Wealth, Wages, and Employment

Preliminary

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

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- Especially, Eeckhout and Sepahsalari (2015), Chaumont and Shi (2017), Griffy (2017).

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.

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6. Multiple types Workers differ in the value of leisure, i.e. attachment to the labor market. Explicit role of Outside Labor Force. Under development.

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- General equilibrium: Workers own firms.

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

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

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

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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 at different wages & filling probabilities

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

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- Free entry condition requires that for all offered wages

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

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  3. An interest rate r clears the asset market

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

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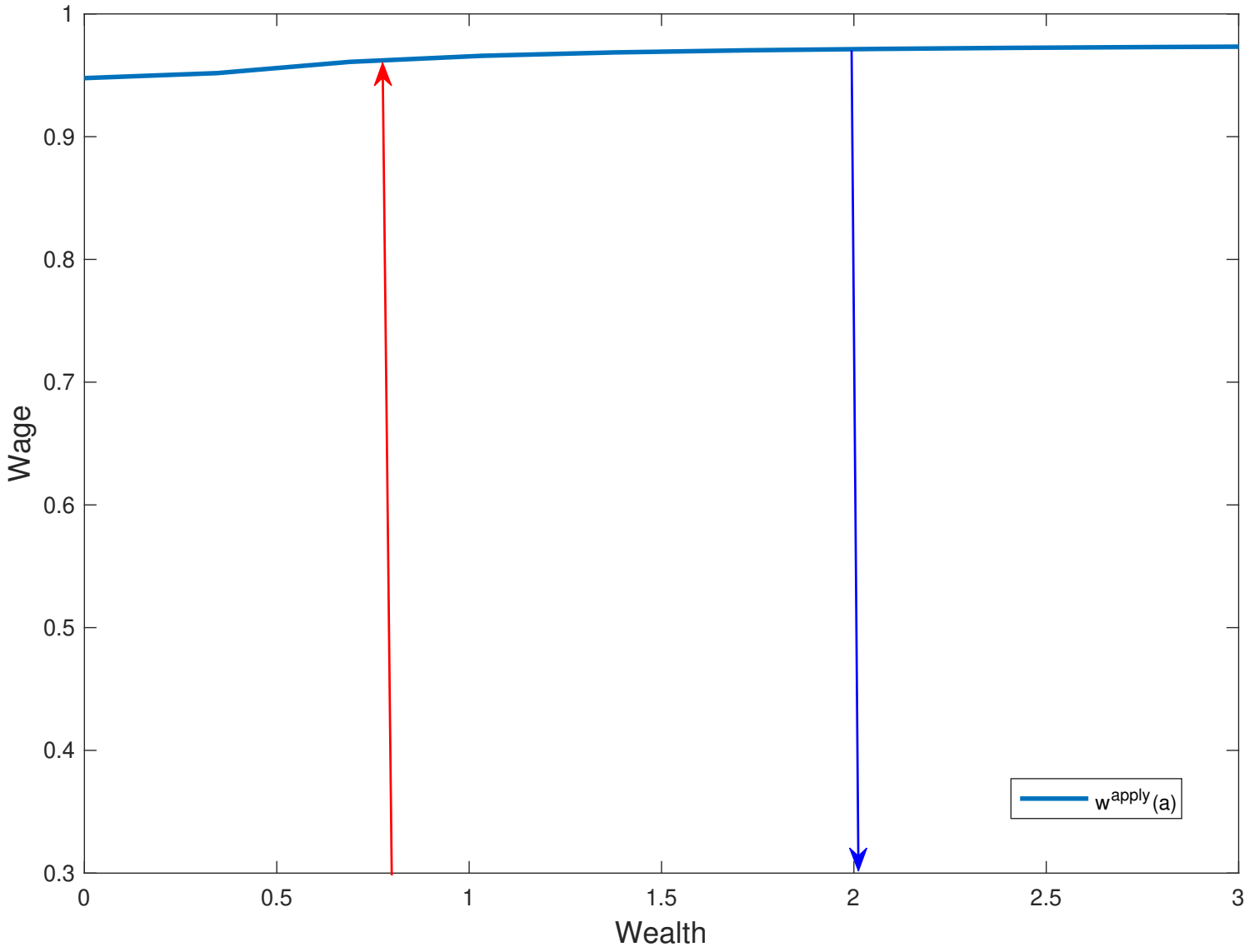
- Households with more wealth are able to insure better against unemployment risk.

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

How does the Model Work



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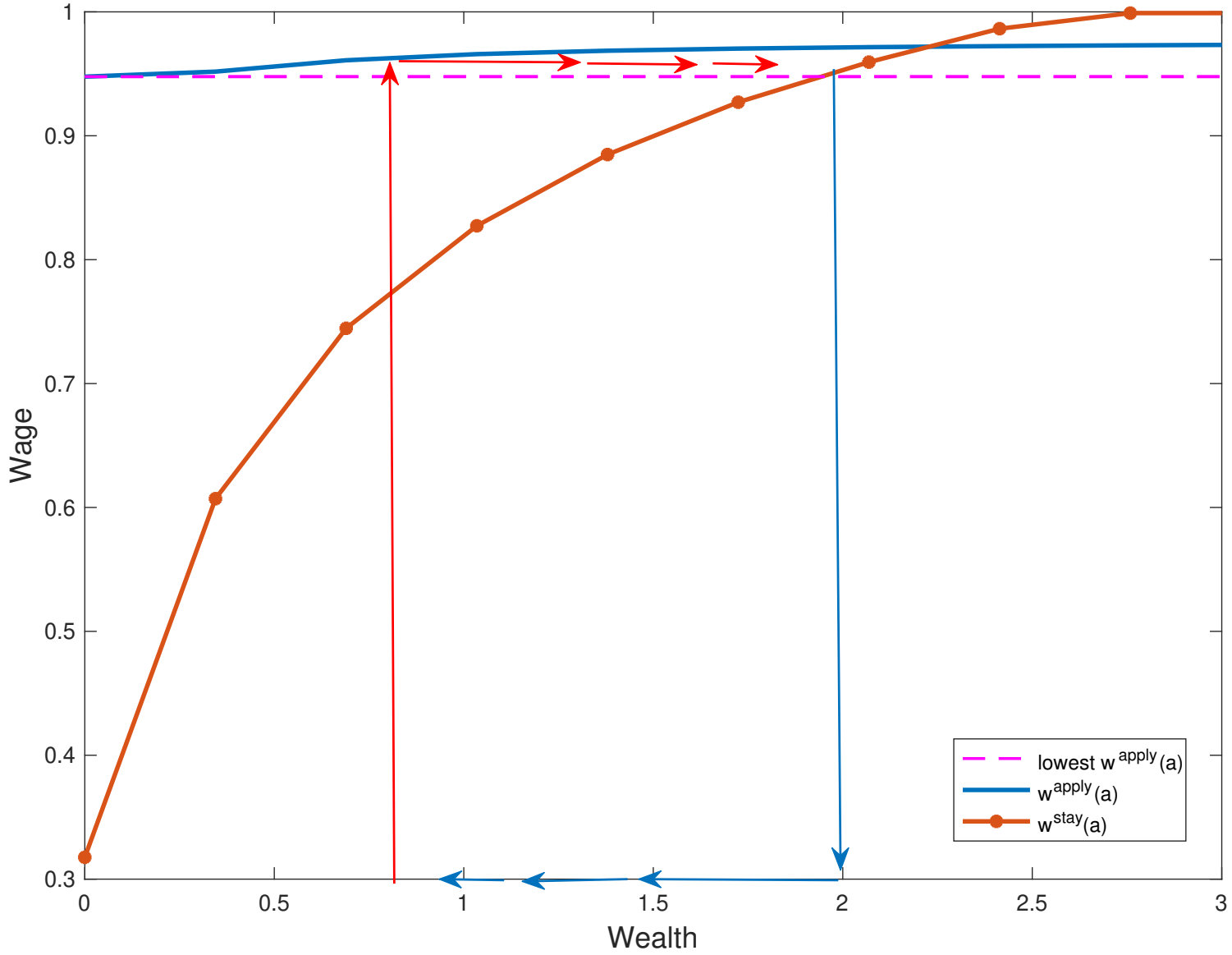

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2. In the following we will examine whether more wage dispersion obtains under additional assumptions –given that frictional wage dispersion is considered large in the data

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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.

Quitting Model: Time-line

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

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- 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.

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- 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.

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

Quitting Model: Value of the firm

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

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

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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)

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

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

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- Firm's value

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

Quitting Model: Solving forward for the Value of the firm

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

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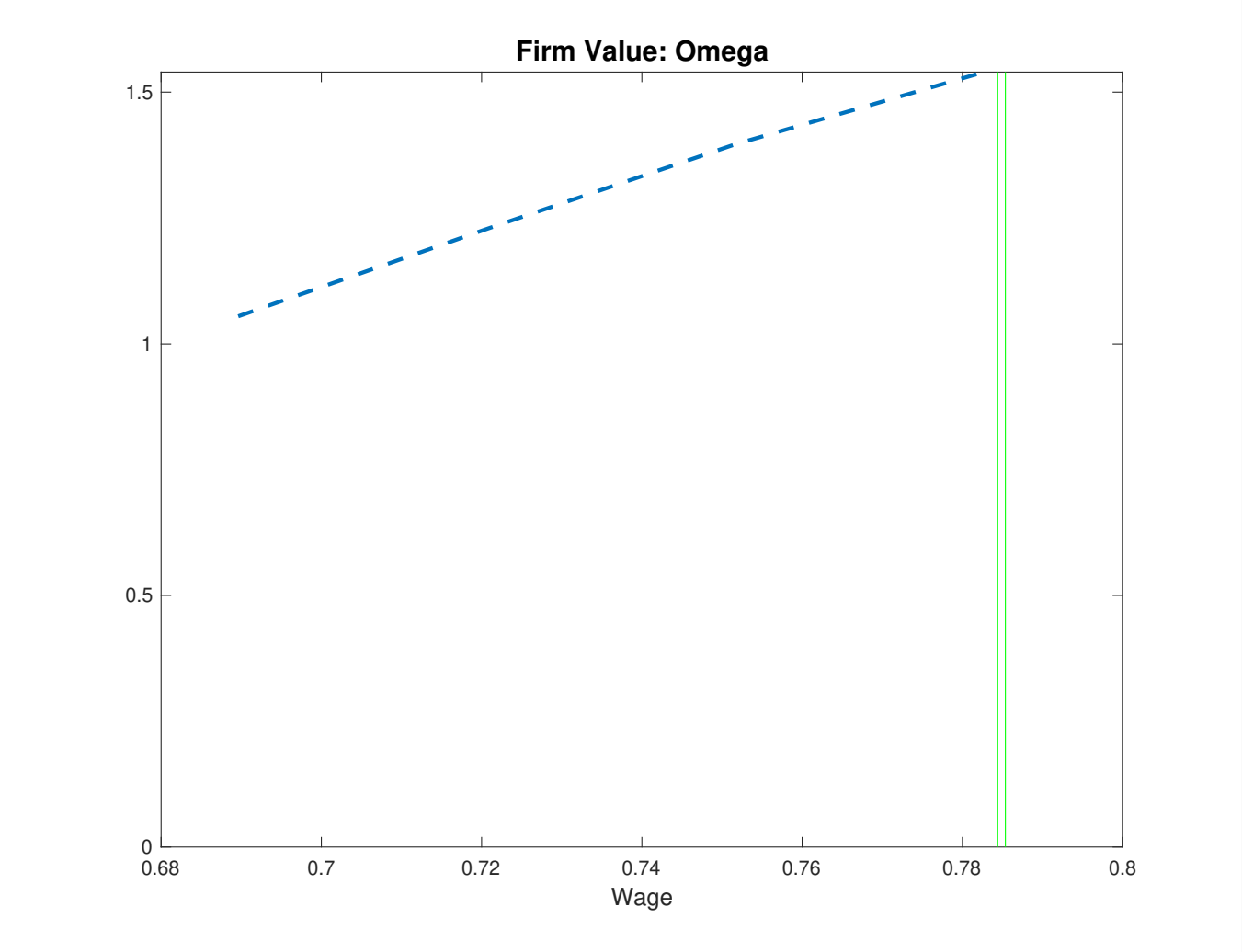
- New equilibrium objects $\{Q^0(w), Q^1(w)\}$. Rest is unchanged.
- It is Block Recursive, (even if contracts are not indexed by wealth (as in Chaumont and Shi (2017)) because wealth can be inferred from w).

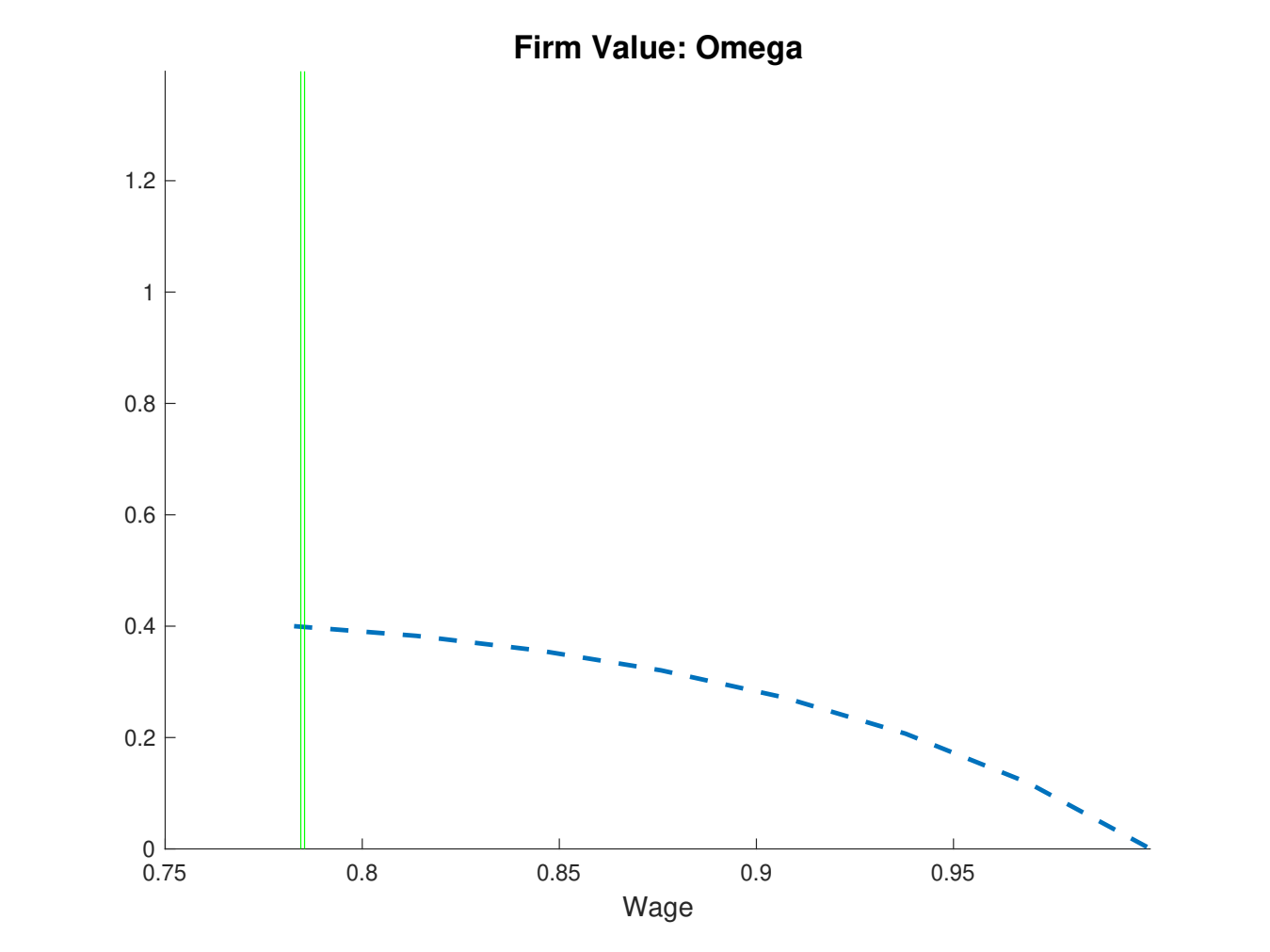
Value of the firm as wage varies: The Poor

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



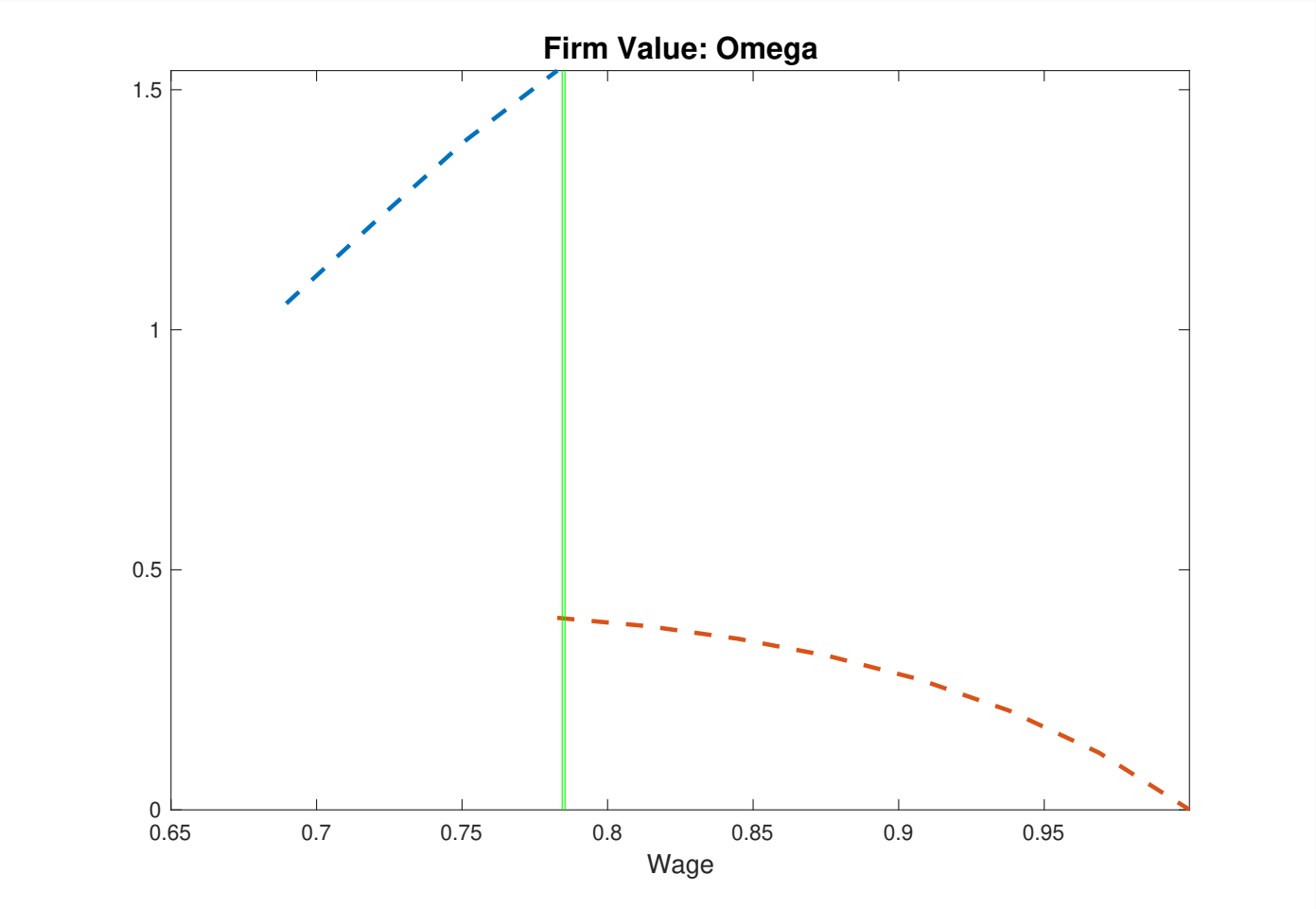
Value of the firm as wage varies: The Rich

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



Value of the firm: Accounting for Worker Selection

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



Effect of Quitting: The Mechanism

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- In equilibrium, the wage gap is narrow and the effect of wealth dominates.
- Need to weaken link between wages and wealth

Aiming and Quitting Shocks Model: Time-line

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

Aiming and Quitting Shocks: Household Probl

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

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no longer FOC for which wage to apply.

- 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.

Aiming and Quitting Shocks: Household Probl

- The employed solve

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

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Aiming and Quitting Shocks Model: Value of the Firm

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

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- Explicitly Not Block Recursive unless contracts were indexed by wealth which is illegal.

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- 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

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- 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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- 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

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

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- Households solve

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

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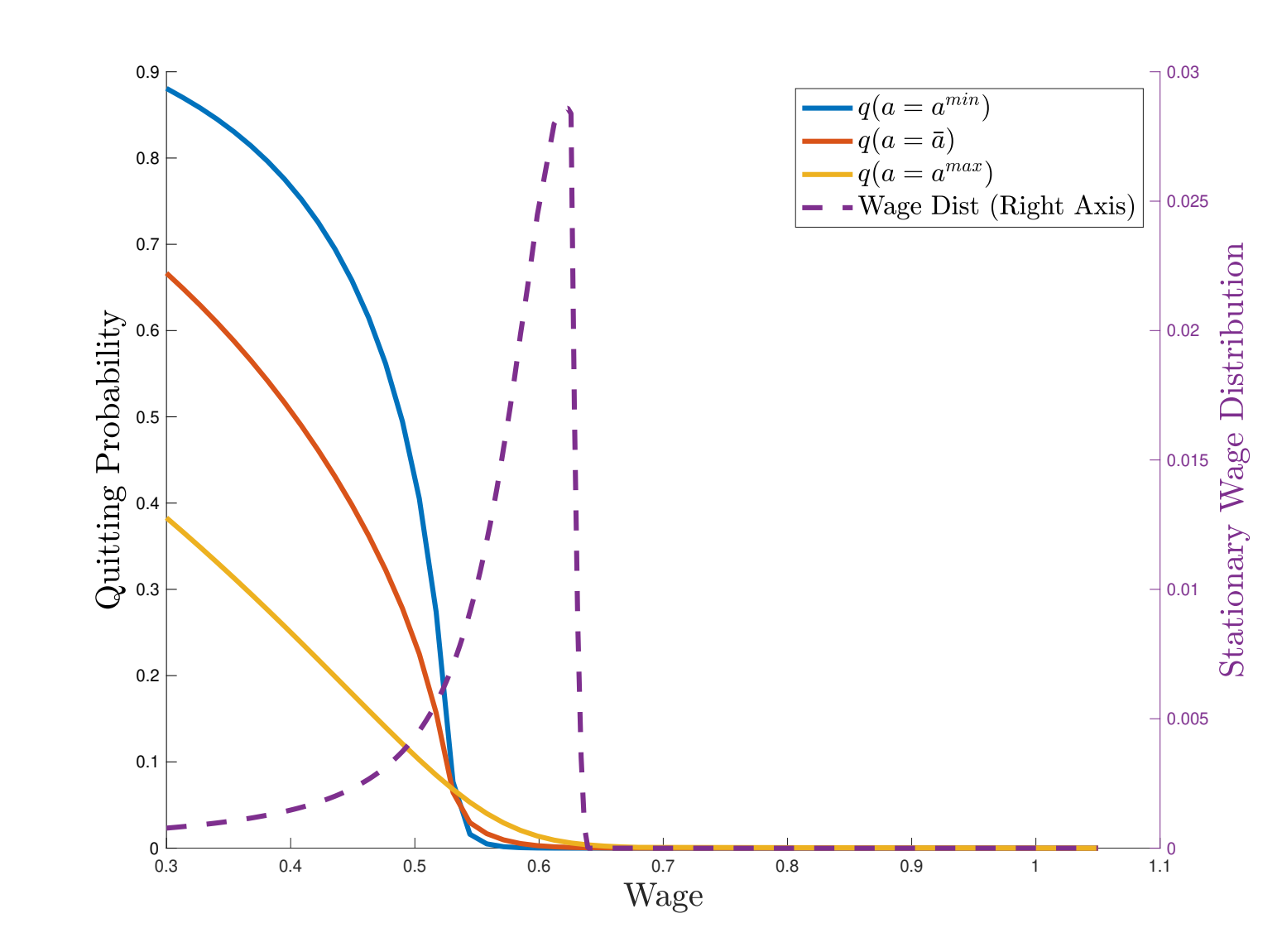
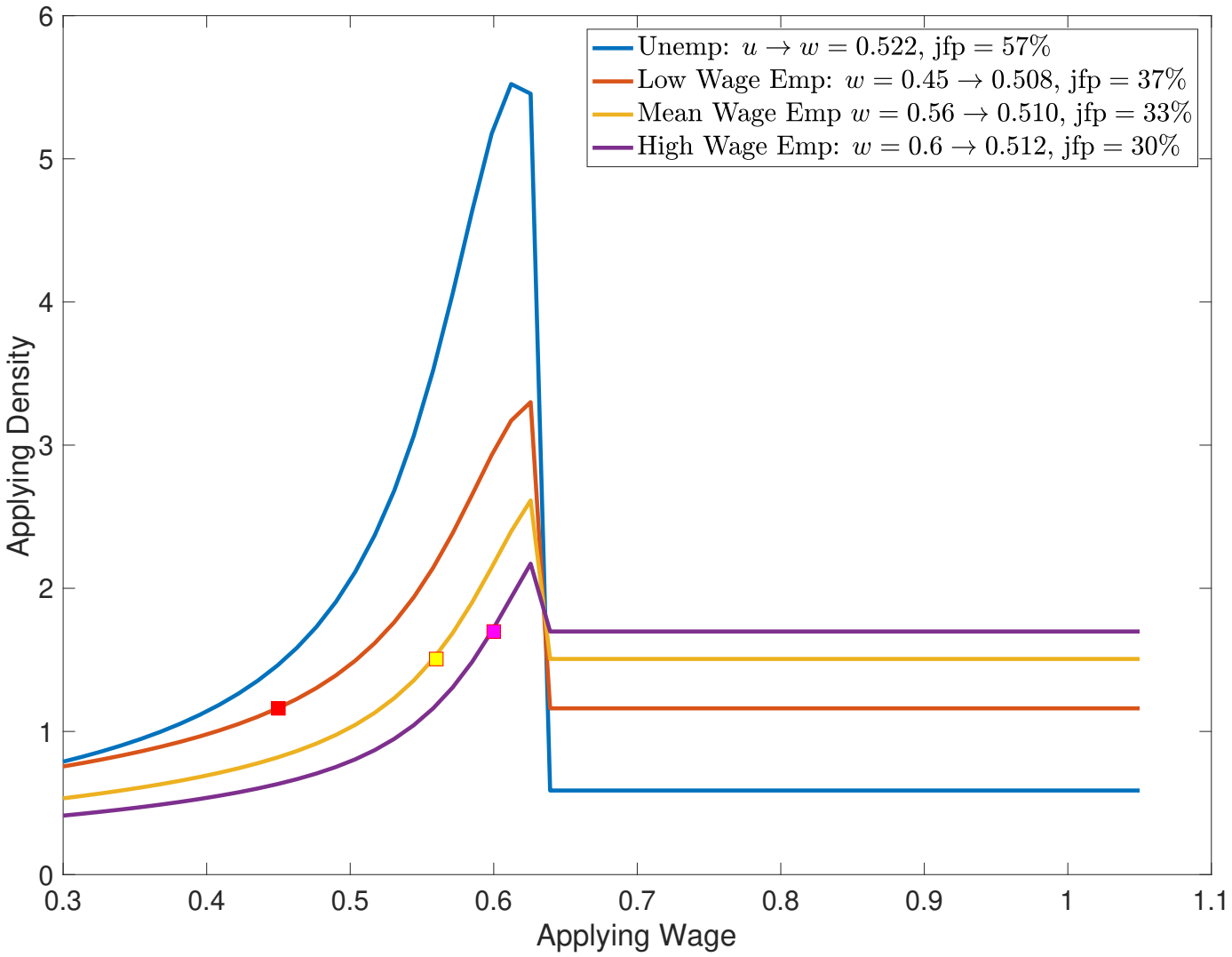
OJS Quitting Probabilities, Various wealths & Wage Density



- The rich pursue often other activities (leisure?)

OJS Which Jobs to Move to?



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

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    - 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

On the Job Search with types η Model: Time-line

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On the Job Search with types η Model: Time-line

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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 $u^{e,\eta}(c) = u(c) - \chi^{\eta}$

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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.

On the Job Search with types η: Household Probl

- After saving, the unemployed problem is

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

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

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- The value of searching is

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

On the Job Search with types η: Household choices

- The probabilities of quitting and of searching are

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

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- Household solves

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

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

Multuple Types Model: Value of the Firm

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

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

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

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

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

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

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

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

Various Economies

- Limited Comparable Results
- Right now we have five Economies
  1. No Aiming and Not Quitting
  2. Aiming and Not Quitting
  3. An Aiming and Quitting (Closed Economy) General Equilibrium
  4. An Aiming-Quitting & On the Job Search
  5. Same to 4 but with higher β
- Potential output is Normalized to 1.

Steady State Statistics of Various Economies: $r = 1.5\%$ quarterly

β
interest rate
avg consumption
avg wage
avg wealth
stock market value
avg labor income
consumption to wealth ratio
labor income to wealth ratio
quit ratio
OJS search ratio
unemployment rate
wage of newly hired unemployed
std consumption
std wage
std wealth
mean-min consumption
mean-min wage
UE transition
EE transition
total vacancy
avg unemp duration
avg emp duration

Steady State Statistics of Various Economies: $r = 1.5\%$ quarterly

	NANQ
β	0.992
interest rate	0.015
avg consumption	0.640
avg wage	0.613
avg wealth	6.542
stock market value	6.553
avg labor income	0.575
consumption to wealth ratio	0.098
labor income to wealth ratio	0.088
quit ratio	-
OJS search ratio	-
unemployment rate	0.121
wage of newly hired unemployed	0.609
std consumption	0.124
std wage	0.000
std wealth	7.581
mean-min consumption	2.132
mean-min wage	1.000
UE transition	0.056
EE transition	-
total vacancy	0.066
avg unemp duration	2.159
avg emp duration	33.33

Steady State Statistics of Various Economies: $r = 1.5\%$ quarterly

	ANQ
β	0.992
interest rate	0.015
avg consumption	0.622
avg wage	0.541
avg wealth	9.299
stock market value	9.196
avg labor income	0.530
consumption to wealth ratio	0.067
labor income to wealth ratio	0.057
quit ratio	-
OJS search ratio	-
unemployment rate	0.047
wage of newly hired unemployed	0.542
std consumption	0.154
std wage	0.049
std wealth	11.51
mean-min consumption	2.074
mean-min wage	1.804
UE transition	0.034
EE transition	-
total vacancy	0.154
avg unemp duration	1.306
avg emp duration	33.33

Steady State Statistics of Various Economies: $r = 1.5\%$ quarterly

	AQ
β	0.992
interest rate	0.015
avg consumption	0.603
avg wage	0.540
avg wealth	8.903
stock market value	8.903
avg labor income	0.515
consumption to wealth ratio	0.068
labor income to wealth ratio	0.058
quit ratio	0.039
OJS search ratio	-
unemployment rate	0.103
wage of newly hired unemployed	0.498
std consumption	0.141
std wage	0.057
std wealth	10.46
mean-min consumption	2.010
mean-min wage	1.799
UE transition	0.065
EE transition	-
total vacancy	0.176
avg unemp duration	1.564
avg emp duration	14.78

Steady State Statistics of Various Economies: $r = 1.5\%$ quarterly

	AQOJS
β	0.992
interest rate	0.015
avg consumption	0.539
avg wage	0.488
avg wealth	6.739
stock market value	11.47
avg labor income	0.473
consumption to wealth ratio	0.080
labor income to wealth ratio	0.070
quit ratio	0.018
OJS search ratio	0.229
unemployment rate	0.082
wage of newly hired unemployed	0.458
std consumption	0.106
std wage	0.073
std wealth	7.514
mean-min consumption	1.798
mean-min wage	1.627
UE transition	0.048
EE transition	0.123
total vacancy	0.372
avg unemp duration	1.692
avg emp duration	21.21

Steady State Statistics of Various Economies: $r = 1.5\%$ quarterly

	AQOJS $\beta \uparrow$
β	0.994
interest rate	0.015
avg consumption	0.622
avg wage	0.481
avg wealth	15.63
stock market value	11.66
avg labor income	0.466
consumption to wealth ratio	0.040
labor income to wealth ratio	0.030
quit ratio	0.020
OJS search ratio	0.232
unemployment rate	0.084
wage of newly hired unemployed	0.452
std consumption	0.255
std wage	0.075
std wealth	18.72
mean-min consumption	2.073
mean-min wage	1.605
UE transition	0.050
EE transition	0.124
total vacancy	0.385
avg unemp duration	1.680
avg emp duration	20.37

Steady State Statistics of Various Economies: $r = 1.5\%$ quarterly

	NANQ	ANQ	AQ	AQOJS	AQOJS $\beta \uparrow$
β	0.992	0.992	0.992	0.992	0.994
interest rate	0.015	0.015	0.015	0.015	0.015
avg consumption	0.640	0.622	0.603	0.539	0.622
avg wage	0.613	0.541	0.540	0.488	0.481
avg wealth	6.542	9.299	8.903	6.739	15.63
stock market value	6.553	9.196	8.903	11.47	11.66
avg labor income	0.575	0.530	0.515	0.473	0.466
consumption to wealth ratio	0.098	0.067	0.068	0.080	0.040
labor income to wealth ratio	0.088	0.057	0.058	0.070	0.030
quit ratio	-	-	0.039	0.018	0.020
OJS search ratio	-	-	-	0.229	0.232
unemployment rate	0.121	0.047	0.103	0.082	0.084
wage of newly hired unemployed	0.609	0.542	0.498	0.458	0.452
std consumption	0.124	0.154	0.141	0.106	0.255
std wage	0.000	0.049	0.057	0.073	0.075
std wealth	7.581	11.51	10.46	7.514	18.72
mean-min consumption	2.132	2.074	2.010	1.798	2.073
mean-min wage	1.000	1.804	1.799	1.627	1.605
UE transition	0.056	0.034	0.065	0.048	0.050
EE transition	-	-	-	0.123	0.124
total vacancy	0.066	0.154	0.176	0.372	0.385
avg unemp duration	2.159	1.306	1.564	1.692	1.680
avg emp duration	33.33	33.33	14.78	21.21	20.37

Aggregate Fluctuations

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

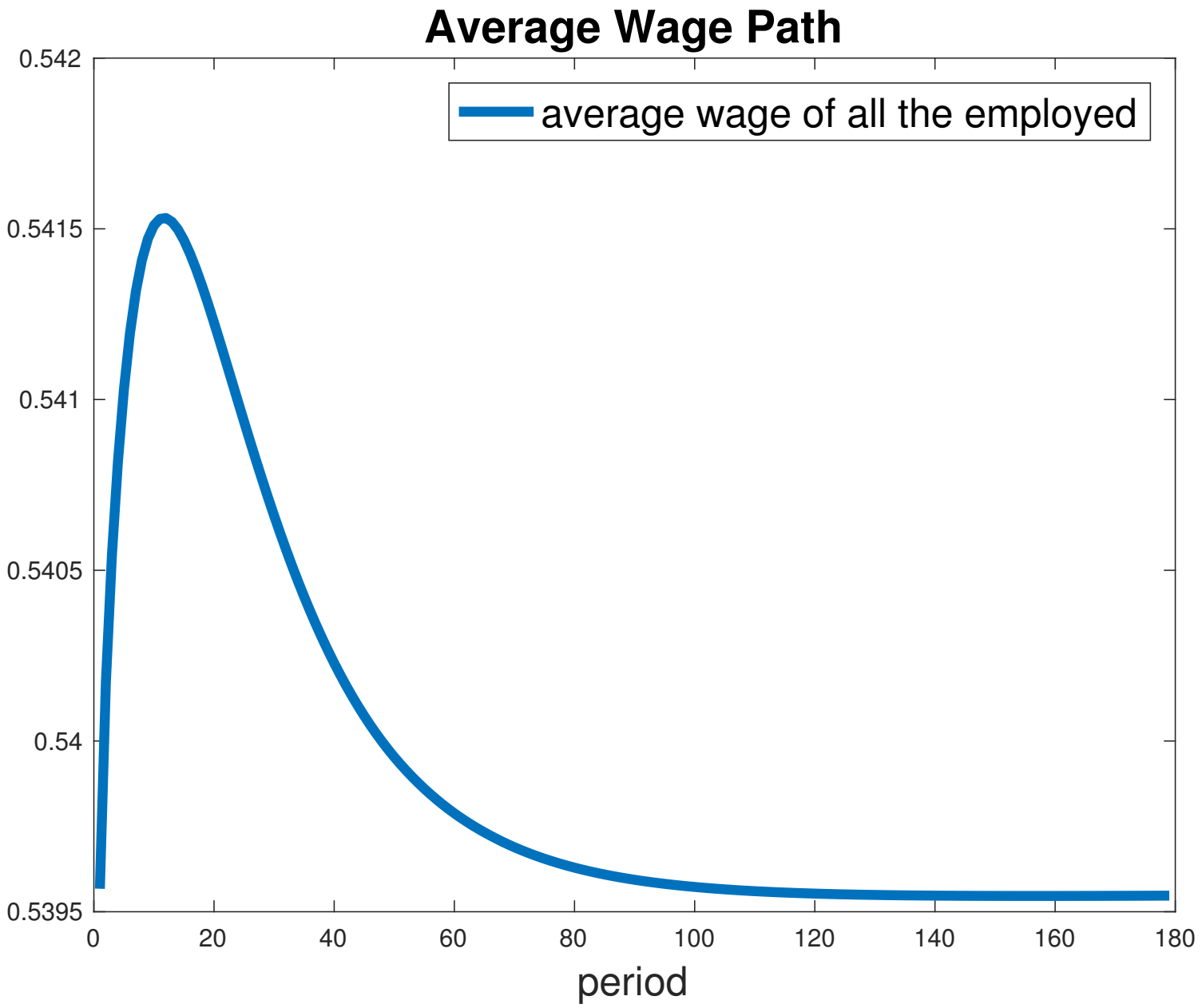
- So it is a second order difference functional equation.

Aiming and Quitting Model.

5% Productivity Shock ($\rho = .9$)

- Average wages don't move much but wages of new workers do!
- Newly hired Wage Distribution Shifts upward
- Quits are pro-cyclical but excessive
- Employment moves more (not so much of Shimer puzzle)

Aiming and Quitting Model. 5% Productivity Shock ($\rho = .9$)



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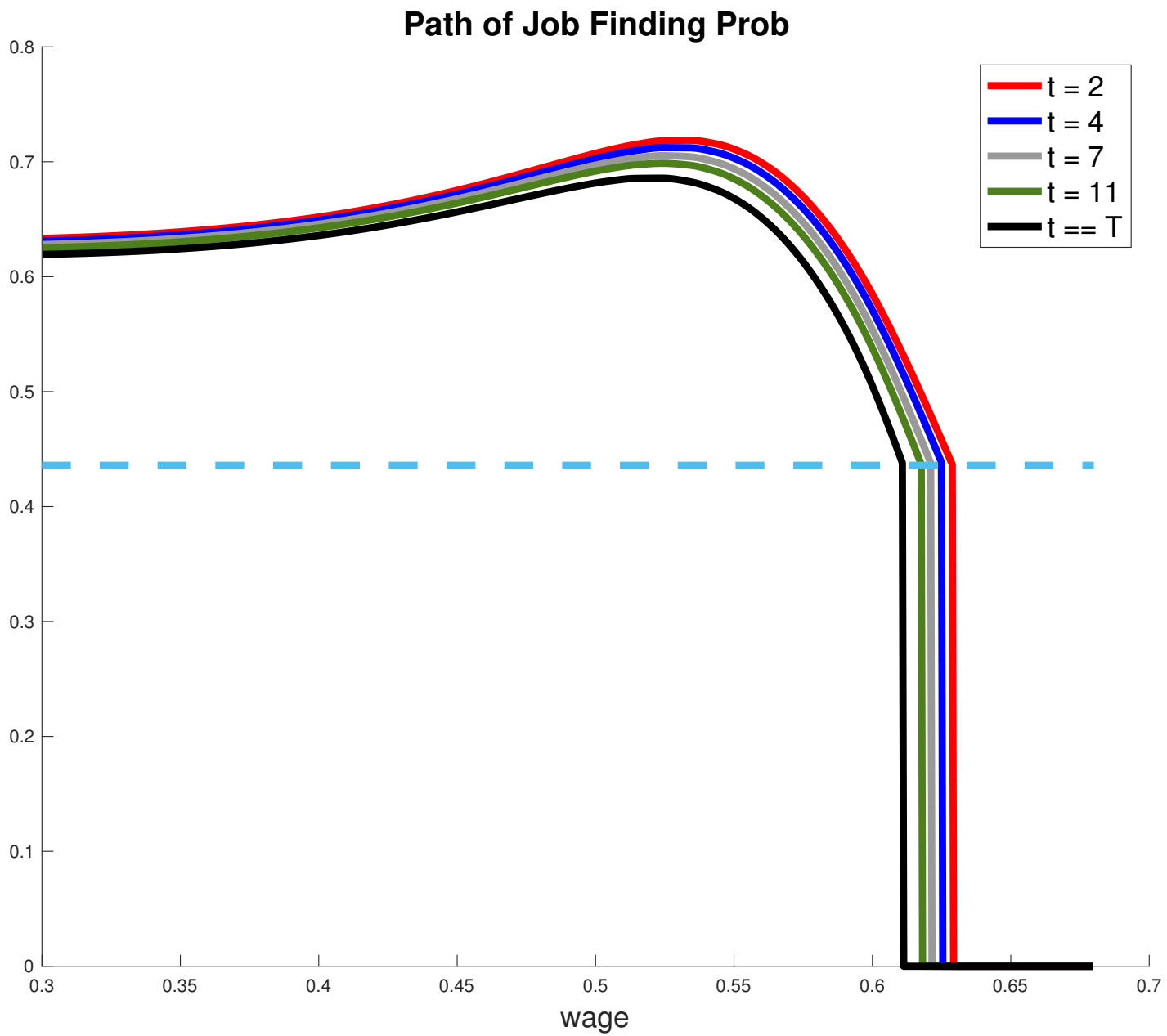

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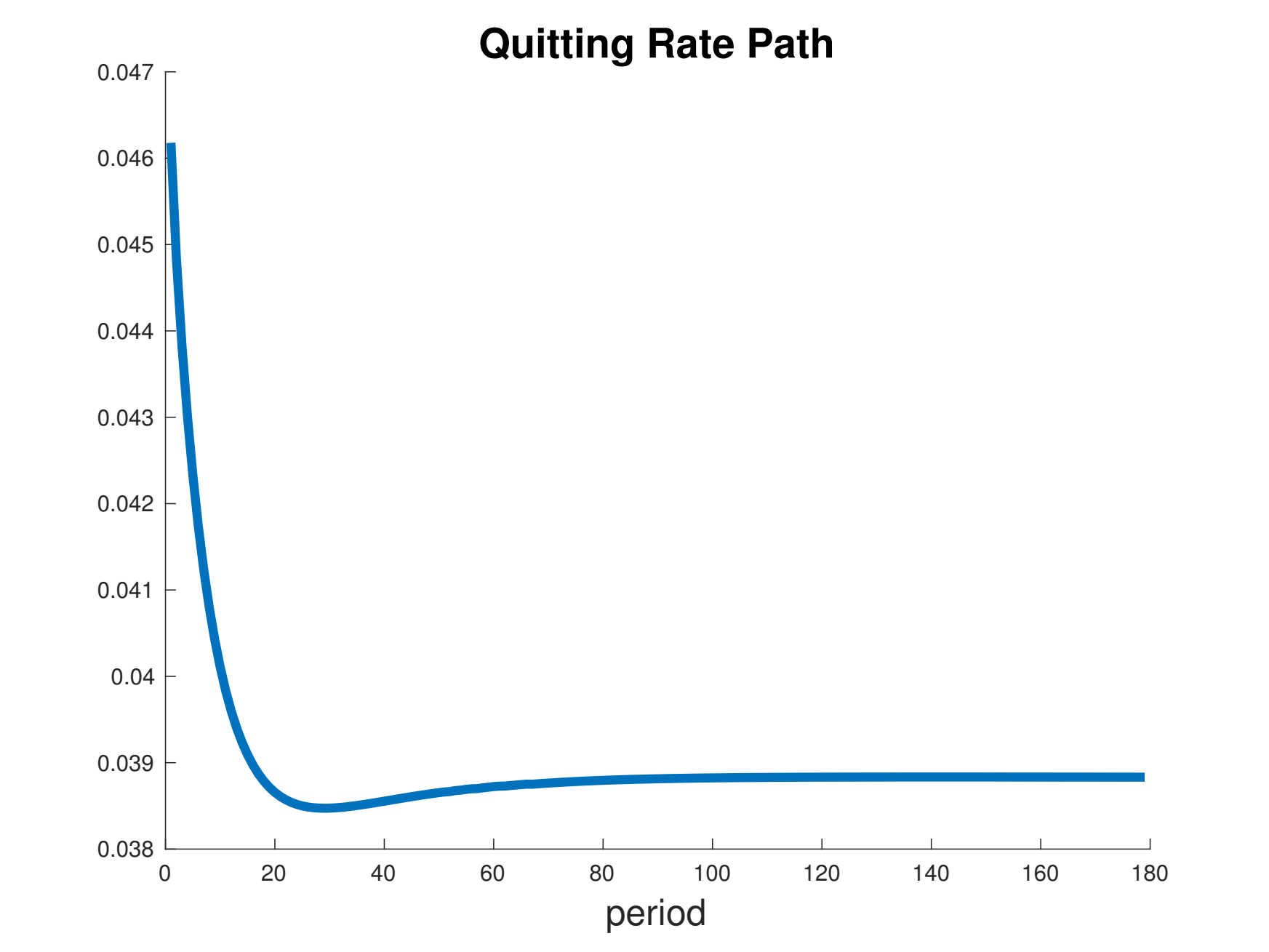
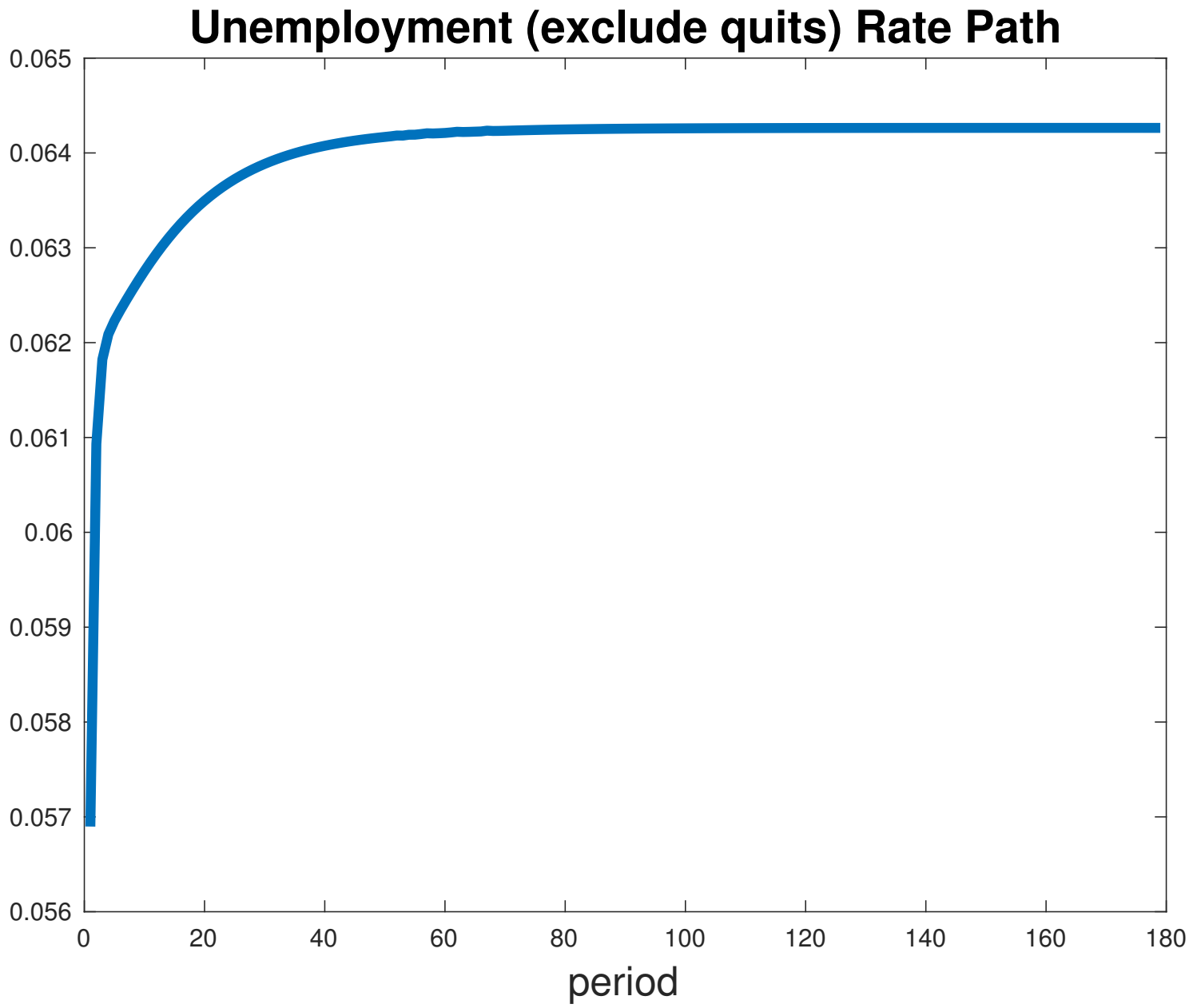


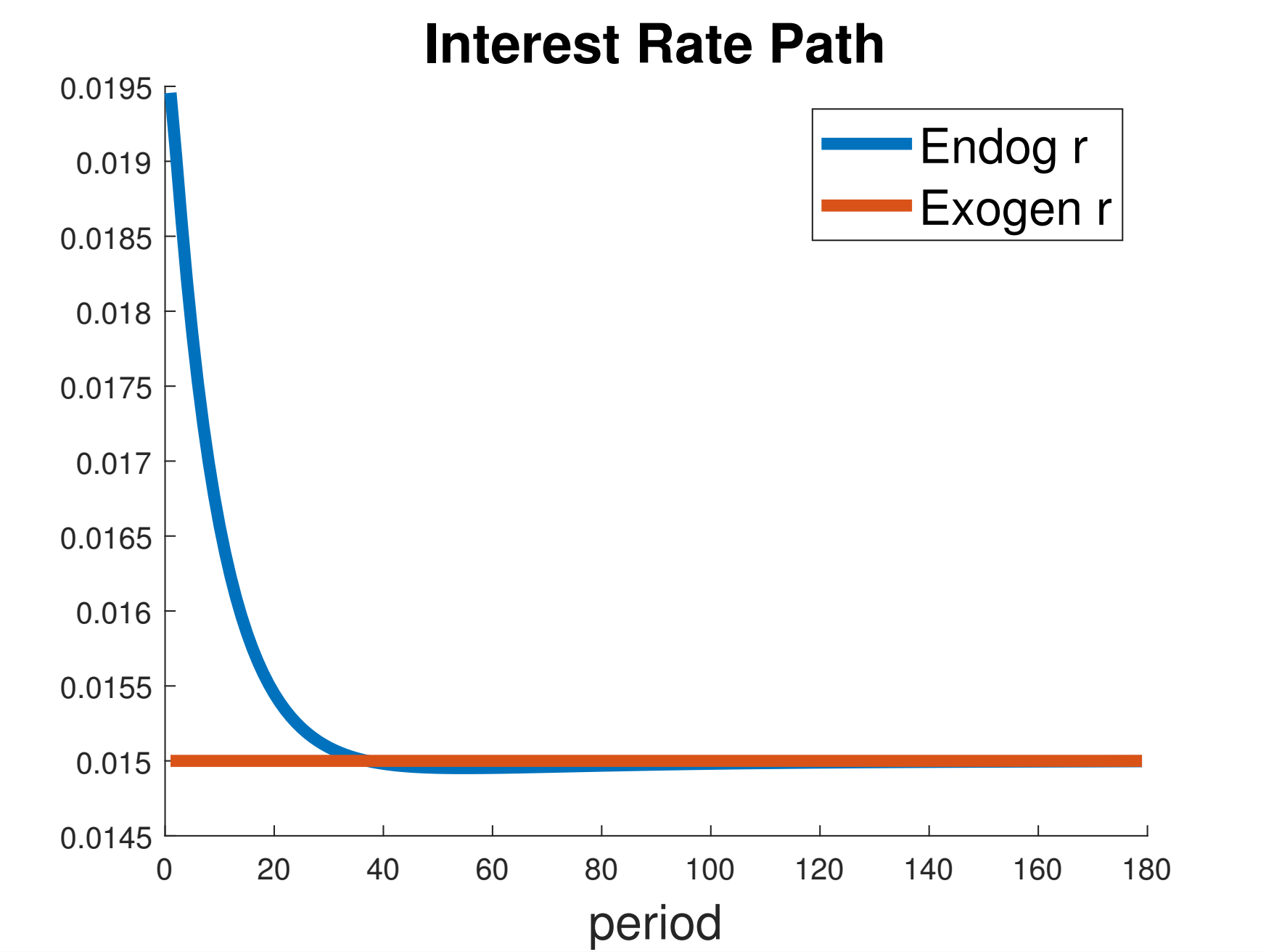
Aiming and Quitting Model. 5% Productivity Shock ($\rho = .99$)



Aiming and Quitting Model (Endogenous r). 5% Productivity Shock ($\rho = .9$)

- Interest rate r goes up endogenously as a response of positive technology shocks
- As a consequence wages and employment move less
- Quits are still pro-cyclical but much less in magnitude
- Massive movements in mutual fund value but little in wages and employment

Aiming and Quitting Model. 5% Productivity Shock ($\rho = .9$)



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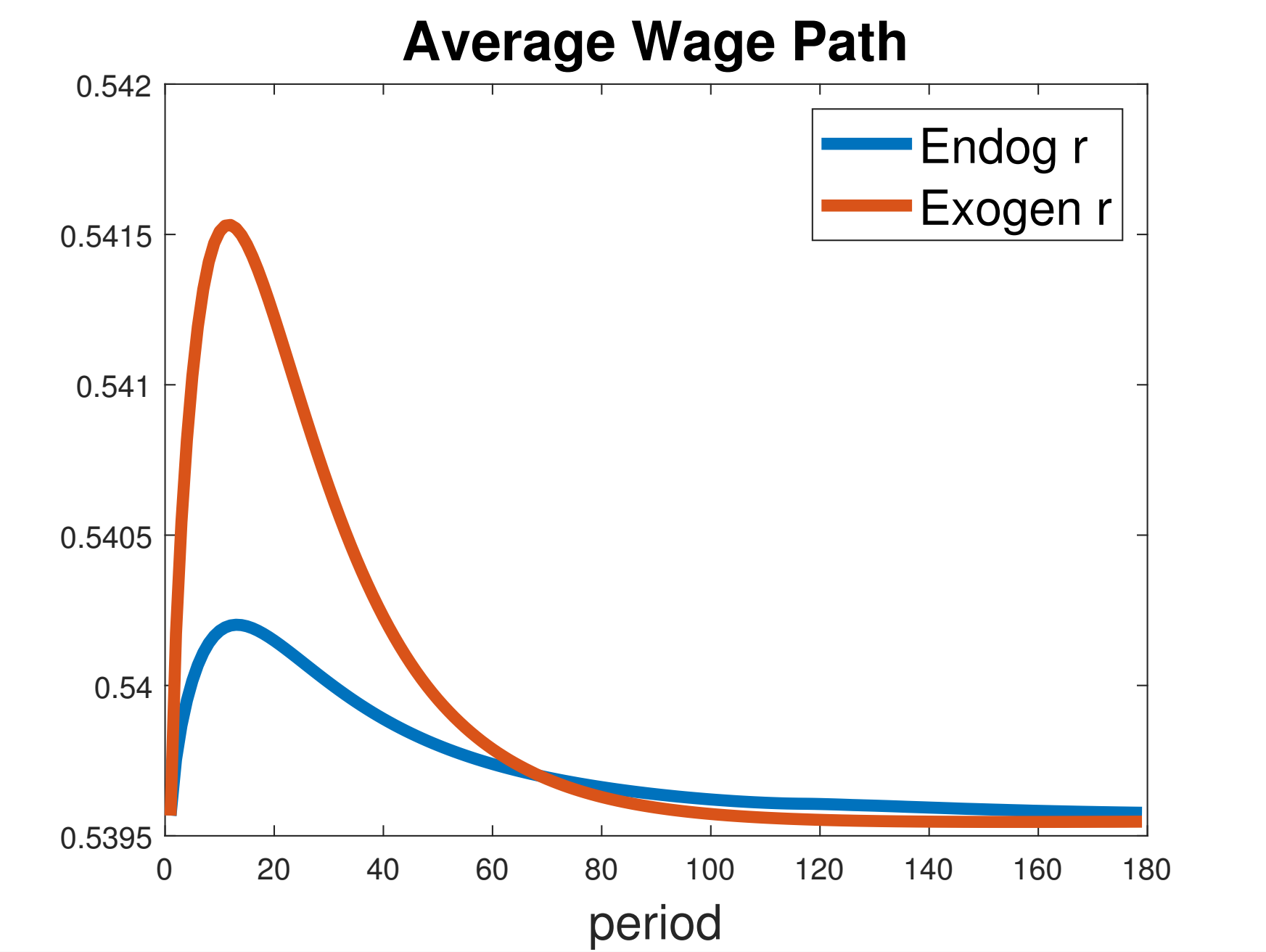

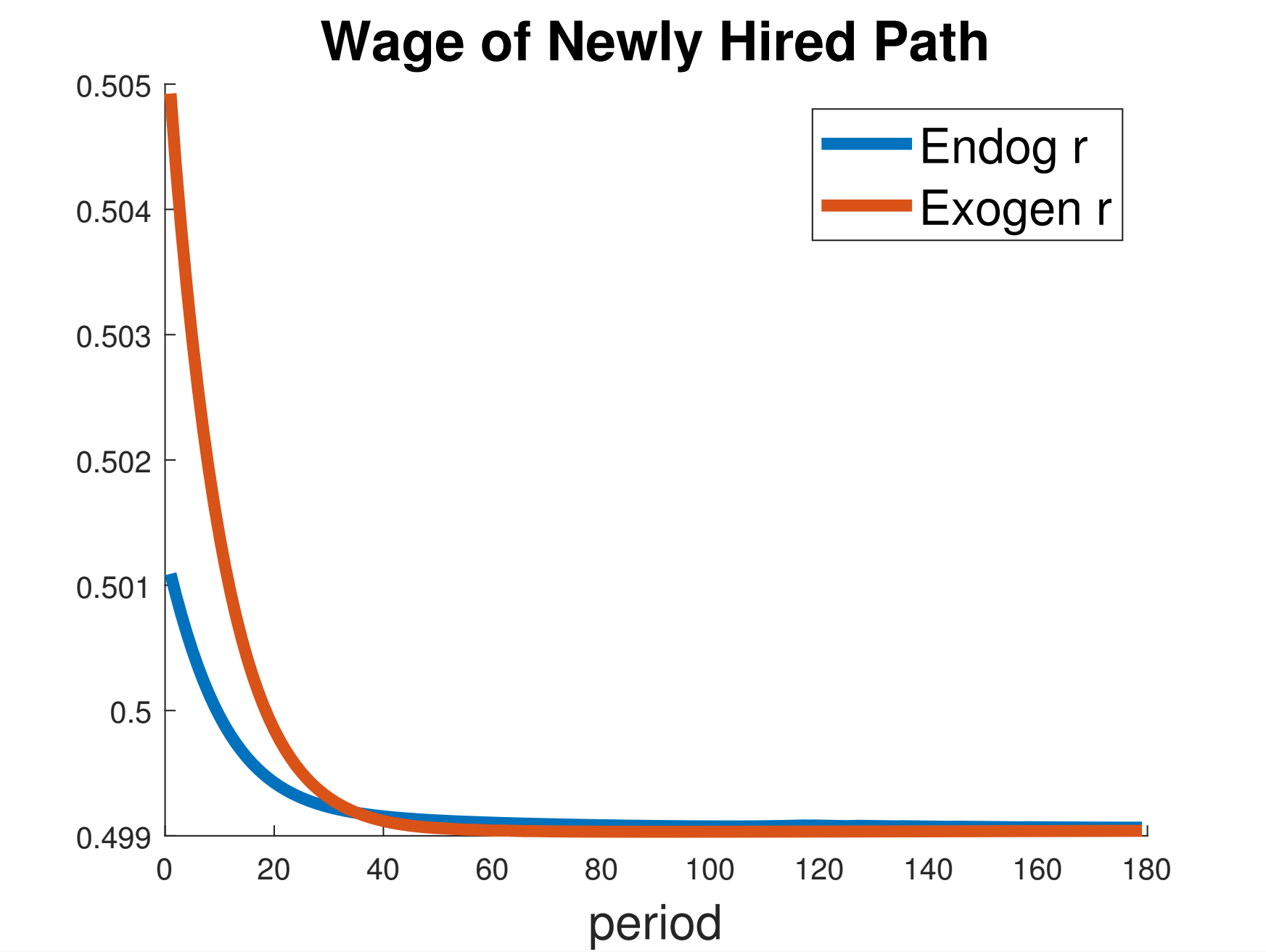
Wage of Newly Hired Path
0.505
0.504
0.503
0.502
0.501
0.5
0.499
0
20
40
60
80
100
120
140
160
180
period
Endog r
Exogen r

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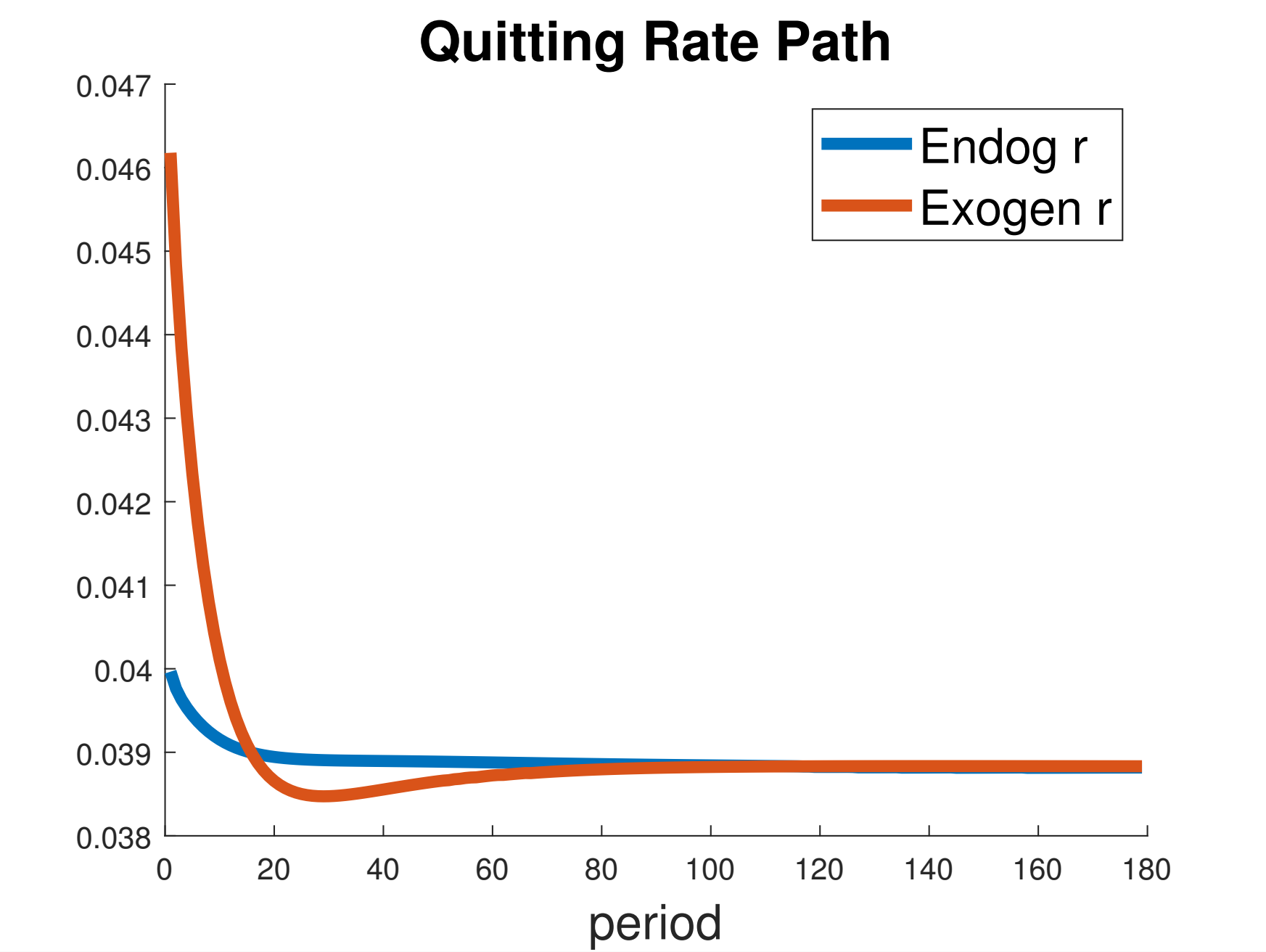

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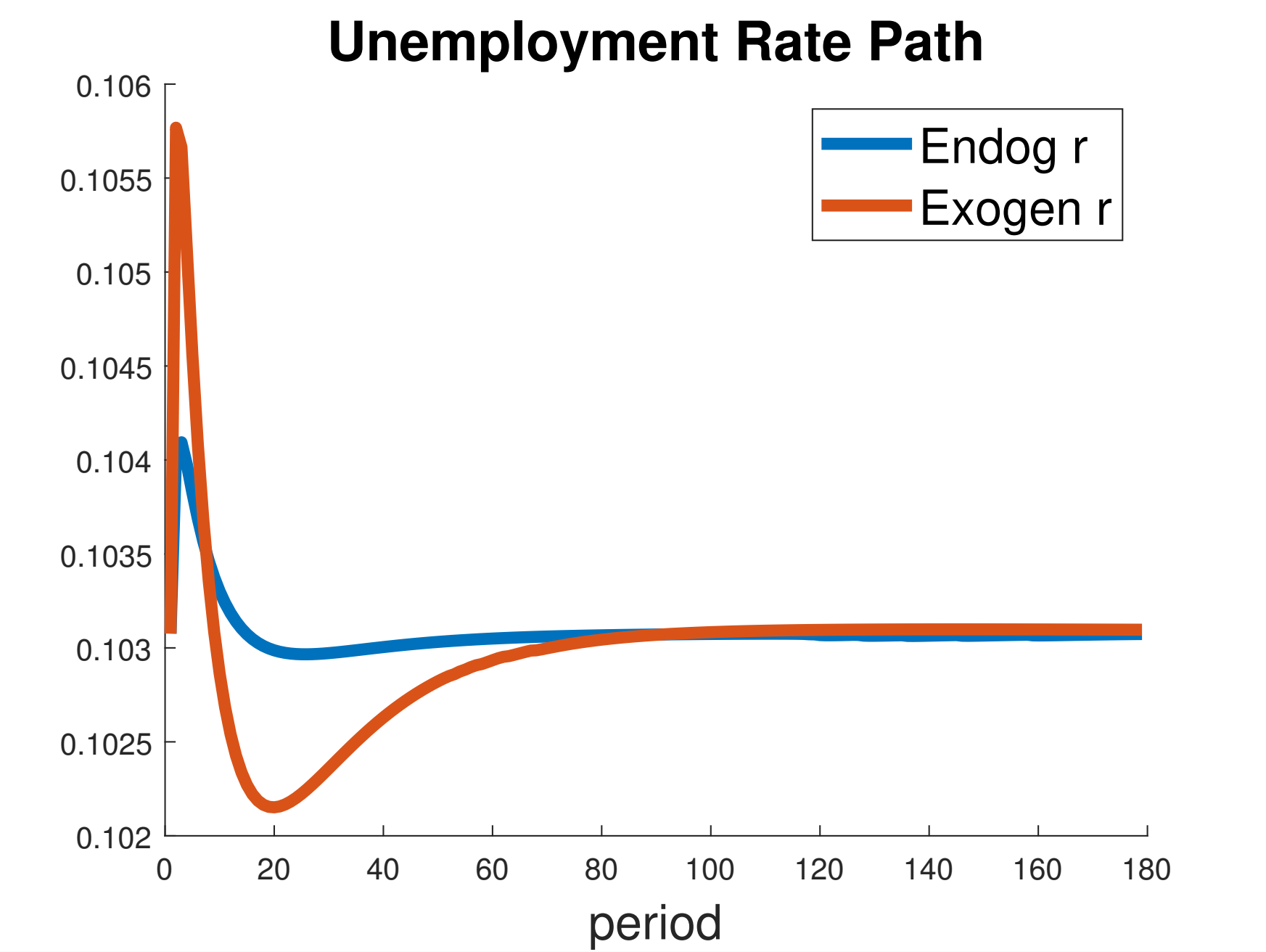

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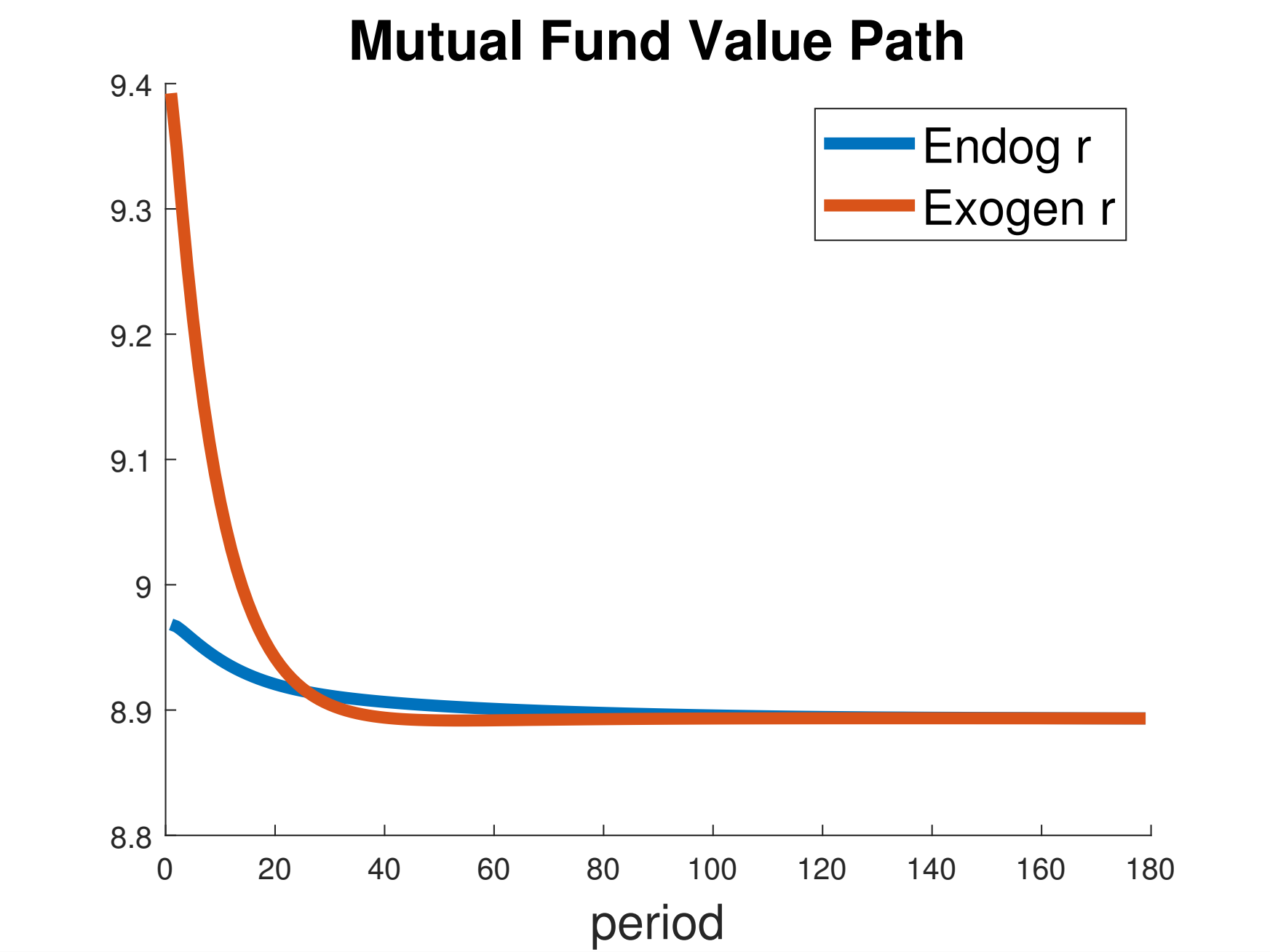
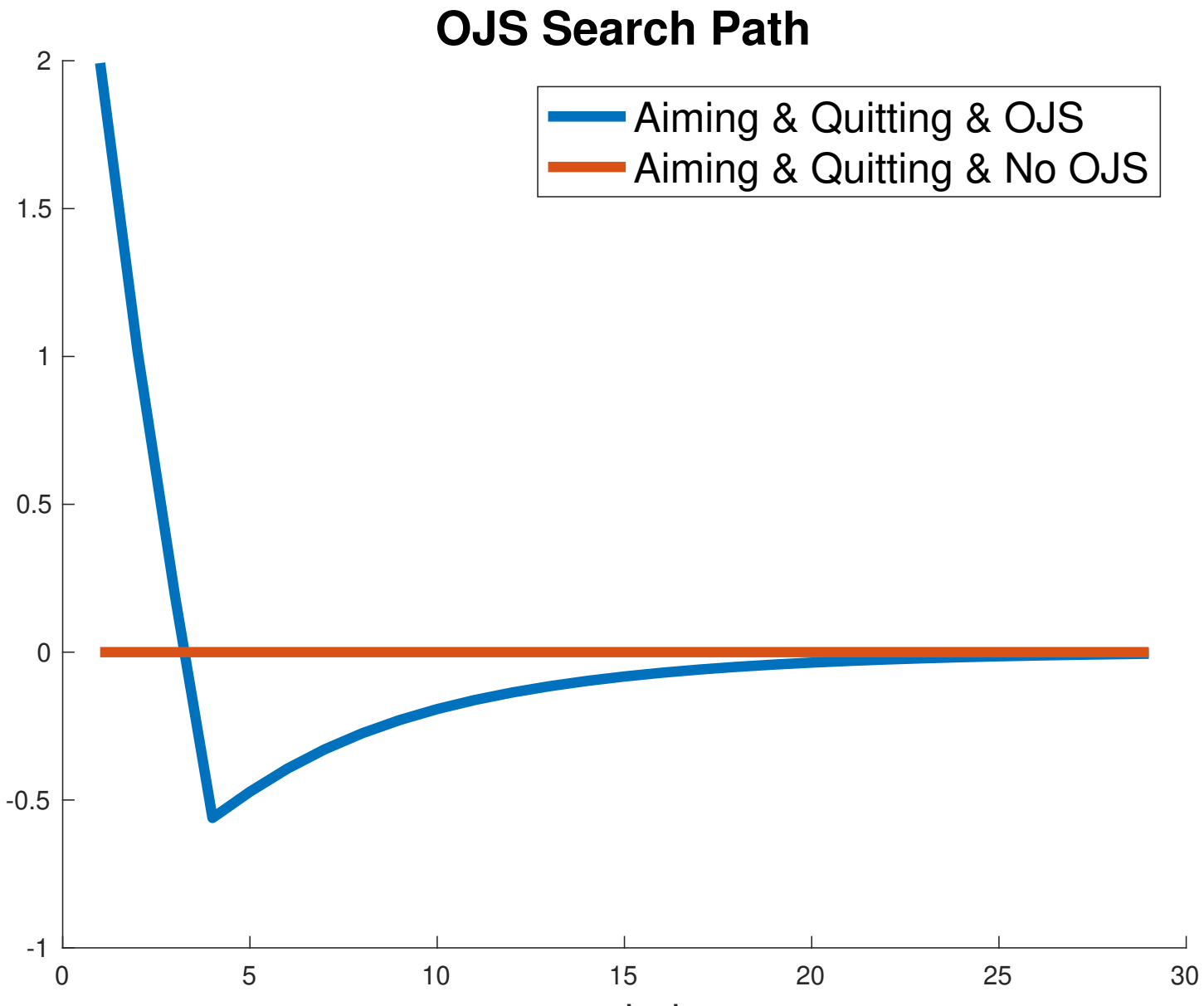


Business Cycle Behavior of On the Job Search

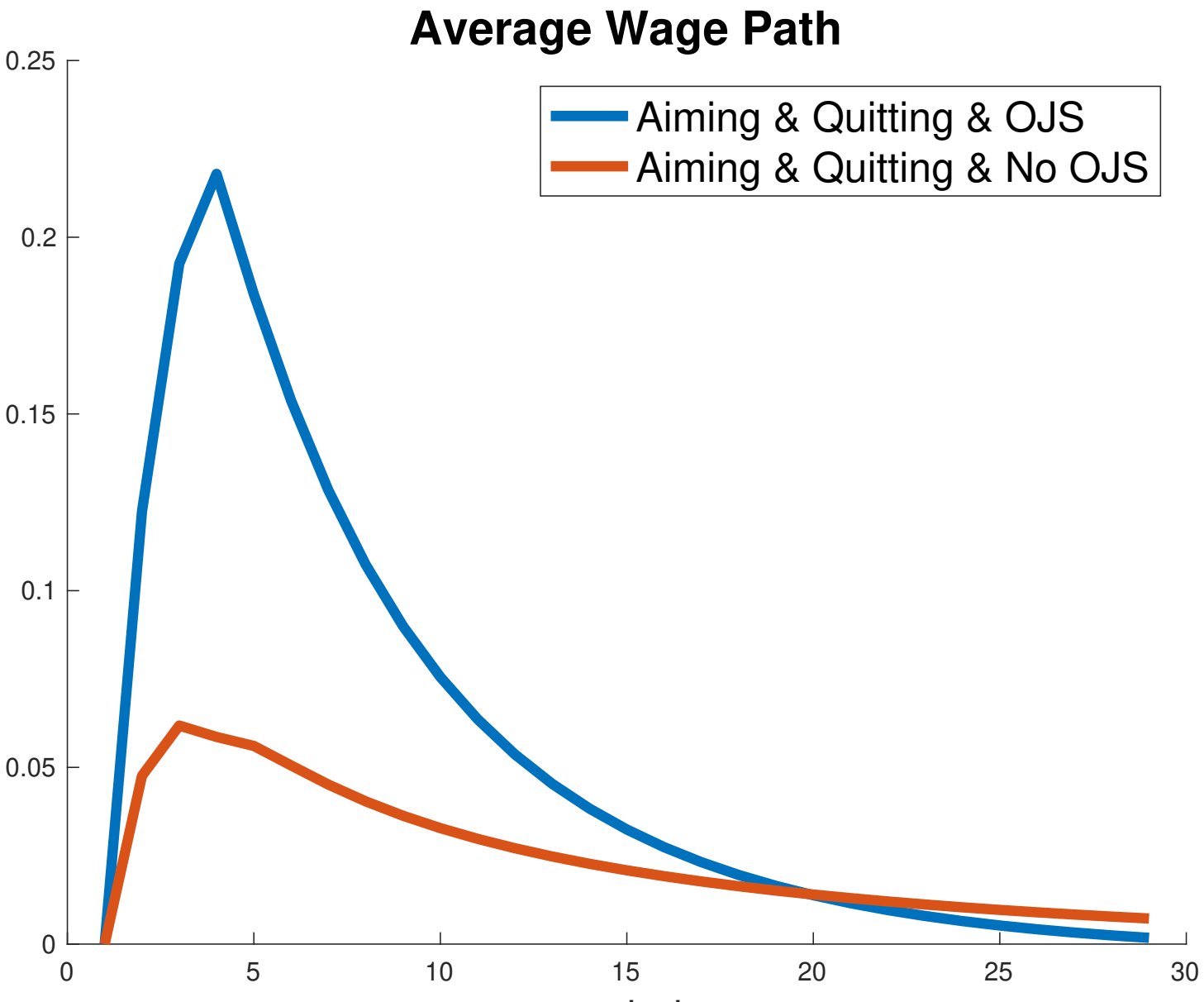
5% Produ. Shock ($\rho = .9$) for 5 periods

- Shocks are truncated at $t = 5$
  - Eliminating future shocks reins in the massive initial quits
  - Converge faster and less computational burden
- OJS Switches are Pro-cyclical
- OJS search amplifies the responses of wages and employment

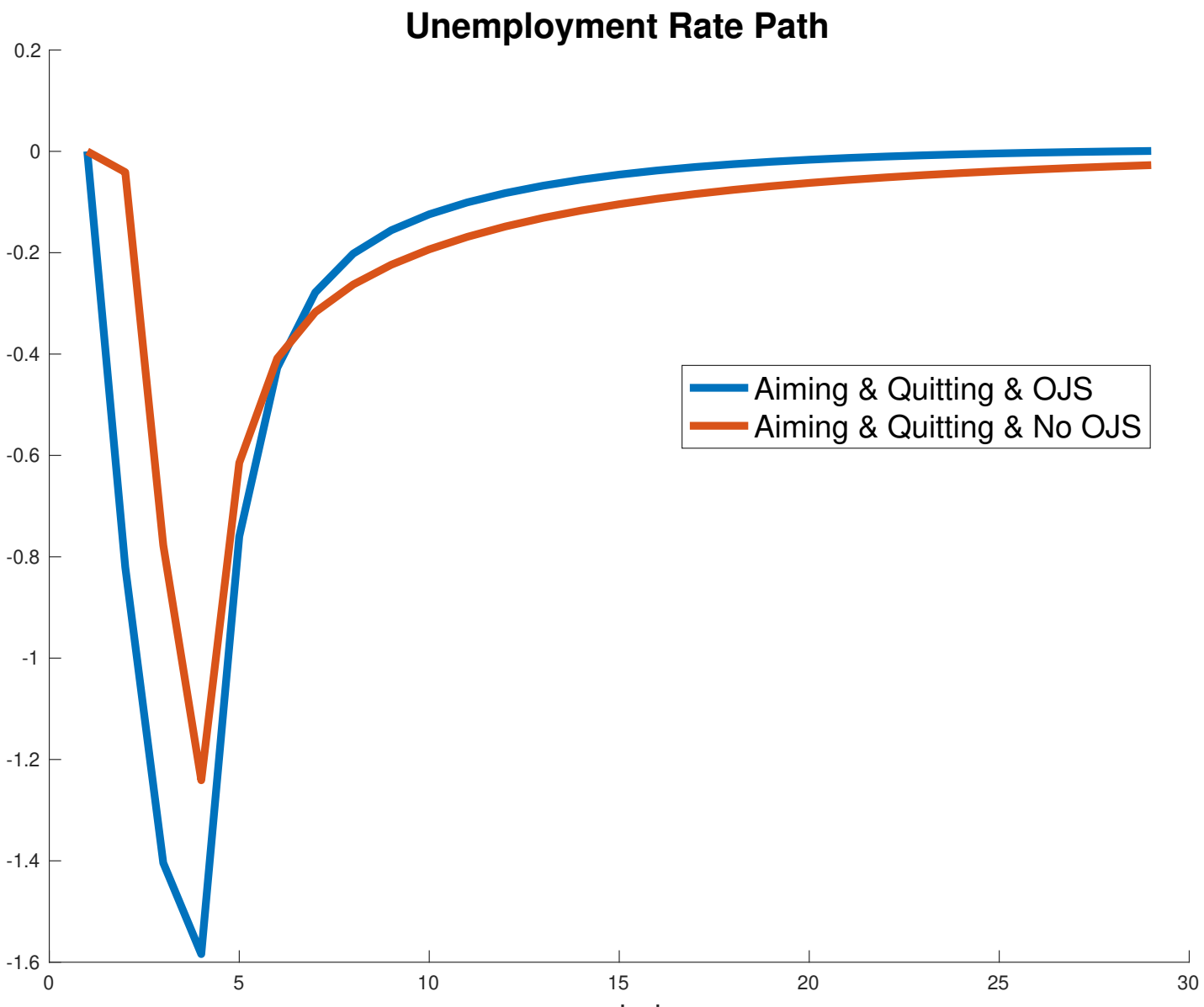
OJS 5% Productivity Shock ($\rho = .9$, truncated at t=5) OJS Search Rate, Percent Deviations



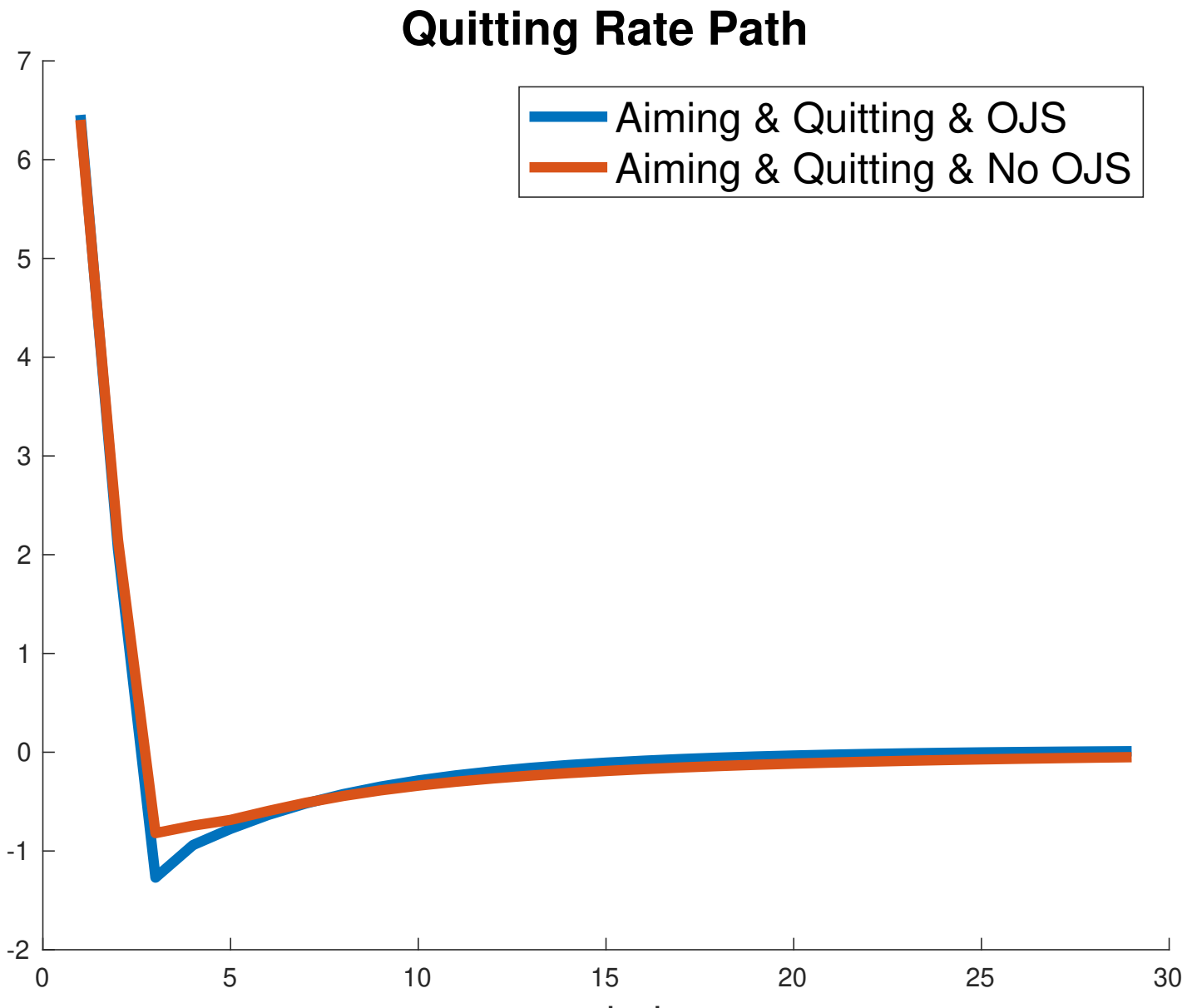
OJS 5% Productivity Shock ($\rho = .9$, truncated at t=5) Avg Wage, Percent Deviations



OJS 5% Productivity Shock ($\rho = .9$, truncated at t=5) Unemployment, Percent Deviations



OJS 5% Productivity Shock ($\rho = .9$, truncated at t=5) Quits, Percent Deviations



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- Useful for business cycle analysis: We are getting procyclical

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  - Move towards more sophisticated life cycle movements

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.

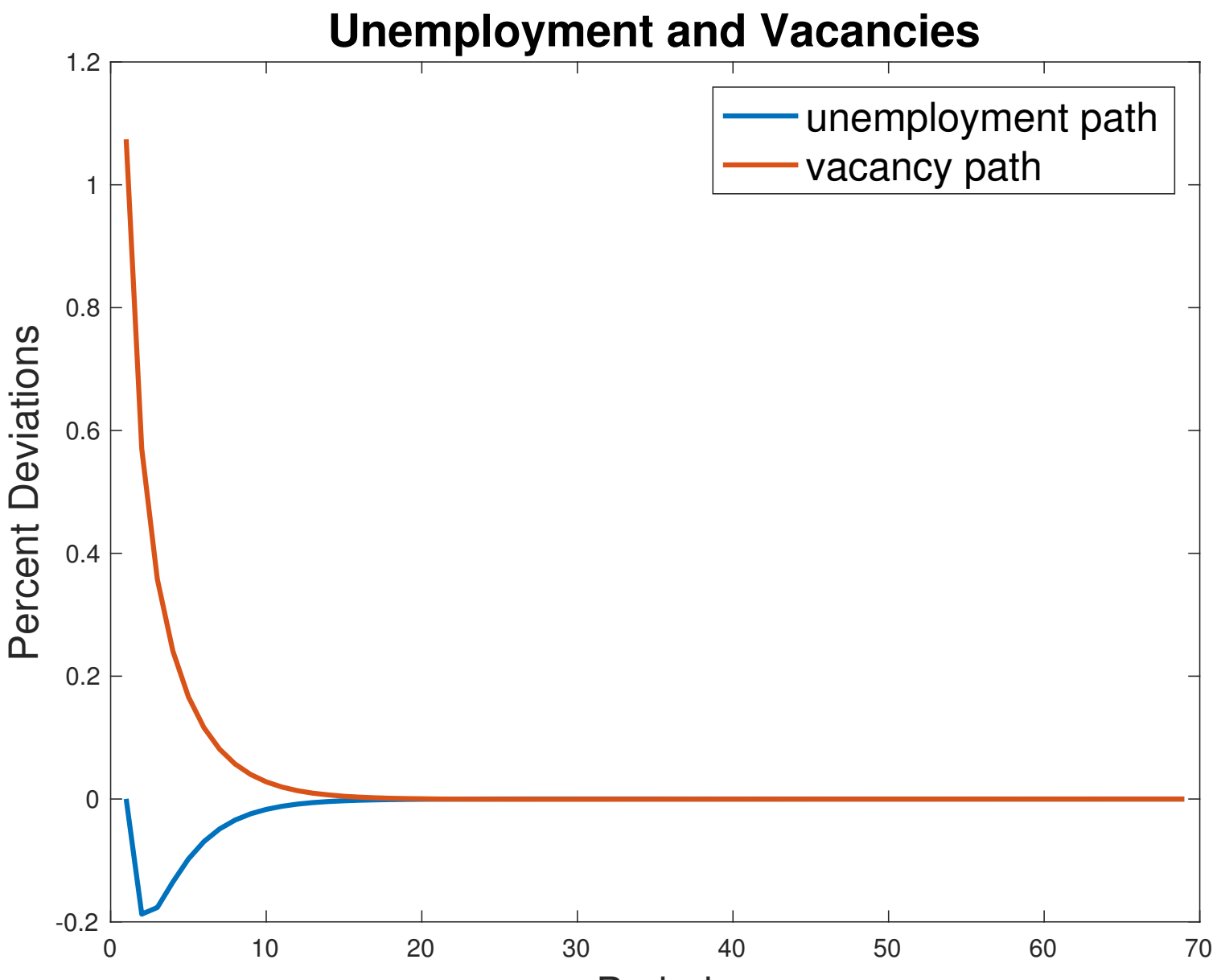
———. 2017. "Job uncertainty and deep recessions." *Journal of Monetary Economics* 90 (C):125–141. URL https://ideas.repec.org/a/eee/moneco/v90y2017icp125-141.html.

Appendix

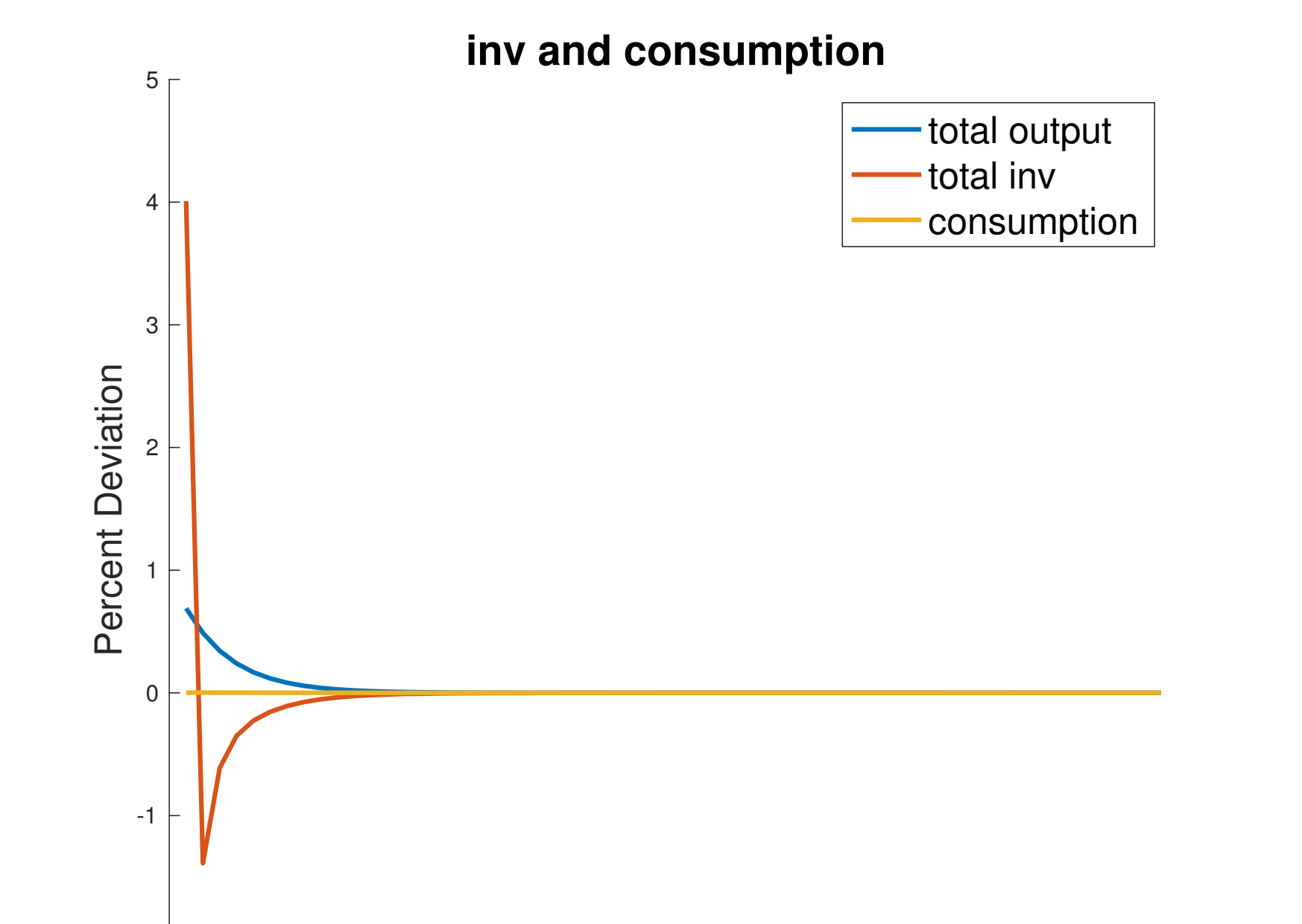
Appendix A: Insufficient Employment Volatility

- The model features strong response of investment but insufficient response of employment.
  - We examine the mechanics of this.
- Consider for simplicity the model with aiming shocks but no quitting shocks (ANQ model). For a 1% productivity shock (with persistence 0.7), it generates
  - 1% increase of vacancies
  - 0.2% decrease of unemployment, which translates to only 0.01% increase of employment
  - and 4% increase of investment

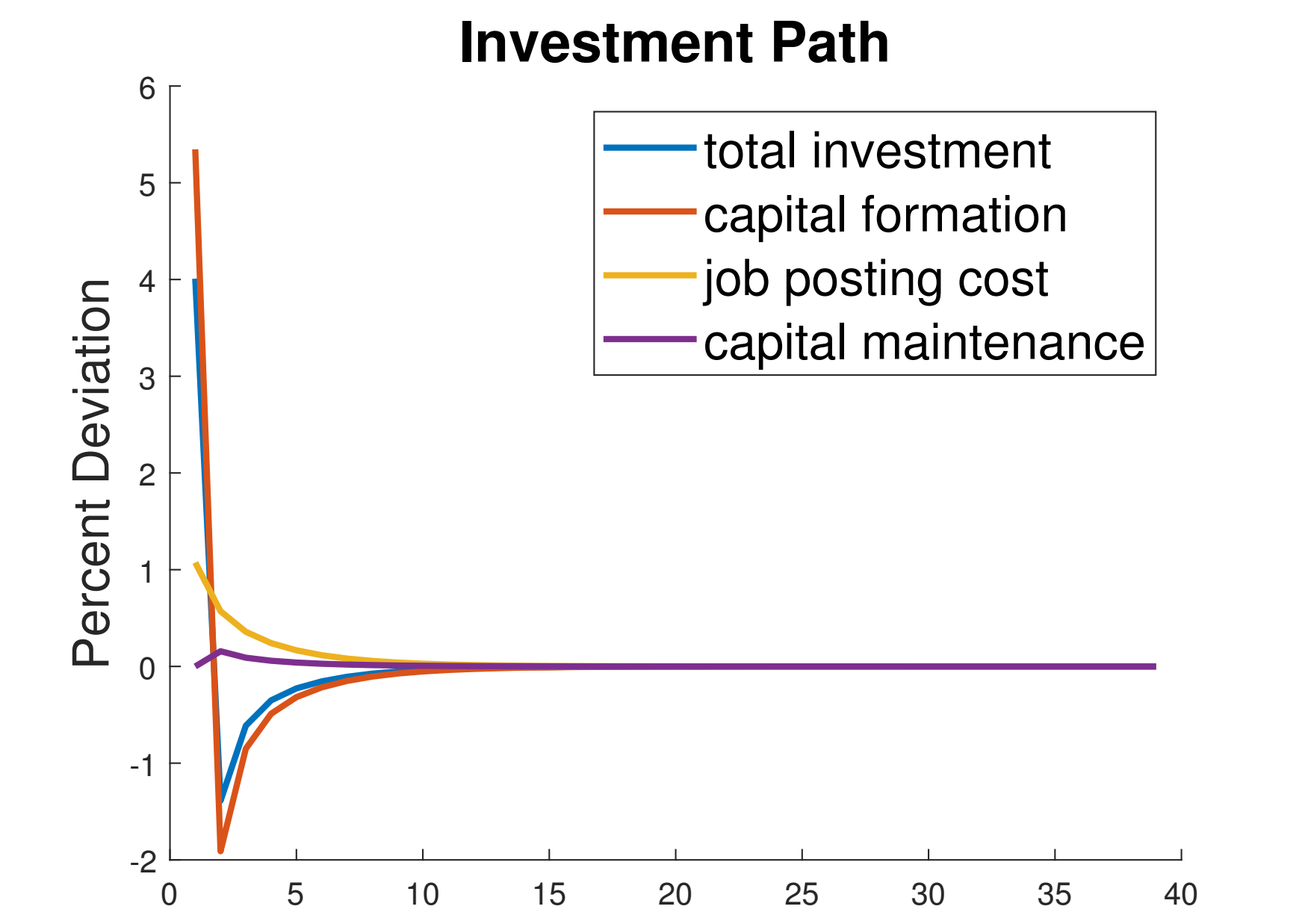
ANQ: 1% Productivity Shock ($\rho = .7$) unemployment and vacancies



ANQ: 1% Productivity Shock ($\rho = .7$) Output, investment and consumption



ANQ: 1% Productivity Shock ($\rho = .7$) Decomposition of the investment



Appendix A: Insufficient Employment Volatility

- Why does 1% increase of vacancies v generate 4% increase of investment?
  - At the steady state, about 80% of the vacancies are posted by old idle firms and 20% by newly created firms.
  - Investment = wage posting cost + capital maintenance cost + new capital formation
  - As the shock hits the economy, firstly it only increases the creation of new firms, generating massive movements of investment in the form of capital formation (ek).
- Why does 1% increase of vacancies v generate only 0.01% increase of employment?
  - As an approximation, $\hat{m} = (1-\eta)\hat{v} + \eta\hat{u}$.
  - Upon facing the shock, at first u does not move. So the response of matches depend on the response of v and the parameter η.
  - $\hat{m} \approx (1-0.72) \times 1\% = 0.28\%$, and $\frac{\Delta m}{1-u} = \frac{0.28\% \times 0.03}{0.95} \approx 0.01\%$
  - Lower η relieves the problem (see the next page).

Lower η and Truncated 5% shock: AQ Economy