Economics 742 Bonus Macro-Labor Lecture 3: The Unemployment Volatility Puzzle and Sticky Wages

Adam M. Guren

Boston University

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Unemployment Volatility Puzzle and Stick Wages

1. Unemployment Volatility Puzzle
   - 1.1 Shimer (2005)
   - 1.2 Ljungqvist and Sargent (2017) Framework
2. Value of Unemployment: Hagedorn and Manovskii (2008)
3. Wage Stickiness
   - 3.1 Hall (2005), Hall and Milgrom (2008), Shimer (book) and the Barro (1979) Critique
   - 3.2 Evidence on Sticky Wages
     - 3.2.1 Barsky, Solon, and Parker (1992)
     - 3.2.2 Elsby, Shin, and Solon (2016)
   - 3.3 Pissarides (2009)
4. Finance and Discount Rates: Schoefer (2016), Hall (2014)
5. Rationing: Michaillat (2012)

How Well Does the DMP Model Explain the World?

- Initial literature: Pretty well!
- Shimer (2005): Very badly.
  - Volatility of unemployment in response to reasonably-sized shocks is many orders of magnitude smaller than in the data.
  - Similar to RBC: Prices adjust a lot, quantities very little.
    - Instead of working to flatten supply and demand curves, flatten job creation and wage condition in (θ, w) space.
- Huge literature in last 10 years seeks to explain puzzle.
  - Primary focus of macro labor for a decade.
  - Active debate: many explanations, difficult to distinguish.
    - Wage cyclicality and recruiting costs tough to measure.
  - I will cover key papers in this voluminous literature.

Shimer (2005): Volatilities and Correlations in Data

TABLE 1—SUMMARY STATISTICS, QUARTERLY U.S. DATA, 1951–2003

		u	v	v/u	f	s	p
Standard deviation		0.190	0.202	0.382	0.118	0.075	0.020
Quarterly autocorrelation		0.936	0.940	0.941	0.908	0.733	0.878
Correlation matrix	u	1	−0.894	−0.971	−0.949	0.709	−0.408
	v	—	1	0.975	0.897	−0.684	0.364
	v/u	—	—	1	0.948	−0.715	0.396
	f	—	—	—	1	−0.574	0.396
	s	—	—	—	—	1	−0.524
	p	—	—	—	—	—	1

u = unemp , v= vacancy, f= finding rate,
s = separation rate, p= labor productivity

Shimer (2005): Matching Function

- $m(u, v) = \mu u^{\alpha} v^{1-\alpha}$ estimates $\alpha \in [0.70, 0.75]$ depending on specification. Central estimate is 0.72 (0.01).

Shimer (2005): Pissarides Model With Poisson Shocks

- Shimer takes Pissarides (1985) model with exogenous separations, undirected search and Nash bargaining adds shocks to y or λ that occur at poisson rate ζ.
  - Previously had one equilibrium condition:

$$(1-\chi)\frac{y-b}{k} = \frac{r+\lambda}{q(\theta)} + \chi\theta$$

  - This becomes:

$$(1-\chi)\frac{y-b}{k} + \zeta E_{y,\lambda}\frac{1}{q(\theta_{y',\lambda'})} = \frac{r+\lambda+\zeta}{q(\theta_{\theta,\lambda})} + \chi\theta_{y,\lambda}$$

- Trivial to solve this on a grid for (y, λ).
  - Shimer uses approximation to Oronstein-Uhlenbeck process.
  - When shock hits, new value y' moves up or down one grid point with asymmetric probability.

Shimer (2005): Comparative Statics

- Before calibrating and simulating, comparative statics on no-aggregate-shock steady state to develop intuition.
  - Adjustment to steady state is quick.
  - So approximate dynamics with comparative statics.
- Assuming $\zeta = 0$,

$$(1-\chi)\frac{y-b}{k} = \frac{r+\lambda}{q(\theta)} + \chi\theta$$

- The elasticity of θ w.r.t $y-b$ is:

$$\varepsilon_{\theta,y-b} = \frac{r+\lambda+\chi\theta q(\theta)}{(r+\lambda)\eta(\theta)+\chi\theta q(\theta)}$$

Shimer (2005): Comparative Statics: Productivity

$$\varepsilon_{\theta,y} = \frac{r + \lambda + \chi\theta q(\theta)}{(r + \lambda)\eta(\theta) + \chi\theta q(\theta)}$$

- This is large only if η is close to zero (bounded above by $\frac{1}{\eta}$) and χ is small.
  - $\eta = .72 \Rightarrow \varepsilon_{\theta,y-b}$ is small in a wide range of calibrations. "It would take implausible parameter values for this to exceed 2."
  - In data, θ is 19 times as volatile as labor productivity.
- Intuition:
  - Increase in $y - b$ makes jobs more valuable and increases vacancy creation.
  - This shortens unemployment duration, raising workers threat point and wages.
  - In equilibrium, higher wages absorb most of increase, and $v - u$ ratio moves little.

Shimer (2005): Comparative Statics: Separations

- Similarly, for the separation rate,

$$\varepsilon_{\theta,\lambda} = \frac{-\lambda}{(r+\lambda)(1-\eta(\theta)) + \chi\theta q(\theta)}$$

- This elasticity is tiny given λ, r, and η in data.
- Increase in separations $\Rightarrow$ increase in u $\Rightarrow$ with θ roughly unchanged $\Rightarrow$ increase in v.
  - Generates counterfactual positive $u - v$ correlation.
- Pissarides (2009): Result holds with endogenous job destruction due to envelope theorem: profit of jobs near y_R near zero; their destruction has ε effect on NPV of creation.

Shimer (2005): Calibration

- Choose stochastic processes to match labor productivity and separations (in two separate calibrations).
- Annual discount rate of $\approx 5\%$.
- Quarterly matching function $q(\theta) = 1.355\theta^{-.72}$
  - Matching function constant and vacancy cost to match average job finding rate and average V-U ratio.
  - Bargaining weight χ to satisfy Hosios condition.
- Value of leisure is 40% of value of employment.

Shimer (2005): Results For Productivity Shocks

		u	v	v/u	f	p
Standard deviation		0.009	0.027	0.035	0.010	0.020
		(0.001)	(0.004)	(0.005)	(0.001)	(0.003)
Quarterly autocorrelation		0.939	0.835	0.878	0.878	0.878
		(0.018)	(0.045)	(0.035)	(0.035)	(0.035)
Correlation matrix	u	1	−0.927	−0.958	−0.958	−0.958
			(0.020)	(0.012)	(0.012)	(0.012)
	v	—	1	0.996	0.996	0.995
				(0.001)	(0.001)	(0.001)
	v/u	—	—	1	1.000	0.999
					(0.000)	(0.001)
	f	—	—	—	1	0.999
						(0.001)
	p	—	—	—	—	1

- Recall $\sigma(u) = 0.19$, $\sigma(v/u) = 0.382$.

Shimer (2005): Results For Separation Shocks

		u	v	v/u	f	s
Standard deviation		0.065	0.059	0.006	0.002	0.075
		(0.007)	(0.006)	(0.001)	(0.000)	(0.007)
Quarterly autocorrelation		0.864	0.862	0.732	0.732	0.733
		(0.026)	(0.026)	(0.048)	(0.048)	(0.048)
Correlation matrix	u	1	0.999	−0.906	−0.906	0.908
			(0.000)	(0.017)	(0.017)	(0.017)
	v	—	1	−0.887	−0.887	0.888
				(0.020)	(0.020)	(0.021)
	v/u	—	—	1	1.000	−0.999
					(0.000)	(0.000)
	f	—	—	—	1	−0.999
						(0.000)
	s	—	—	—	—	1

- Recall $corr\,(u, v) = -0.894$.

Ljungqvist and Sargent (2017): Fundamental Surplus

- Ljungqvist and Sargent (2017) provide a useful framework for thinking about the unemployment volatility puzzle and the "resolutions" we will turn to next.
- Take steady state elasticity of θ w.r.t $y-b$ and make it wrt y:

$$\varepsilon_{\theta,y} = \frac{r+\lambda+\chi\theta q(\theta)}{(r+\lambda)\eta(\theta)+\chi\theta q(\theta)}\frac{y}{y-b} \equiv \Upsilon^{Nash}\frac{y}{y-b}$$

- The first factor $\Upsilon^{Nash} = \varepsilon_{\theta,y-b}$, the quantity Shimer argued was small based on the elasticity of the matching function.
- $\frac{y-b}{y}$ is what Ljungqvist and Sargent call the *fundamental surplus fraction*.
  - $\varepsilon_{\theta,y}$ is big when the fundamental surplus fraction is small.
  - Shimer sets $\frac{y-b}{y} = .6$ so it is large.
  - $b = .7$ is now used frequently due to Hall and Milgrom (2008), which halves size of problem

Ljungqvist and Sargent (2017): Fundamental Surplus

- The fundamental surplus $y - b$ is an upper bound on how much of a job's surplus can be allocated to vacancy creation.
  - A given change in y causes a bigger percentage change in $y - b$ when $\frac{y-b}{y}$ is small.
  - This leads to a bigger percentage change in the resources allocated to vacancy creation.
  - And thus a bigger response of θ and unemployment.

- Interpretation: The unemployment volatility puzzle arises because a shock to productivity causes a small percentage change in resources allocated to vacancy creation.
  - LS argue all "resolutions" work through shrinking the fundamental surplus fraction.
  - Let's go through the most well-known resolutions.

Hagedorn and Manovskii (2008): Value of Unemployment

- Hagedorn and Manovskii introduce alternate calibration procedure that generates observed volatility in θ.
  - Shimer set $b = .4$ and $\chi = .72$ to satisfy Hosios.
  - Hagedorn and Manovskii set $b = .955$ and $\chi = .052$.
  - Low b (and to much lesser extent low χ) leads to a very high elasticity, as small shocks to y affect surplus substantially:

$$\varepsilon_{\theta,y} = \frac{r + \lambda + \chi\theta q(\theta)}{(r + \lambda)\eta(\theta) + \chi\theta q(\theta)} \frac{y}{y - b}$$

- Get params by matching the elasticity of real wages to labor productivity and the size of vacancy posting costs:
  - Low cyclicality of wages $\Rightarrow$ low worker bargaining power.
  - Low vacancy posting costs $\Rightarrow$ low profits from creating vacancy $\Rightarrow$ given high firm bargaining power, must be very low $y - b$.
- Simulation: $\sigma(v/u) = 0.29, 0.26$ in preferred data.

Chodorow-Reich and Karabarbounis (2016): Cyclical b

- Chodorow-Reich and Karabarbounis (2016) critique Hagedorn and Manovskii (2008).
  - But not just saying their b is too high!
- Construct time series for b, opportunity cost of employment.
  - Foregone public benefits. Countercyclical but small.
  - Foregone value of non-working time. This is highly pro-cyclical because leisure time valued less when consumption is low.
  - Second effect dominates the first.
- Pro-Cyclical b works against Hagedorn and Manovskii. y and b move together $\Rightarrow$ $y - b$ acyclical $\Rightarrow$ incentive to create vacancy acyclical.
- Hall and Milgrom (2008) also critique Hagedorn and Manovskii (2008) by pointing out their calibration generates too high of a labor supply elasticity.

Hall (2005): Wage Stickiness

- Hall (2005) proposes wage stickiness as a solution to the unemployment volatility puzzle.
  - If productivity fluctuates while wage does not, value of posting a job fluctuates a lot over the cycle.
- Issue: Barro (1977) Critique of Wage Stickiness
  - Wage stickiness excludes mutually advantageous trades.
  - Workers want to work more at lower wages, employers want to hire more at lower wages. Rational agents should agree to cut wages.
- Hall's solution:
  - Wage is sticky (or even fixed), but always in the bargaining set.
  - Nothing special about Nash bargain. Can have fixed wage as long as it is in bargaining set.
  - Avoids Barro critique: Stickiness not preventing mutually-advantageous trade.

Hall (2005): Fixed Wages

- Hall (2005) shows that the model fits well with an entirely fixed wage that remains in bargaining set.
- The job creation condition is:

$$y - \bar{w} = \frac{r + \lambda}{q(\theta)} k$$

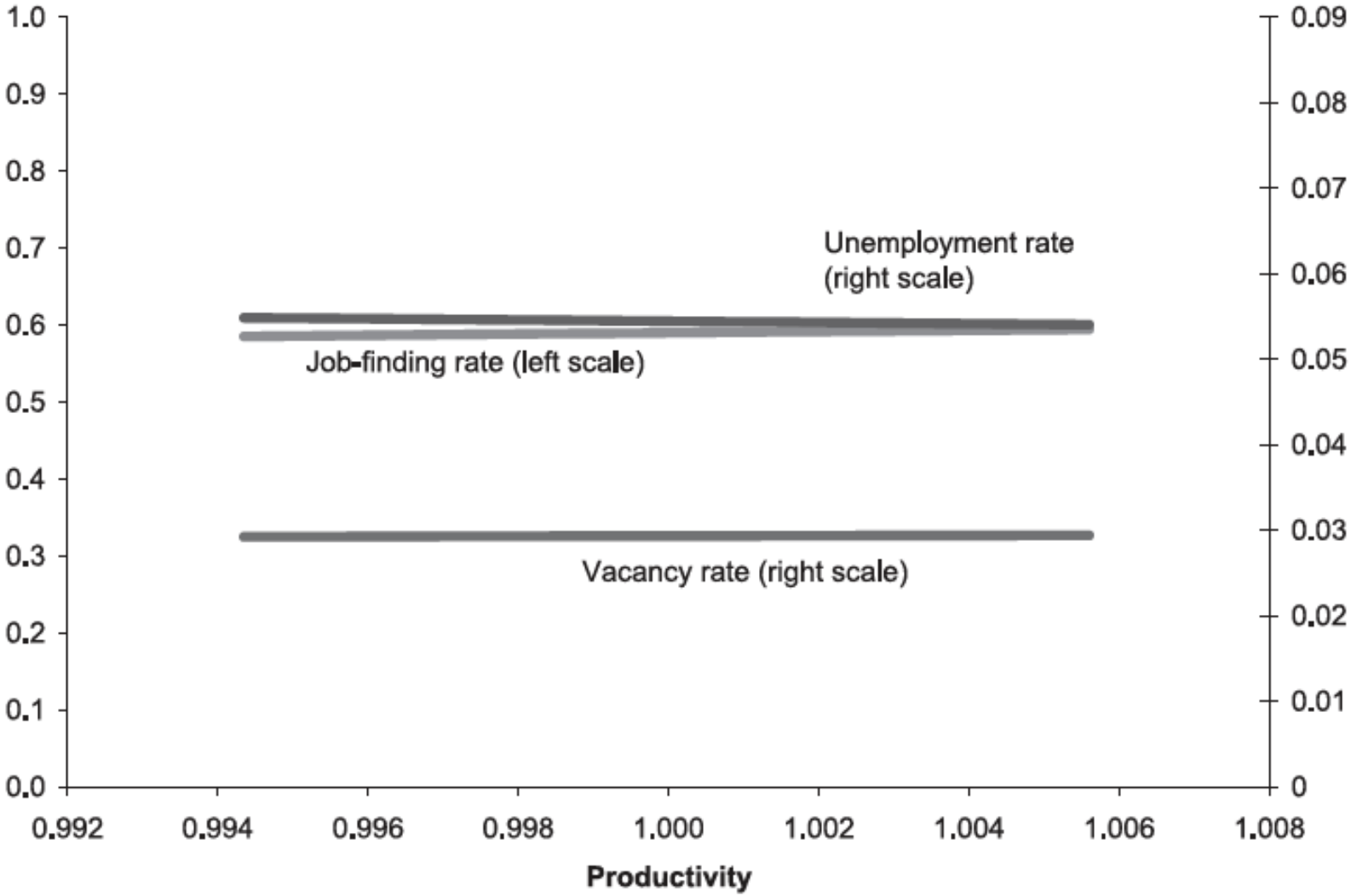
- The steady state elasticity is:

$$\varepsilon_{\theta,y} = \frac{1}{\eta} \frac{y}{y - \bar{w}} \equiv \Upsilon^{sticky} \frac{y}{y - \bar{w}}$$

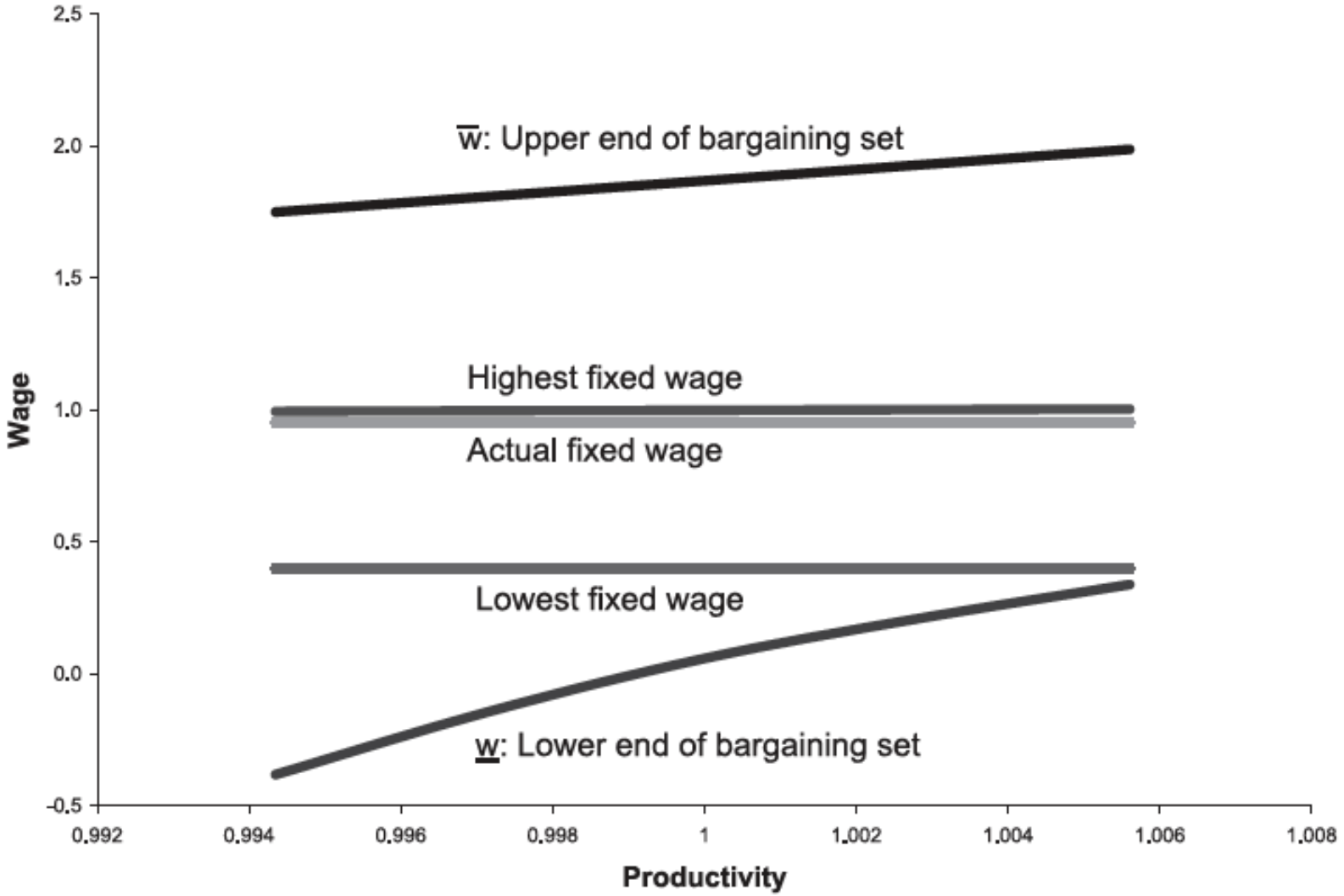
  - Ljungqvist and Sargent's (2017) fundamental surplus fraction is now relative to the sticky wage $\bar{w}$.
  - If this fraction is small, get volatile θ.

- Pro-cyclical employer share of surplus.

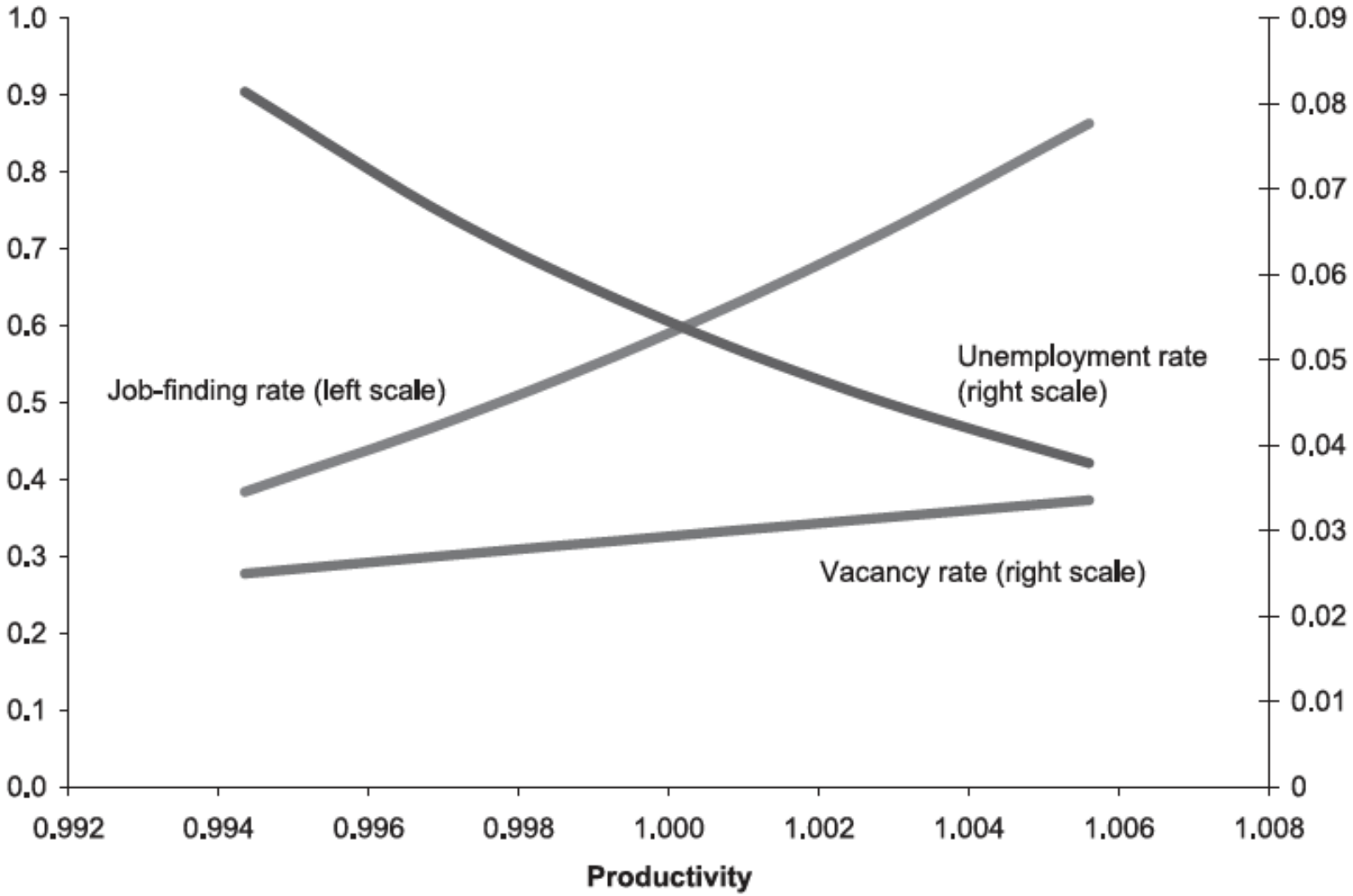
Hall (2005): Wage Stickiness



Hall (2005): Wage Stickiness



Hall (2005): Wage Stickiness



Hall (2005) and Shimer (2010): Adaptive Wages

- Hall also suggests alternatives, including an adaptive wage:

$$w_t^A = (1 - \alpha)\, w_{t-1}^A + \alpha w_t^{Nash}$$

- This type of adaptive wage is used frequently.
- Shimer (2010 book) argues that this explains the data well quite well on a number of dimensions.

Hall and Milgrom (2008): "Credible" Bargaining

- Hall and Milgrom (2008) provide an alternate bargaining protocol to Nash that gives sticky wages.
  - Noncooperative game of alternating take-it-or-leave-it offers.
  - Firm costs of delay $\gamma > 0$. Worker gets b not w due to delay.
  - Discrete time with discount factor β; wage less-sensitive to y:

$$w = \frac{b + \beta(1-\lambda)(y+\gamma)}{1 + \beta(1-\lambda)}$$

- Higher elasticity due to low fundamental surplus fraction:

$$\varepsilon_{\theta,y} = \frac{1}{\alpha} \frac{y}{y - b - \beta(1-\lambda)\gamma} = \Upsilon^{sticky} \frac{y}{y - b - \beta(1-\lambda)\gamma}$$

- Subject to Chodorow-Reich and Karabarbounis critique because worker's threat point in bargaining and wage become cyclical if b is cyclical.

Gertler and Trigari (2009): Calvo Wage Contracts

- Gertler and Trigari (2009) add staggered multi-period wage contracting to DMP model.
  - Fixed probability can re-negotiate as in Calvo (1983).
- Generates generalization of Nash bargaining with sticky wage.
  - Looks like adaptive wage, but end up with target wage that is not Nash.
- Bargaining based on outside options, generating "spillover" effects reminiscent of real rigidities.
  - If others have not adjusted, workers' outside option is worse and so bargained wage is lower.
- Looks like data if average wage lasts just under a year.

Evidence on Wage Stickiness

- How cyclical are wages?
- Seems like a simple question, but it is not!
- Wages are difficult to measure.
  - Many components: Regular wage, overtime, time off, benefits, workplace amenities, etc.
  - Hard to hold unobservable components of wage fixed.
    - Even if looking at one worker over time.
- Workers are heterogenous, both observably and unobservably.
  - Heterogeneity potentially varying over cycle, creating *composition bias* in aggregate statistics (Stockman, 1983).

Barsky, Solon, and Parker (1994): Composition Bias

- Initial time-series studies in 70s and 80s: low cyclicality.
- Bils (1985) upends this by using longitudinal panel data. Finds substantial pro-cyclicality, but little evidence of composition bias.
- Barsky, Solon, and Parker (1994) establish dominant view today that composition bias is substantial.
  - Employment of low-wage, low-skill workers is more cyclical.
  - Biases aggregates towards acyclicality because low-wage workers over-represented in booms, under-represented in busts.
  - Instead, real wages are highly pro-cyclical.
- Modern emphasis is on panel regressions of individual workers (e.g. PSID, NLSY, new matched employer-employee data).
- See Abraham and Haltiwanger (1995) for survey.

Barsky, Solon, and Parker (1994): Composition Bias

- Typical regression uses unemployment U or other measure of cycle, takes out polynomial time trend:

$$\log W_t = \gamma_1 + \gamma_2 t + \gamma_3 t^2 + \gamma_4 \left(U_t - \delta_1 - \delta_2 t - \delta_3 t^2 \right) + \epsilon_t$$

- Because ϵ_t is non-stationary, first difference:

$$\Delta \log W_t = \beta_1 + \beta_2 t + \beta_3 \Delta U_t + \nu_t$$

- This is key equation from Bils (1985) and Barsky, Solon, and Parker (1994).
  - Be careful with how treat unemployed or partially employed.
  - Requires balanced panel, create alternate unbalanced regression controlling for observables.

- Identifying assumption: Average worker wage / skill does not vary over cycle so first differencing eliminates bias.

Barsky, Solon, and Parker (1994): Composition Bias

ESTIMATES OF CYCLICALITY OF BLS WAGE VARIABLE

	1947–1948 to 1991–1992		1967–1968 to 1986–1987		
Cycle regressor					
Δ unemployment rate	−0.0028		−0.0060		
	(0.0012)		(0.0017)		
Δ ln (real GNP)		0.146		0.293	
		(0.055)		(0.077)	
Δ ln (per capita hours of work)					0.373
					(0.101)
R^2	0.58	0.60	0.50	0.54	0.53
Durbin-Watson statistic	1.64	1.80	1.44	1.68	1.38

- $-0.0028 \Rightarrow$ 1% change in $u \Rightarrow$ 1/4% change in real wage.
- Mildly pro-cyclical.

Barsky, Solon, and Parker (1994): Composition Bias

	Men's samples			
	Balanced			Unbalanced
Cycle regressor				
Δ unemployment rate	−0.0135			−0.0140
	(0.0035)			(0.0020)
Δ ln (real GNP)		0.617		
		(0.165)		
Δ ln (per capita hours of work)			0.699	
			(0.233)	
R^2	0.58	0.57	0.49	0.82
Durbin-Watson statistic	1.75	2.11	1.99	2.14

- $-0.0135 \Rightarrow 1\%$ change in $u \Rightarrow > 1\%$ change in real wage.
- But smaller numbers for women

Pissarides (2009): New Match Rigidity Required

- Pissarides (2009) points out that all that matters for the search model is wages in *new* matches.
  - Job creation driven by NPV of difference between expected output and wages in new matches.
  - If use Nash at job creation, wages could be fixed for existing jobs and model looks like Nash.
  - Consequently, compare Nash wage equation only to wages in new matches.

- New match wages are far more cyclical.
  - Surveys literature: "The wages of workers who change jobs...are at least as cyclical as labor productivity, but the wages of those in ongoing jobs are only one-third to one-half as cyclical (in terms of the wage-productivity elasticity)."
  - Concludes wage rigidity cannot explain unemployment volatility puzzle.

Pissarides (2009): Wages Very Cyclical for New Hires

ESTIMATES OF THE CYCLICALITY OF HOURLY WAGES, UNITED STATES[a]

Author	Data	Coefficient on $-\Delta u \times 100$	
Bils (1985)	NLSY 1966–1980	All (whites/nonwh.) Stayers Changers	1.6/1.8 0.6/0.4 3.0/4.0
Shin (1994)	NLSY 1966–1981	All (whites/nonwh.) Stayers Changers	1.7/1.4 1.2/0.2 2.7/3.8
Barlevi (2001)	PSID, 1968–1993 NLSY, 1979–1993	Changers Changers	2.59 3.00
Beaudry and DiNardo (1991)	PSID 1976–1984	All, cont. u All, initial u All, min. u	0.7 0.6 2.9
	CPS 1979, 1983	All, cont. u All, initial u All, min. u	0.0 0.0 3.1
Grant (2003)	NLSY 1966–1981	All, cont. u All, initial u All, min. u	2.37 0.60 2.29
Solon, Barsky, and Parker (1994)	PSID 1968–1987	All men All women Stayers, men	1.40 0.53 1.24
Devereux (2001)	PSID 1970–1991	All Stayers Single job holders	1.16 0.81 0.54
Shin and Solon (2006)	NLSY 1979–1993	All Stayers Single job holders	1.37 1.17 1.13

Pissarides (2009): Wages Very Cyclical for New Hires

	All workers	New hires	Job changers
PSID, 1970–1991			
Elasticity wrt unemployment	−1.01		−2.43
Std. error	0.21		0.68
Elasticity wrt productivity	0.43		0.96
Std. error	0.21		0.74
Observations	52 525		6406
Years	21		21
CPS, 1994–2006			
Elasticity wrt productivity	0.42	1.31	2.02
Std. error	0.54	1.74	2.09
Observations	863 600	62 753	57 619
Quarters	45	45	45

- Haefke, Sonntag, and van Rens (2013) (above) show workers who transition from nonemployment to employment and from job to job receive higher wages in expansions.
  - Criticism: People may be moving to better jobs in expansions.
- Martins, Solon and Thomas (2012) and Carneiro, Guimaraes, and Portugal (2012) use Portuguese data that allows them to control for the exact job title.
  - Cyclical elasticity for new hire wages similar to for employment.

Pissarides (2009): Fixed Matching Cost Solves Puzzle

- Pissarides (2009) suggests an alternate resolution: firm cost of matching with worker is partially a fixed cost.
- Regular model: When productivity rises, cost of filling vacancy rises proportionally with duration, reducing incentives to post.
- Fixed matching costs make makes cost rise less than one-for-one with duration of vacancies, so firm incentives to post in a boom remain high.
    - Relies crucially on cost being paid at matching, not posting.
- Argues fixed costs are high because of training and similar expenses upon hiring.

Pissarides (2009): Fixed Matching Cost Solves Puzzle

- With fixed matching cost H,

$$\begin{aligned} \frac{y-w}{r+\lambda} &= \frac{k}{q(\theta)} + H \\ w &= (1-\chi)\, b + \chi\,(y + \theta k + \theta q(\theta)\, H) \end{aligned}$$

- The steady state elasticity is:

$$\varepsilon_{\theta,y} = \frac{1}{\alpha} \frac{y - \varepsilon_w w}{y - w - (r+\lambda) H}$$

- If H is large, $\varepsilon_{\theta,y}$ can be large while the elasticity of new wages $\varepsilon_{w,y}$ can be unchanged from Nash:

H	c	ε_θ	ε_w
0	0.36	3.67	0.98
0.1	0.27	4.18	0.99
0.2	0.20	4.87	0.99
0.3	0.11	5.82	1.00
0.4	0.02	7.25	1.01

Schoefer (2016): Financial Channel of Wage Rigidity

- Schoefer (2016) shows wage rigidity for existing workers increases u volatility in presence of costly external financing.
  - Firms need cash flow to finance posting of vacancies.
  - $y \downarrow$ falls while $w^{existing}$ is rigid $\Rightarrow \downarrow$ cash flows $\Rightarrow \uparrow$ cost of vacancy posting $\Rightarrow \downarrow$ vacancies, $\uparrow u$.

- Simple model:

$$\max_{n_1} \{\beta (y n_1 - w_1 n_1) - c(n_1)\}$$

$$\text{FOC: } c'(n_1^*) = \beta (y - w_1)$$

$$\varepsilon_{n_1^*, z} = \frac{n_1 c'}{c''} \frac{y}{y - w_1} \left(1 - \frac{\partial w_1}{\partial y}\right)$$

- Effect of wage response of new workers $\frac{\partial w_1}{\partial y}$ determines hiring.
  - If $\frac{\partial w_1}{\partial y} \approx 1$, no response.

Schoefer (2016): Financial Channel of Wage Rigidity

- Now consider constraint that recruiting costs can only be financed by internal funds (relaxes in full model):

$$c\left(n_1\right) \leq y n_0 - w_0 n_0$$

- If constraint binds:

$$\begin{aligned} c\left(n_1^*\right) &= n_0\left(y - w_0\right) \\ \varepsilon_{n_1^*, y} &= \frac{c'}{n_1 c} \frac{y}{y - w_0}\left(1 - \frac{\partial w_0}{\partial y}\right) \end{aligned}$$

- Can have $\frac{\partial w_1}{\partial y} = 1$ and get large $\varepsilon_{n_1, y}$ if $\frac{\partial w_0}{\partial y}$ is low.
- Shows reduced-form causal evidence of cash flow's effect on hiring in micro data.
- Calibrated model explains 50% of unemp vol puzzle.

Other Finance Papers

- Hall (2014) suggests an alternate financial channel: counter-cyclical discount rates (risk premia).
  - Does not specify where this comes from: takes from finance literature.
  - Discount rate $\uparrow \Rightarrow$ NPV of employer surplus $\downarrow \Rightarrow$ value of match $\downarrow \Rightarrow$ vacancy posting $\downarrow$, $u \uparrow$.
  - Still have volatility puzzle, and need sticky wages.
  - Provides alternate source of disturbances to productivity shocks, explaining why unemployment rose when financial markets froze but productivity fell little.

- Petrosky-Nadeau (2014) adds credit frictions affecting the cost of posting a vacancy, reducing recruiting in a bust.
  - Two channels: free entry directly, and affecting employer outside option and reducing response of wage.

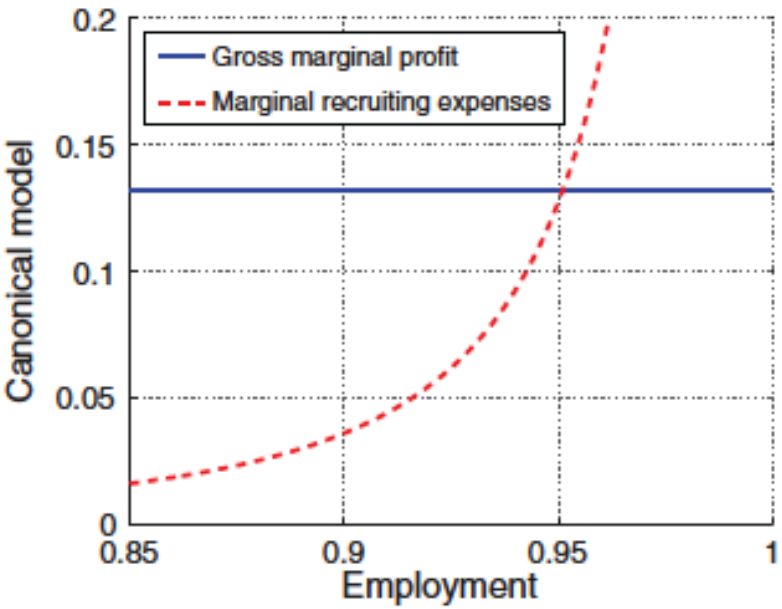
Incomplete Information: Venkateswaran (2014)

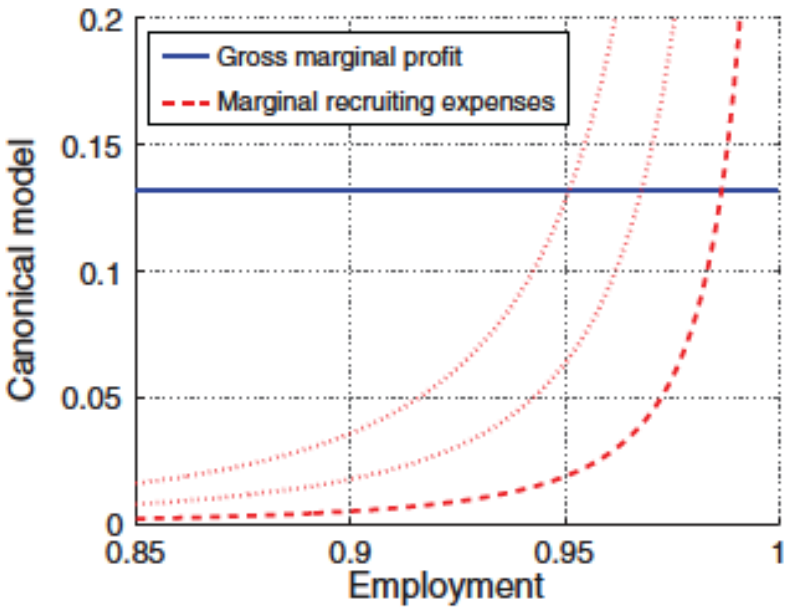
- Venkateswaran (2014) argues that unemployment volatility is higher with incomplete information.
- Intuition:
  - Response to aggregate shock is smaller than response to idiosyncratic productivity shock because of GE effects on search frictions and wages.
  - If firms cannot disentangle shocks, respond to agg shock as if it is partially idiosyncratic.
  - Result is more volatility.
- Calibrated model almost fully explains unemp vol in data.

Michaillat (2012): Rationing and Frictional Unemployment

- Michaillat (2012) combines DMP-style *frictional unemployment* with *rationing unemployment*.
  - In boom, all frictional unemployment.
  - In bust, rationing (would occur without frictions) dominates.
  - Builds on efficiency wage and fairness theories of rationing in downturns.Venkateswaran
- Key ingredients: Rigid wages and decreasing returns to scale.
  - With DRS, MPL falls when y falls.
  - If large enough, MPL falls below w for marginal workers.
    - Would not be hired even if recruiting were free $\Rightarrow$ rationing.
  - Wage rigidity need not be significant for this to be strong.

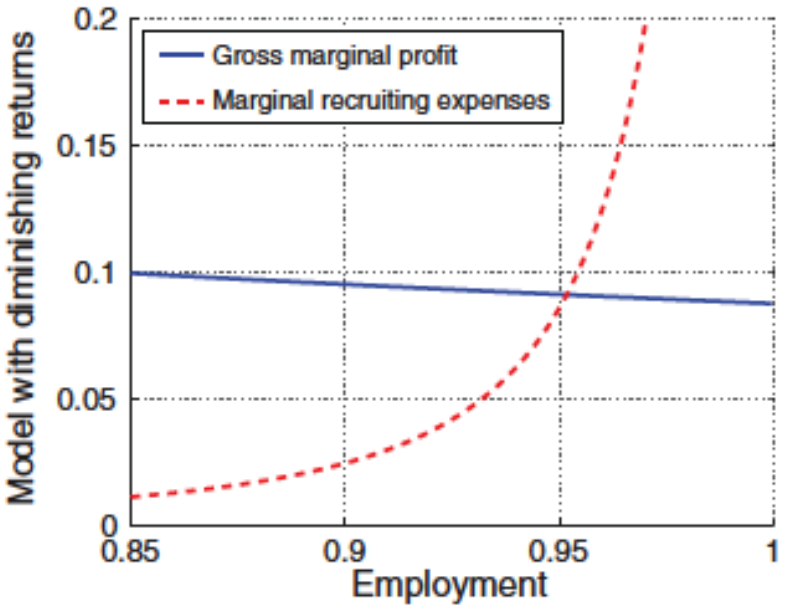
Michaillat (2012): CRS and Nash

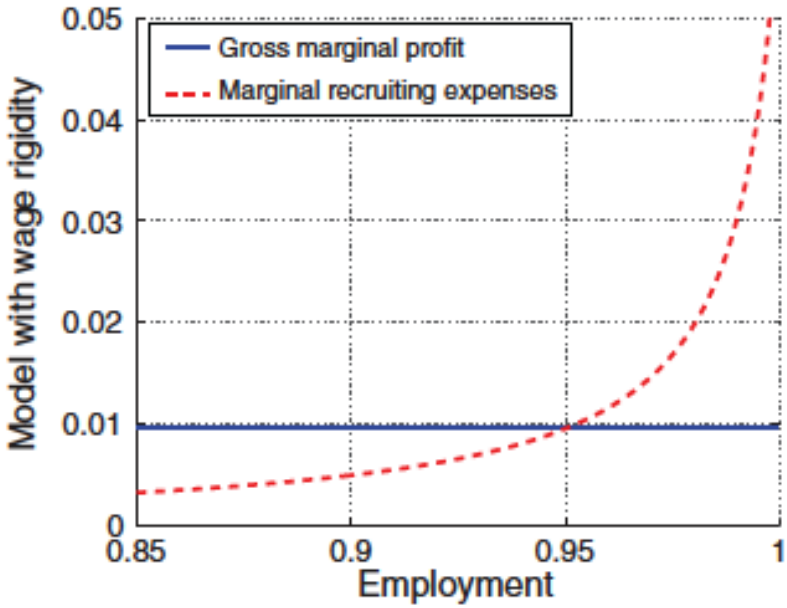




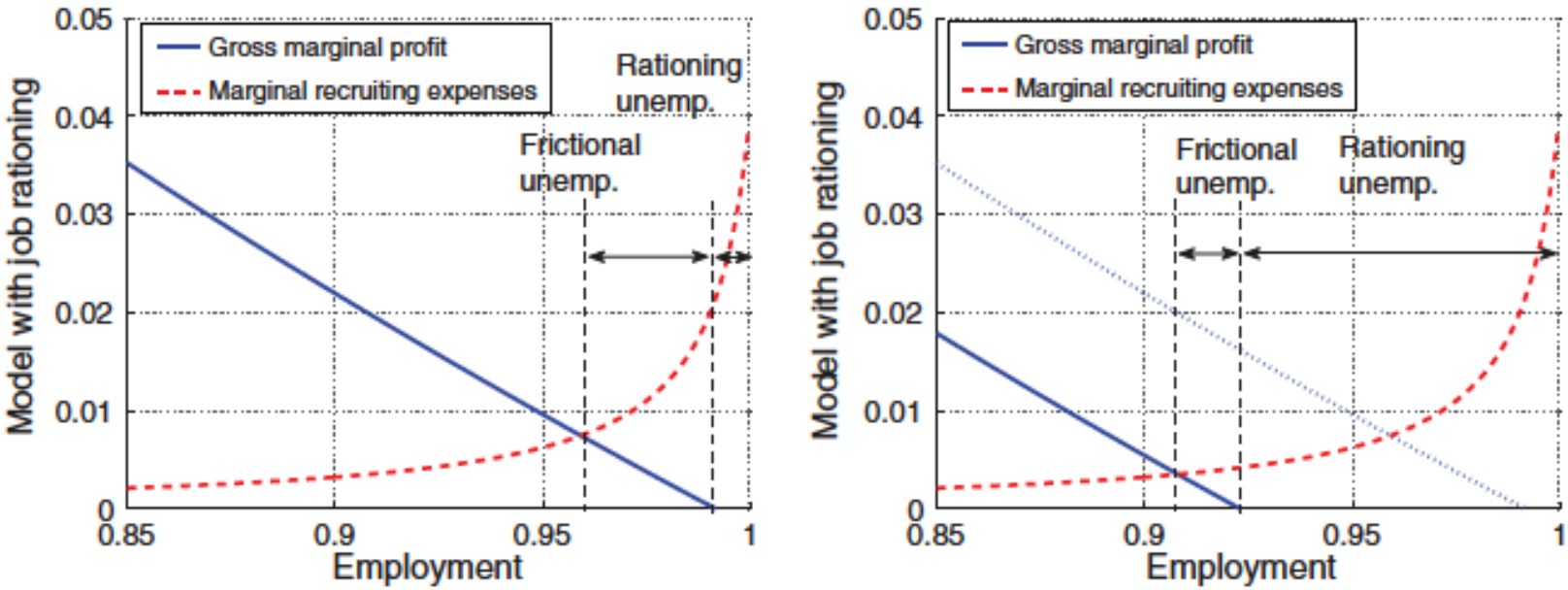
Michaillat (2012): DRS and Rigid Wages Separately

- DRS through Stole and Zwiebel (1996) generalization of Nash.





Michaillat (2012): DRS and Rigid Wages Together



Michaillat (2012): Model Decomposition of U.S. Unemployment into Frictional and Rationing