New Wage	1.35	0.68-1.09
Unemployment	2.59	4.84
Quits + OJS moves	23.98	4.2

Both Shocks: Relative Volatility Uncorrelated

- Interact productivity shock and delta shock
  - Low Correlation of shocks = 0
  - Relative Std of shocks: each shock contributes roughly equal to output volatility

	Model	Data
Output	1	1
Average Wage	0.40	0.44-0.84
New Wage	1.35	0.68-1.09
Unemployment	2.59	4.84
Quits + OJS moves	23.98	4.2
OJS moves	28.45	4.62

Table 7: Standard Deviation Relative to Output: Both Shocks

Both Shocks: Correlation Uncorrelated

- Interact productivity shock and delta shock
  - Relative Std of shocks: each shock contributes roughly equal to output volatility

	Model	Data
Output	1	1

Both Shocks: Correlation Uncorrelated

- Interact productivity shock and delta shock
  - Relative Std of shocks: each shock contributes roughly equal to output volatility

	Model	Data
Output	1	1
Average Wage	0.82	0.24-0.37

Both Shocks: Correlation Uncorrelated

- Interact productivity shock and delta shock
  - Relative Std of shocks: each shock contributes roughly equal to output volatility

	Model	Data
Output	1	1
Average Wage	0.82	0.24-0.37
New Wage	0.62	0.79-0.83

Both Shocks: Correlation Uncorrelated

- Interact productivity shock and delta shock
  - Relative Std of shocks: each shock contributes roughly equal to output volatility

	Model	Data
Output	1	1
Average Wage	0.82	0.24-0.37
New Wage	0.62	0.79-0.83
Unemployment	-0.61	-0.85

Both Shocks: Correlation Uncorrelated

- Interact productivity shock and delta shock
  - Relative Std of shocks: each shock contributes roughly equal to output volatility

	Model	Data
Output	1	1
Average Wage	0.82	0.24-0.37
New Wage	0.62	0.79-0.83
Unemployment	-0.61	-0.85
Quits + OJS moves	0.47	0.85

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OJS moves	0.48	0.70

Table 8: Correlation with Contemprary Output: Both Shocks

8 Clumsy Extensions

Two Extensions

- An Economy that illuminates the Shimer/Hagedorn-Manowski debate.

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    - But only for an Economy without quits or Job-to-Job movements.

Two Extensions

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  - But only for an Economy without quits or Job-to-Job movements.

- An Economy with lower effectiveness in on-the-job search ($\xi = .7$ instead of 1). St St J2J is .29 rather than .40 per year.

High-b Economy: (Without quits or OJS only TFP)

	Low-b			High-b		
	Mean	Std	Corr	Mean	Std	Corr
Output	1	1	1	1	1	1

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	Low-b			High-b		
	Mean	Std	Corr	Mean	Std	Corr
Output	1	1	1	1	1	1
Avg Wage	0.70	0.51	1.00	0.74	0.33	0.84

- Very Promising: Much higher unemployment volatility

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	Low-b			High-b		
	Mean	Std	Corr	Mean	Std	Corr
Output	1	1	1	1	1	1
Avg Wage	0.70	0.51	1.00	0.74	0.33	0.84
New Wage	0.70	0.73	0.99	0.74	0.38	0.84

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- We are moving towards an Economy with both types of agents moving across types.

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New Wage	0.70	0.73	0.99	0.74	0.38	0.84
Unemp Rate	12.6%	0.28	-0.55	22.2%	0.97	-0.86

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Unemp Rate	12.6%	0.28	-0.55	22.2%	0.97	-0.86
Quits	9%	-	-	9%	-	-

Table 9: The High-b Benchmark Economy: M4

- Very Promising: Much higher unemployment volatility
- We are moving towards an Economy with both types of agents moving across types.

Low Ave J-2-J 1% Productivity Shock ($\rho = .95$) [IRF]

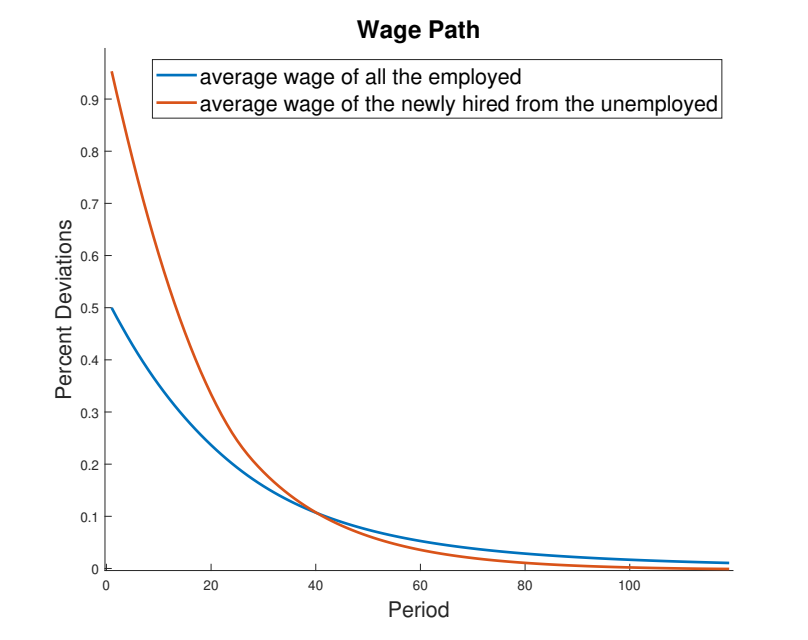

Figure 9: Wages

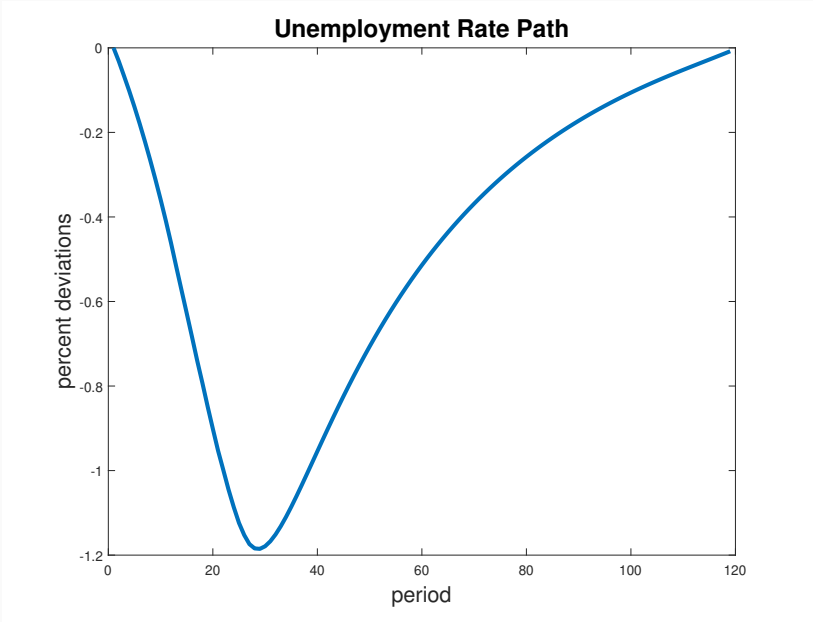

Figure 10: Unemployment Rate

- Similar Wage Responses
- 70% more unemployment volatility

Low Ave J-2-J 1% Productivity Shock ($\rho = .95$) IRF

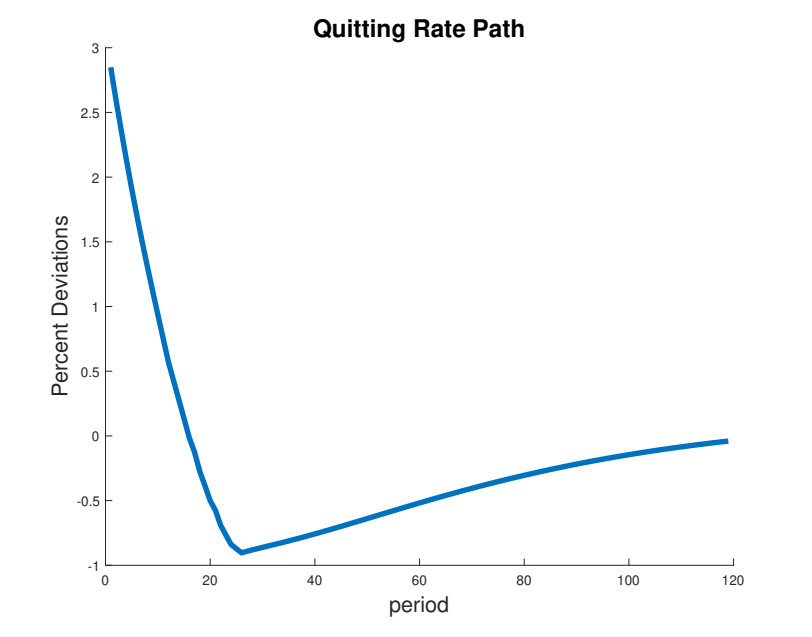

Figure 11: Quits

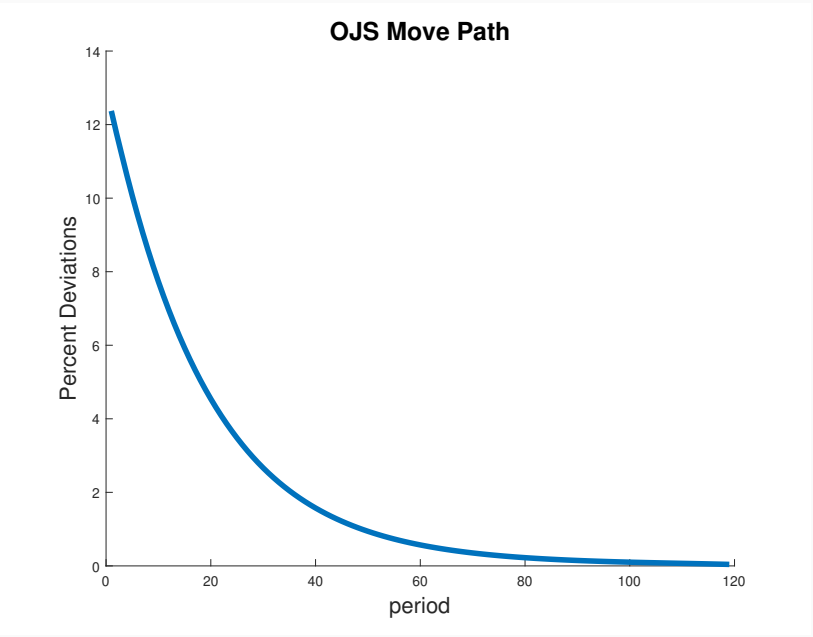

Figure 12: Job-to-job Moves

- More quitting
- Similar (excessive) J-2-J transitions

Low Ave J-2-J 1% Delta Shock ($\rho = .95$)

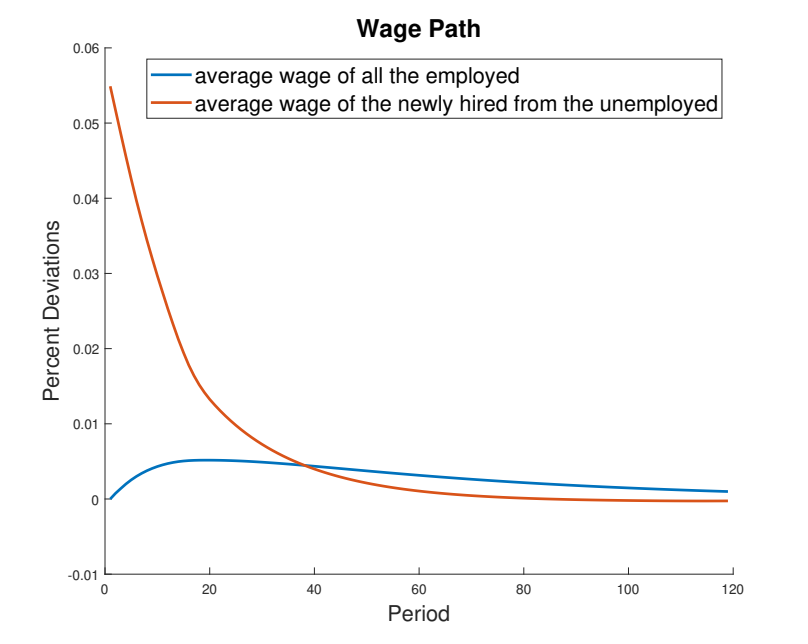

Figure 13: Wages

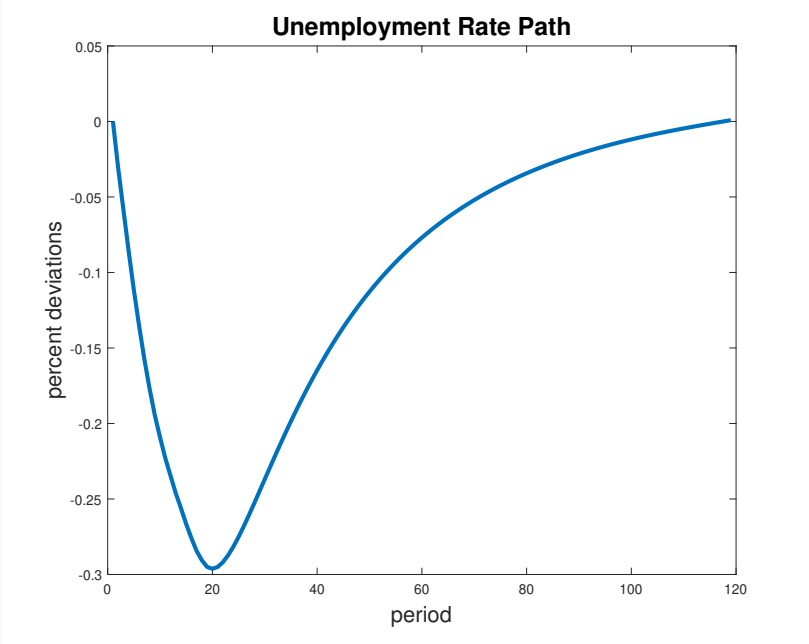

Figure 14: Unemployment Rate

- Similar Wage Response
- 16% more unemployment response
- Note wage is not pegged to the delta shock

M4: 1% Delta Shock ($\rho = .95$)

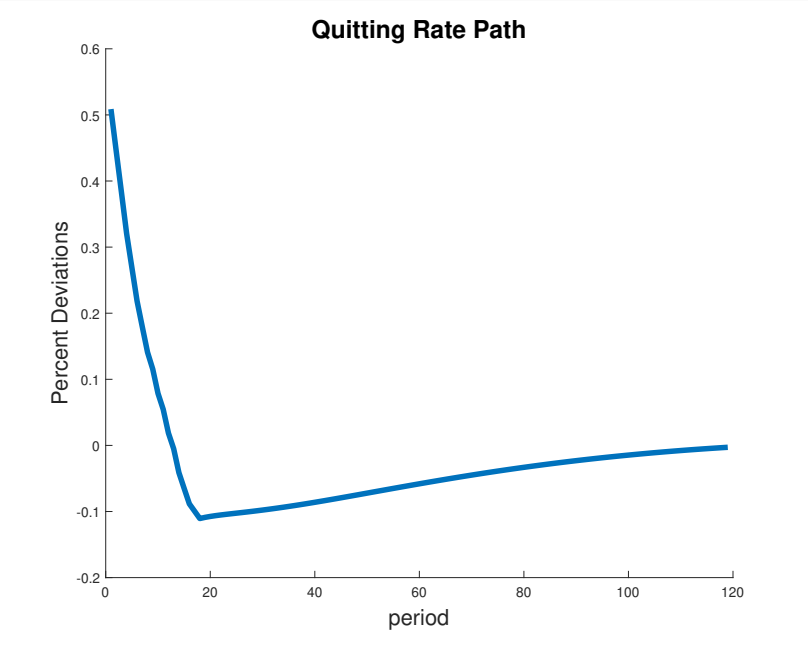

Figure 15: Quits

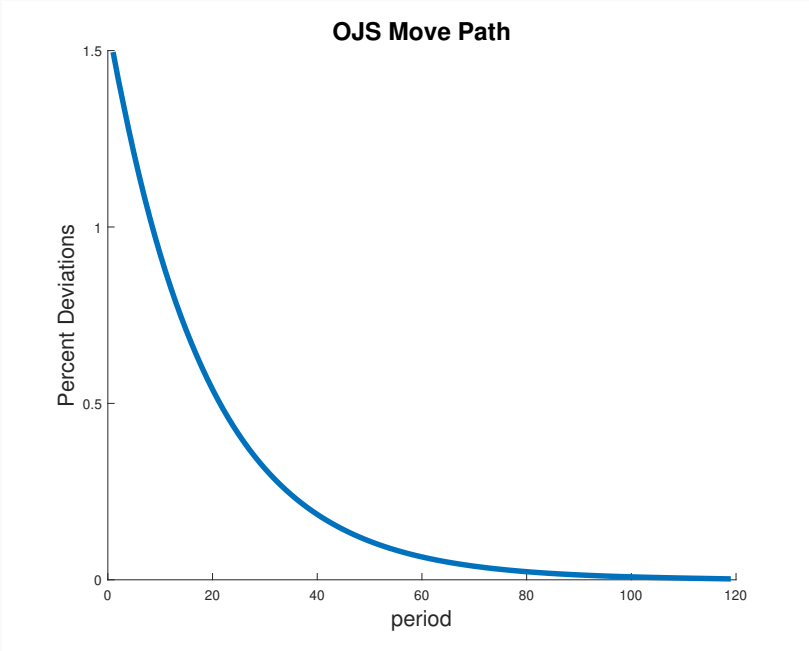

Figure 16: Job-to-job Moves

- More Quit similar (excessive) volatility for job-to-job transitions

Looking for Lower Job-to-Job Transitions

- Two ways to aggregate shocks

	corr = 0.95		shock corr = 0	
	Std	corr	Std	corr
output	1.00	1.00	1.00	1.00
avg wage	0.41	0.93	0.41	0.90
new wage	1.69	0.76	1.38	0.52
unemployment	2.59	-0.73	2.80	-0.63
quits + j2j movers	29.85	0.77	26.72	0.38
J2J movers	36.30	0.79	32.51	0.41

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- Not too successful in reducing volatility of quits and J2J movers.
- Need to look for alternatives.

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  - Quits
  - Employment
  - Investment and Consumption
  - Wages
- On the Job Search seems to Magnify Fluctuation a lot

Conclusions II

- Exciting set of continuation projects:
  1. Incorporate the movements outside of the labor force.
  2. Endogenous Search intensity on the part of firms
  3. Aiming Shocks to soften correlation between wages and wealth
  4. Efficiency Wages: Endogenous Productivity (firms use different technologies with different costs of idleness)
  5. Move towards more sophisticated household structures (more life cycle movements, multiperson households).

9 Extensions

Firms Choose Search Intensity

Firms choose Search Intensity

- The number of vacancies posted is chosen by firms
- Easy to implement
- Slightly Different steady state

Free entry with variable recruiting intensity

- Let $v(\overline{c})$ be a technology to post vacancies where $\overline{c}$ is the cost paid.

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- Then the free entry condition requires that for all offered wages

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

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- With FOC given by

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

- If $v(\overline{c}) = \frac{\upsilon_1 \overline{c}^2}{2} + \upsilon_2 \, \overline{c}$, we have

$$(\upsilon_1 \, \overline{c} \; + \upsilon_2) \left\{ \psi^f [\theta(w)] \quad \left[\frac{\Omega(w)}{1+r} - \quad \frac{\overline{k}(1-\delta_k)}{1+r} \right] \right\} = 1,$$

How to make it consistent with the current steady state

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- By Choosing υ so that for the numbers that have now

$$\left\{ \left[\frac{\upsilon_1 \overline{c}^2}{2} + \upsilon_2 \overline{c} \right] \psi^f[\theta(w)] \frac{\Omega(w)}{1+r} + \left[1 - \frac{\upsilon_1 \overline{c}^2}{2} - \upsilon_2 \overline{c} \right] \psi^f[\theta(w)] \frac{\overline{k}(1-\delta_k)}{1+r} \right\} = \overline{c} + \overline{k}$$

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- Solving for $\{\upsilon_1, \upsilon_2\}$ that satisfy both equations given our choice of $\overline{c}$ we are done

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High-b Economy

- Recompute the M1 economy but with $b = 0.6$.
- People are much picker in jobs, leading to much higher unemployment rate (20%).
- As we expect, higher b translates to higher eq wages, small firm profits, and thus more volatile job creations (and unemployment).

	Mean	Std	Corr
Output	0.80	1	1
Average Wage	0.73	0.01	0.32
New Wage	0.73	0.10	0.83
Unemployment	20%	1.20	-0.80
Quits	8.56%	-	-
OJS moves	-	-	-

Table 10: The High-b Benchmark Economy