Introduction and labor market facts

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January 28, 2016

Introduction

- frictionless models of labor market
  - Walrasian, market-clearing models
  - Rogerson(1988), Hansen(1985), RBC, DSGE models
  - labor supply decision comes from intertemporal substitution of consumption and leisure
  - broadly consistent with movements of hours
  - does not account for fluctuations in employment
  - intensity margin of labor (how much to work)
  - most cyclical movement in extensive margin
- fluctuations in duration account for most fluctuations in unemployment
  - decompose aggregate hours $H_t = h_t N_t$
  - $var(\log H_t) = var(\log h_t) + var(\log N_t) + 2cov(\log h_t, \log N_t)$
  - 55% of variance is due to N_t (extensive), 20% to hours per workers h_t (intensive), the rest is correlation

Extensive margin

- labor force status: workers entering and leaving labor force
  - retirement, education, female participation
  - rather acyclical
  - usually long-term trends
- unemployment
  - bulk of business cycle fluctuations
- modelling unemployment is at the core of search models

Search models

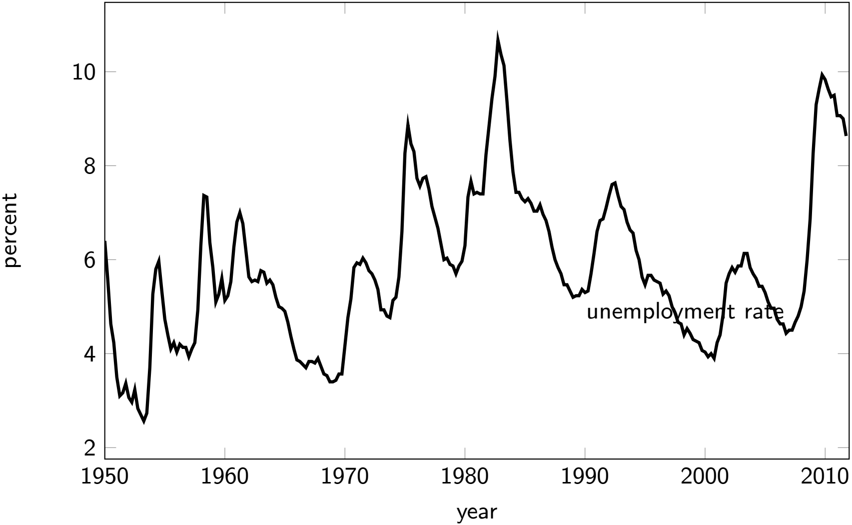
- pay attention to relevant data
  - unemployment and vacancies
  - definition of unemployment is in line with measurement: workers available for work and actively searching
- search behavior itself can help us understand labor market
  - employment may be low because workers are losing jobs at high rate or because it is hard for unemployed to find a job

Four facts

1. unemployment fluctuations account for 2/3 of hours fluctuations
2. fluctuations in duration account for most fluctuations in unemployment
    - simple model
    - worker heterogeneity
    - labor force participation
3. fluctuations in vacancies account for most fluctuations in duration
4. looks as if there is a cyclical labor wedge

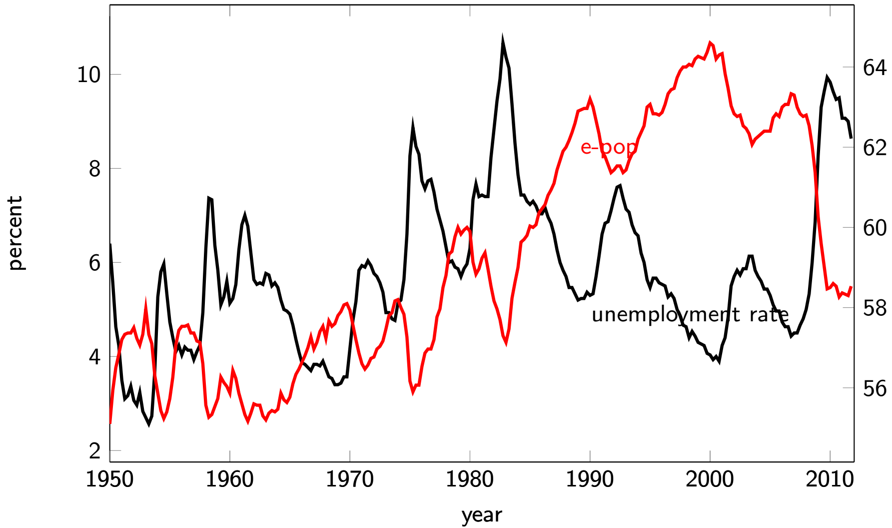
Hours vs. unemployment

Unemployment rate



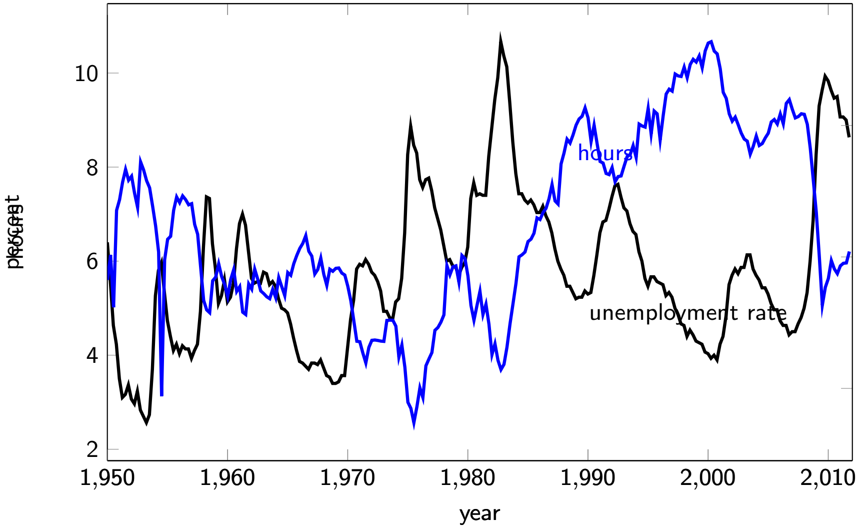
source: Fred dataset

Employment-population ratio



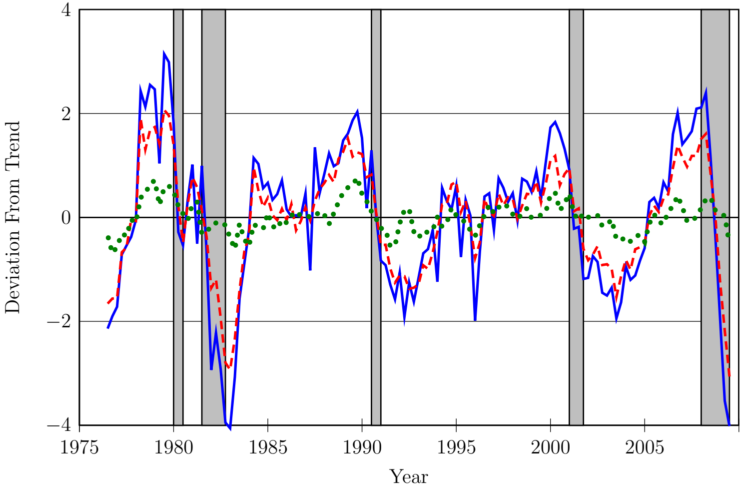
source: Fred dataset

Hours per week per adult



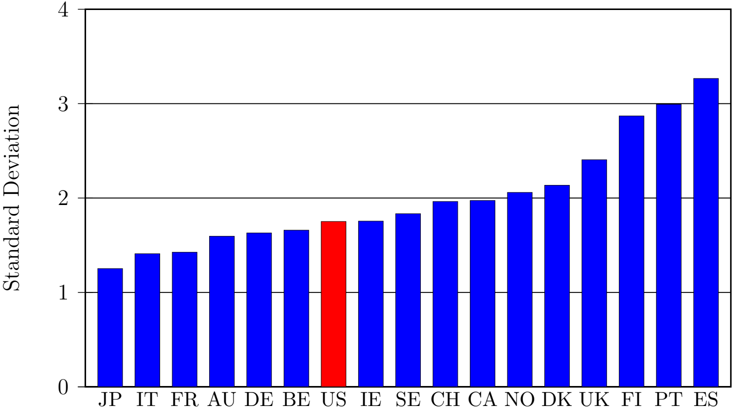
source: Fred dataset, Simona Cocuiba's website

Hours (blue), employment(red), labor force(green)



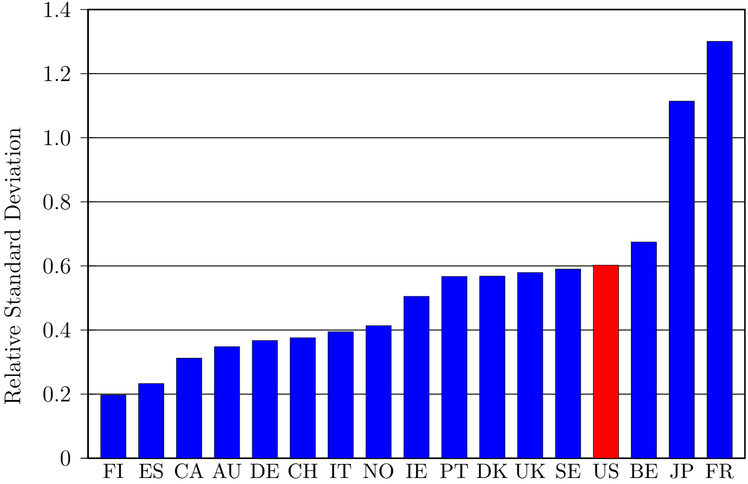
source: Rogerson, Shimer (2010)

SD(total hours) for OECD countries



source: Rogerson, Shimer (2010)

SD(E-Pop)/SD(Total Hours) for OECD countries



source: Rogerson, Shimer (2010)

Worker flows

Time aggregation problem

- Shimer (2012): Reassessing the ins and outs of unemployment
- measure job-finding and employment-exit rates
- simple measure: share of workers who find/lose a job
- time aggregation: miss workers who lose and find a job within two measurement dates
  - underestimate exit rate when job-finding rate is high (expansions)
  - measure countercyclical employment exit probability
- correction: continuous-time model, but measurement happens only at discrete times

Two-state model

- $t \in \{0, 1, \ldots\}$ and $\tau \in [0, 1]$
- $u_{t+\tau}$ is the number of unemployed at date $t + \tau$
- $e_{t+\tau}$ is the number of employed at date $t + \tau$
- $u_t^s(\tau)$ is a measure of short-term unemployment
  - unemployed at $t + \tau$ but employed at some $t' \in [t, t + \tau)$
  - by definition, $u_t^s(0) = 0$, $u_t^s(1) \equiv u_{t+1}^s$
- x_t is the employment exit rate for employed workers
- f_t is the job finding rate for unemployed workers
- $\dot{u}_{t+\tau} = e_{t+\tau} x_t - u_{t+\tau} f_t$
- $\dot{u}_t^s(\tau) = e_{t+\tau} x_t - u_t^s(\tau) f_t$

Two-state model - continued

- last two imply: $e^{-f_t} = \frac{u_{t+1} - u^s_{t+1}}{u_t} \equiv 1 - F_t$
- job-finding probability: $F_t = 1 - \frac{u_{t+1} - u^s_{t+1}}{u_t}$
- compute the employment exit probability as a residual
  - solve $\dot{u}_{t+\tau} = e_{t+\tau} x_t - u_{t+\tau} f_t$ forward
$$u_{t+1} = \frac{\left(1 - e^{-f_t - x_t}\right) x_t}{f_t + x_t} \left(u_t + e_t\right) + e^{-f_t - x_t} u_t$$
  - $X_t = 1 - e^{-x_t}$
  - time aggregation matters for X_t, not so much for F_t

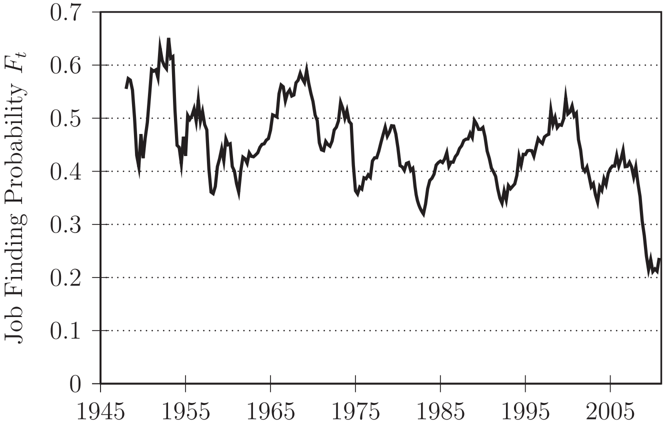
Two-state model - continued

- interpretation

$$u_{t+1} = \frac{\left(1 - e^{-f_t - x_t}\right) x_t}{f_t + x_t} \left(u_t + e_t\right) + e^{-f_t - x_t} u_t$$

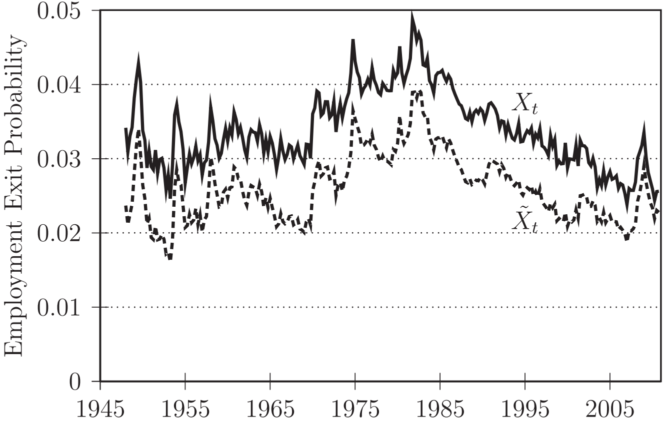
- if f_t is high, the above equation captures that if a worker loses a job, he is more likely to find a job within a short period of time and not be counted as unemployed
- these exits are missed by a "naive" approach $u_{t+1} = \tilde{X}_t e_t + (1 - \tilde{F}_t) u_t$
- the "naive" formula yields fewer exits, and increases cyclicality of X_t

Job-finding probability



source: Shimer (2012)

Employment exit probability

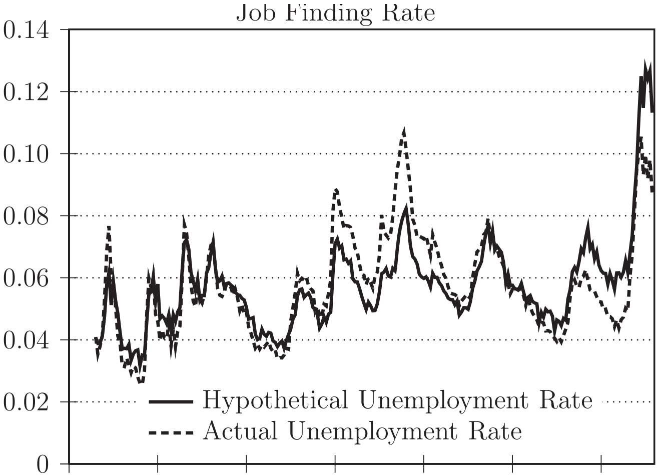


source: Shimer (2012)

Decomposition I

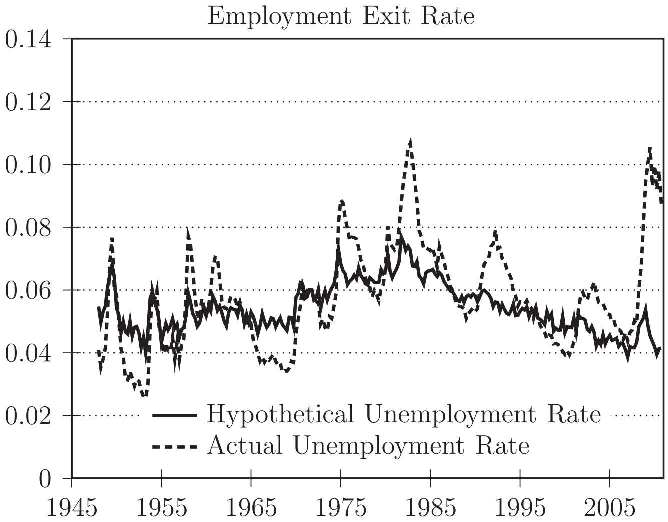
- based on Shimer (2012)
- $x_t/(x_t + f_t)$ is a very good approximation for the end-of-month unemployment rate (correlation 0.98)
- $\bar{x}$ and $\bar{f}$ average values of x_t and f_t
- counterfactual unemployment rate
  - $\bar{x}/(\bar{x} + f_t)$
  - $x_t/(x_t + \bar{f})$
  - compare to actual unemployment rate
- conclusion
  - movements of f_t more important
  - x_t rarely explains more than half of fluctuations

Contribution of fluctuations in F_t to fluctuations in unemployment rate



source: Shimer (2012)

Contribution of fluctuations in X_t to fluctuations in unemployment rate



source: Shimer (2012)

Decomposition II

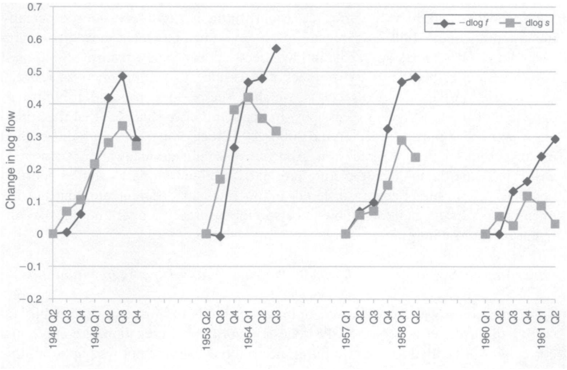
- Elsby, Michael and Solon (AEJ: Macro 2009)
- $u_t \approx u_t^* \equiv x_t / (x_t + f_t)$, log-differentiate

$$\begin{aligned}
d \log u_t^* &= d \log x_t - d \log (x_t + f_t) \\
&= d \log x_t - \frac{dx_t + df_t}{x_t + f_t} \\
&= d \log x_t - \frac{x_t}{x_t + f_t} \frac{dx_t}{x_t} - \frac{f_t}{x_t + f_t} \frac{df_t}{f_t} \\
&= \frac{f_t}{x_t + f_t} (d \log x_t - d \log f_t) \\
d \log u_t^* &= (1 - u_t^*)(d \log x_t - d \log f_t)
\end{aligned}$$

- measure variation of $\log x_t$ and $\log f_t$
- beginning of a recession, change in $\log x_t, \log f_t$ relative to it
- still,

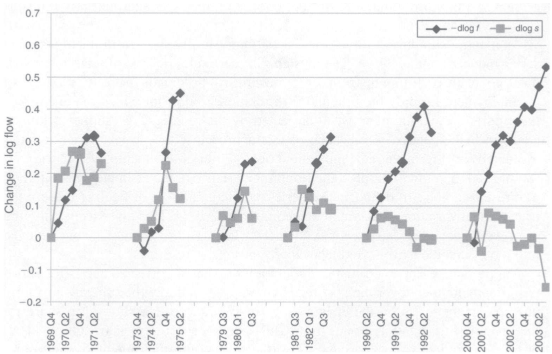
$$\frac{var \log f_t}{var \log x_t} > 4$$

Decomposition from Elsby et al



source: Elsby, Michaels, Solon (2009)

Decomposition from Elsby et al



source: Elsby, Michaels, Solon (2009)

Heterogeneity

Alternative measure I

- mean unemployment duration at time t satisfies

$$d_{t+1} = \frac{(d_t + 1)\left(1 - F_t^d\right) u_t + \left(u_{t+1} - \left(1 - F_t^d\right) u_t\right)}{u_{t+1}}$$

- solve for F_t^d

$$F_t^d = 1 - \frac{(d_{t+1} - 1)\, u_{t+1}}{d_t u_t}$$

- steady state: $u_t = u_{t+1}$ and $d_t = d_{t+1}$ and thus $F^d = 1/d$ - expected duration with a constant arrival rate

- reject that $F_t^d = F_t$

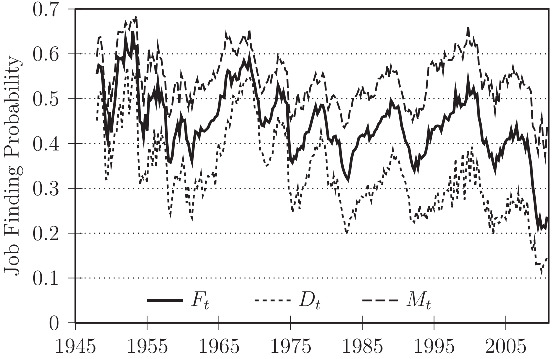
Alternative measure II

- Hall (2005) proposes yet another measure
- u_t^m - the number of medium term unemployed workers (5 to 14 weeks of unemployment)
- u_t^s - the number of short-term unemployed

$$u_{t+1}^m = \left(u_t^s + u_{t-1}^s \left(1 - F_{t-1}^m\right)\right)\left(1 - F_t^m\right)$$

- first-order difference equation, can be solved forward

Different measures of the job-finding probability



source: Shimer (2012)

Heterogeneity

- name the unemployed at time t as $i \in \{1, 2, \ldots u_t\}$
- suppose worker i finds a job with probability F_t^i in period t
- evolution of unemployment rate satisfies

$$u_{t+1} = \sum_{i=1}^{u_t} \left(1 - F_t^i\right) + u_{t+1}^s$$

- from before,

$$F_t \equiv 1 - \frac{u_{t+1} - u_{t+1}^s}{u_t} \Rightarrow F_t \equiv \frac{\sum_{i=1}^{u_t} F_t^i}{u_t}$$

Alternative measure I

- with heterogeneity

$$d_{t+1} = \frac{\sum_{i=1}^{u_t} \left(d_t^i + 1\right)\left(1 - F_t^i\right) + \left(u_{t+1} - \sum_{i=1}^{u_t}\left(1 - F_t^i\right)\right)}{u_{t+1}}$$

- this gives

$$\frac{\sum_{i=1}^{u_t} d_t^i F_t^i}{\sum_{i=1}^{u_t} d_t^i} = 1 - \frac{\left(d_{t+1} - 1\right) u_{t+1}}{d_t u_t}$$

- compare to the expression we derived before

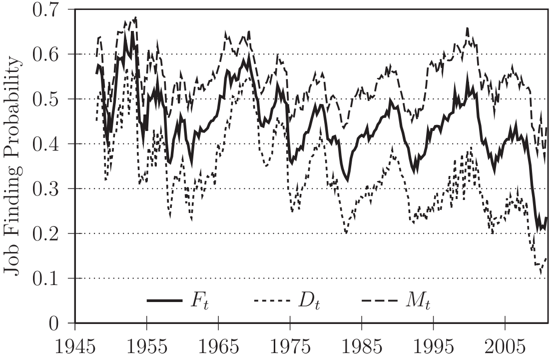
$$F_t^d = 1 - \frac{\left(d_{t+1} - 1\right) u_{t+1}}{d_t u_t}$$

- F_t^d is a weighted average of individual job-finding rates, weights given by the duration

$$F_t^d = \frac{\sum_{i=1}^{u_t} d_t^i F_t^i}{\sum_{i=1}^{u_t} d_t^i}$$

- F_t^d overweights long-term unemployed $\Rightarrow$ lower than F_t

Different measures of the job-finding rate



source: Shimer (2012)

Fast dynamics - Krueger, Cramer, Cho (2014)

- two state model: half-time of around 1 month
- three state model: U.S. monthly average, 2008-2014

		month t		
		E	U	I
	E	0.985	0.186	0.039
month $t+1$	U	0.015	0.595	0.030
	I	0.027	0.220	0.931

- implied 15-month transition matrix

		month t		
		E	U	I
	E	0.675	0.527	0.419
month $t+15$	U	0.044	0.051	0.055
	I	0.281	0.422	0.525

Fast dynamics - Krueger, Cramer, Cho (2014)

- compare short-term and long-term unemployed, 2008–2013

		A^{15}	short-term	long-term
	E	0.527	0.495	0.359
month $t+15$	U	0.051	0.233	0.304
	I	0.422	0.271	0.337

- unemployment is very persistent in the data
- current duration predicts future duration

Lessons

- log-term unemployed have a lower job finding probability
- two-state and three-state model understates persistence in unemployment
- reconciliation: duration dependence in the job finding probability
  - what is the source of it?
  - heterogeneity vs structural duration dependence
  - difficult identification problem
  - we will cover this as a separate topic

Labor force participation

Three-state model

- measure monthly transitions between employment, unemployment and nonparticipation
  - discrete time (data): $s_{t+1} = \tilde{M}_t s_t, \quad s_t = \{e_t, u_t, 1 - e_t - u_t\}$
- correct for time aggregation

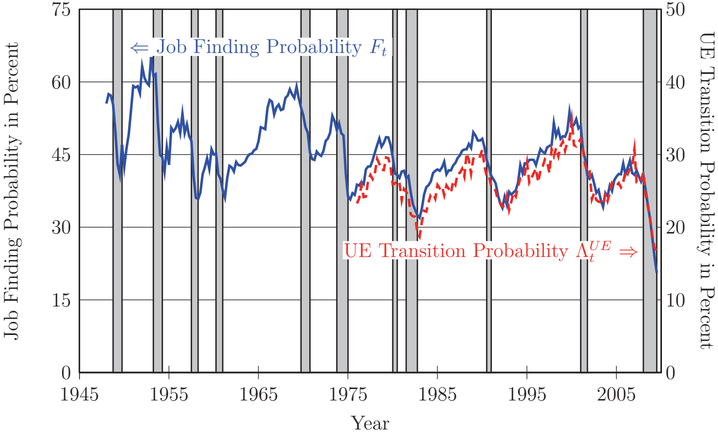
$$\dot{s}\left(t+\tau\right) = M_{t+\tau} s\left(t+\tau\right) = M_t s\left(t+\tau\right) \quad \text{for } \tau \in [0,1)$$

- can we recover M_t from $\tilde{M}_t$?
- M_t is unique if $\tilde{M}_t$ has all positive, real, distinct eigenvalues

$$\begin{aligned} \tilde{M}_t &= \tilde{P}_t \tilde{\Lambda}_t \tilde{P}_t^{-1} \text{ and } M_t = P_t \Lambda_t P_t^{-1} \\ P_t &= \tilde{P}_t \text{ and } \Lambda_{iit} = \log \tilde{\Lambda}_{iit} \end{aligned}$$

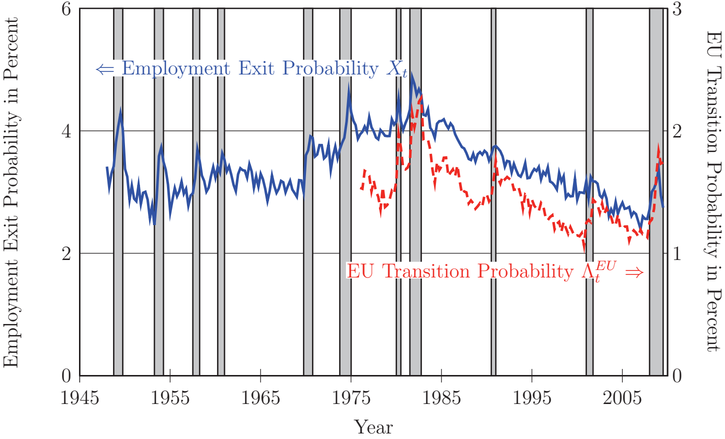
- convert to monthly probabilities: $1 - e^{-M_{ijt}}$

Job-finding and UE transition probability



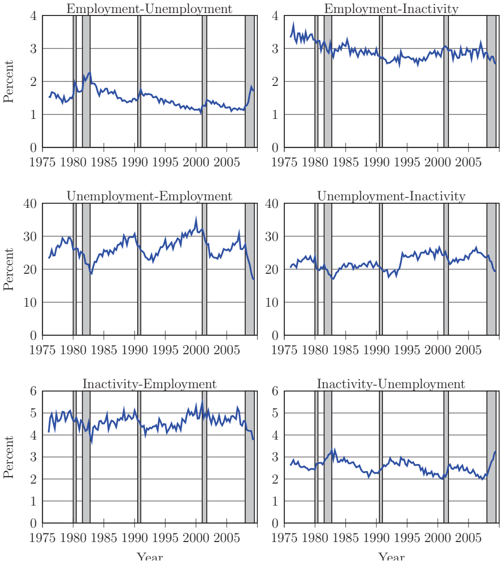
source: Rogerson, Shimer (2010)

Employment exit and EU transition probability



source: Rogerson, Shimer (2010)

Transition probabilities



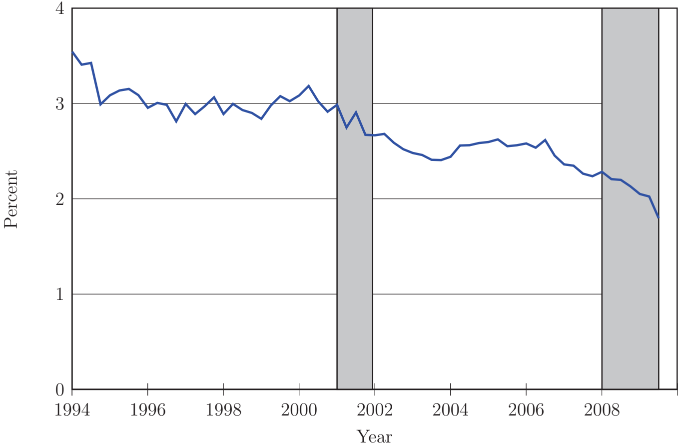
Lessons

- job-finding and UE transitions similar
- employment exit and EU transition probability similar
- $\rightarrow$ non-participation does not seem to be cyclical

Employer-to-employer transitions

- basic MP search model does take this into account
- newer models include on the job search
- secular trend in E-E transitions
- E-E rate drops in recessions

Transition probabilities



source: Rogerson, Shimer (2010)

Matching function

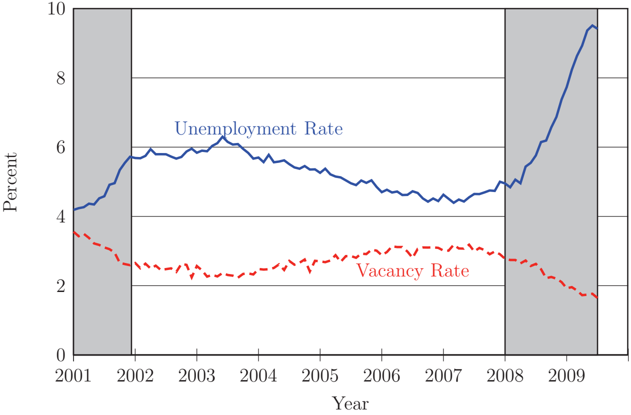
Matching function

- high unemployment:
  - jobs are hard to find - f_t is low
  - workers are more likely to lose a job - x_t is high
- search models focus on the first channel
- first channel seems to be more important

Matching function

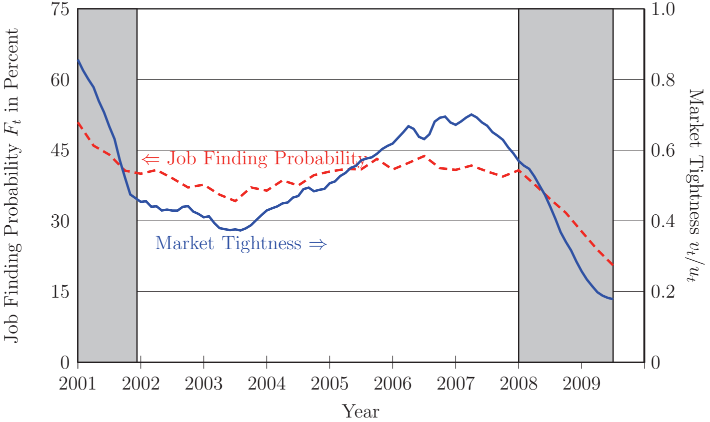
- number of new matches $m_t = m(u_t, v_t)$
  - u_t is unemployment
  - v_t is vacancies
  - increasing in both arguments, constant returns to scale
- job-finding probability is matches per unemployed worker
- $F_t = m_t / u_t = m(1, v_t / u_t)$
- increasing function of vacancy-unemployment ratio
- $F_t = f(\theta_t)$ works well in the data!

Unemployment and vacancies



source: Rogerson, Shimer (2010)

Job finding rate and vacancy-unemployment ratio

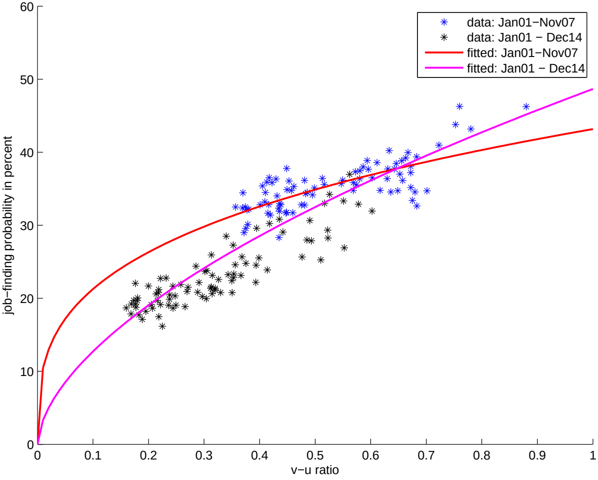


source: Rogerson, Shimer (2010)

Estimating matching function

- assume Cobb-Douglas: $m_t = \bar{m} v_t^{\eta} u_t^{(1-\eta)}$
- then $F_t = \bar{m}\theta_t^{\eta}$
- OLS: $\log F_t = \tilde{m} + \eta \log \theta_t + \nu_t$
- correlation of v_t and u_t in logs -0.94 : test of CRS is weak
- η is hard to estimate
  - period Jan01 - Nov07: $\eta = 0.31$
  - period Jan01 - Dec14: $\eta = 0.58$

Estimated matching function



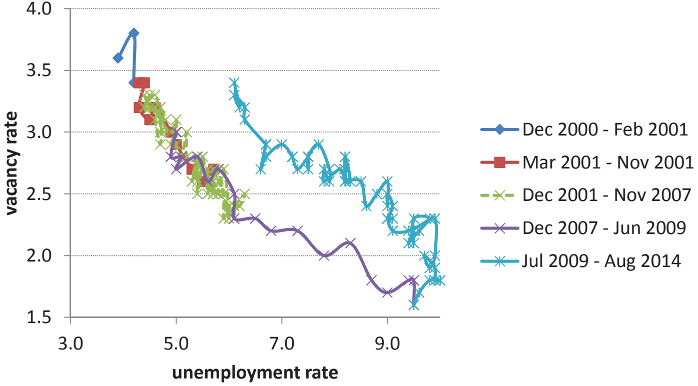
Beveridge curve

- stochastic steady state: $x_t(1-u_t) = m_t(u_t, v_t) = \bar{m}_t u_t^{\eta} v_t^{1-\eta}$
- for fixed x_t and $\bar{m}_t$,

$$\frac{d \log v_t}{d \log u_t} = -\frac{x_t}{(1-\eta)\,\bar{m}_t\,(v_t/u_t)^{1-\eta}} - \frac{\eta}{1-\eta}$$

  - downward-sloping Beveridge curve
  - elasticity approximately -1
  - this is not a good description of recent data
- maybe $\bar{m}_t$ has fallen substantially
  - geographical, occupational, educational mismatch (Sahin et al)
  - financial constraints (Gavazza, Mongey, Violante (2015))
  - increase in long-term unemployment (Krueger, Card, Cho)

Beveridge curve is shifting



Labor wedge

Labor wedge

- Chari, Kehoe, McGrattan
- measure a labor "tax" as the gap between MRS and MPL
- workers are constrained in their ability to supply labor in recessions
- model-dependent measure
- labor-market clearing model

Labor wedge model

- households: choose $\{c_t, h_t\}$ to maximize the expected utility
  - utility $E_0 \sum_{t=0}^{\infty} \beta^t \left(\log c_t - \gamma \frac{\varepsilon}{1+\varepsilon} h_t^{\frac{1+\varepsilon}{\varepsilon}} \right)$
  - budget constraint: $k_{t+1} = (1 + r_t - \delta) k_t + (1 - \tau_t) w_t h_t + T_t - c_t$
- firms: choose $\{k_t, h_t\}$ to maximize profits
  - profits: $k_t^{\alpha} (z_t h_t)^{1-\alpha} - r_t k_t - w_t h_t$
- resource constraint
  - $k_{t+1} = k_t^{\alpha} (z_t h_t)^{1-\alpha} + (1 - \delta) k_t - c_t$
  - equivalent to government budget constraint $T_t = \tau_t w_t h_t$

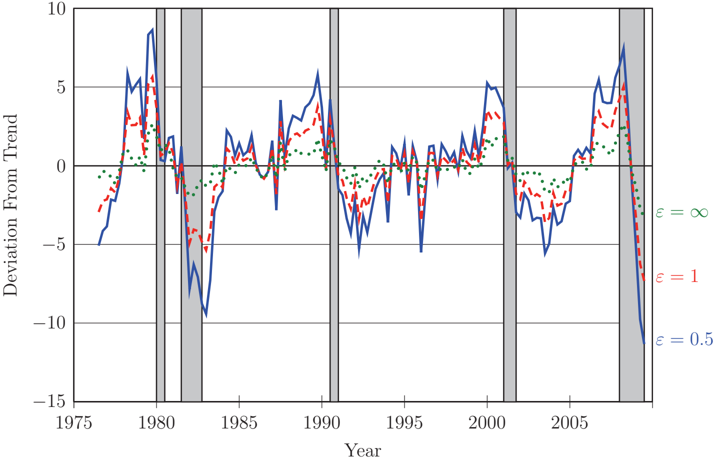
Labor wedge

- first order conditions
  - $MRS_t = \gamma c_t h_t^{1/\varepsilon} = (1 - \tau_t) w_t$
  - $MPL_t = (1 - \alpha) y_t / h_t = w_t$
- solve for $1 - \tau_t$

$$1 - \tau_t = \frac{\gamma c_t h_t^{\frac{1+\varepsilon}{\varepsilon}}}{(1 - \alpha) y_t}$$

- measure int he data and see how this behaves
  - answer depends on ε
  - $\gamma / (1 - \alpha)$ only affects the level of $1 - \tau_t$

Labor wedge: deviation of $1 - \tau$ from trend



source: Rogerson, Shimer (2010)

Labor wedge - continued

- recessions look like times when labor wedge $1 - \tau$ rises
- interpretation
  - workers are constrained from working - search frictions
  - firms cannot choose optimal labor to maximize profits