What Shifts the Beveridge Curve?
Recruiting Intensity and Financial Shocks

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RBA Quantitative Macroeconomics Workshop
The outward shift in the Beveridge curve
The outward shift in the Beveridge curve

It indicates a deterioration in aggregate matching efficiency $\Phi_t$

$$H_t = \Phi_t V_t^\alpha U_t^{1-\alpha}$$
MEASUREMENT OF $\Phi_t$
Estimating $\Phi_t$ accounting for compositional changes
Estimating $\Phi_t$ accounting for compositional changes

- Hall and Schulhofer-Wohl $\rightarrow$ among job-seekers, include
  - Nonparticipants ($N_t$)
  - Employed ($E_t$)

$$H_t = \Phi_t \cdot \left(1 + s_t^N \frac{N_t}{U_t} + s_t^E \frac{E_t}{U_t}\right)^{1-\alpha} \cdot V_t^\alpha U^{1-\alpha}$$

- Veracierto $\rightarrow$ estimate ($s_t^N, s_t^E$) through data on worker flows
Estimating $\Phi_t$ accounting for compositional changes

- Hall and Schulhofer-Wohl → among job-seekers, include
  - Nonparticipants ($N_t$)
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- Veracierto → estimate ($s_t^N, s_t^E$) through data on worker flows

- Fujita and Moscarini → exclude workers on temporary layoff from the matching function

- Fix $\alpha = 0.5$, compute composition factor, and get $\Phi_t$ as a residual
Measured drop in aggregate matching efficiency

2001: −10 percent & fast rebound
2007-09: −30 percent & slow recovery

Gavazza-Mongey-Violante, "What Shifts the Beveridge Curve?"
Explaining the deterioration in matching efficiency

\[ H_t = \Phi_t V_t^\alpha U_t^{1-\alpha} \]

1. Mismatch ↑
   - Sahin-Song-Topa-Violante 2014; Elsby-Michaels-Ratner 2014

2. Worker’s search effort ↓
   - Mukoyama-Patterson-Sahin 2014; Hagedorn-Karahan-Manovskii-Mitman 2014

3. Firm’s recruiting intensity ↓
   - Davis-Faberman-Haltiwanger 2012; Kaas-Kircher 2014
Firms’ recruiting intensity
Firms’ recruiting intensity

• Effective vacancies:

\[ V_t^* = \int e_{it} v_{it} \, di \]

• \( v_{it} \): max open positions ready to be staffed and costly to create

• \( e_{it} \in [0, 1] \): probability of filling an open position —an outcome of how much firms choose to spend on recruitment activities

  ▶ advertisement, networking, screening, outsourcing, etc.
Firms’ recruiting intensity

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• Aggregate matching function:

\[ H_t = (V_t^*)^\alpha U_t^{1-\alpha} = \Phi_t \cdot V_t^\alpha U_t^{1-\alpha} \quad \text{with} \quad \Phi_t = \left[ \int e_{it} \left( \frac{v_{it}}{V_t} \right) dt \right]^\alpha \]
MECHANISM
Mechanism

- **Fact 1**: much of job creation is in young firms
  - Haltiwanger-Jarmin-Miranda 2014
Mechanism

- **Fact I:** much of job creation is in young firms
  - Haltiwanger-Jarmin-Miranda 2014

- **Fact II:** job-filling rate is steeply increasing with firm’s growth rate
  - Davis-Faberman-Haltiwanger 2012
Mechanism

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- **Fact II**: job-filling rate is steeply increasing with firm’s growth rate
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- **Fact III**: recent financial shock hit young firms the hardest
  - Chodorow-Reich 2014; Siemer 2014; Adelino et al. 2013; Fort et al., 2013
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- **Financial shock**: hits start-ups and young firms the most
  - Recruiting intensity $\Phi_t = \left[ \int e_{it} \left( \frac{v_{it}}{V_t} \right) di \right]^\alpha$ falls
Mechanism

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• **Financial shock**: hits start-ups and young firms the most
  ► Recruiting intensity $\Phi_t = \left[ \int e_{it} \left( \frac{v_{it}}{V_t} \right) di \right]^\alpha$ falls

• **TFP shock**: more neutral across firms, so smaller effect on $\Phi_t$
ECONOMIC ENVIRONMENT

RANDOM-MATCHING MODEL WITH MULTI-WORKER FIRMS

COOPER-HALTIWANGER-WILLIS 07, ELSBY-MICHAELS 13, ACEMOGLU-HAWKINS 14
1. **Firms**

   • Operate a DRS technology \( y(z, n), \ z \text{ stochastic} \)
   • Hire in frictional labor markets: choose \((e, v)\)
   • Face non-negative dividend constraint \(\rightarrow\) borrowing
   • **Endogenous entry and exit/default**

     ► Sedlacek 14; Siemer 14; Schott 14
Cast of characters

1. Firms
   - Operate a DRS technology $y(z, n)$, $z$ stochastic
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   - Price loans competitively reflecting default prob. (+ wedge)
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2. Banks
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3. Households
   - Risk neutral representative family (some members unempl.)
   - Save into bank deposits and mutual fund that owns all firms
### Timeline

<table>
<thead>
<tr>
<th>$(n, a, z)$</th>
<th>$\delta$ shock</th>
<th>$n'$</th>
<th>$b'$</th>
<th>$w$</th>
<th>$a' = y(z, n') - b'$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Draw $z$</td>
<td>Exogenous</td>
<td>Exit</td>
<td>Hire</td>
<td>Borrow</td>
<td>V and U meet</td>
</tr>
<tr>
<td>Exit</td>
<td>Entry</td>
<td>Fire</td>
<td>Bargain</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Individual firm’s state variables:

- **$n$:** initial employment (pre-hiring)
- **$a$:** initial net worth
- **$z$:** productivity
Entry, exit, hire/fire decisions

- **Entry decision:** \( \lambda_0 \) potential entrants drawing \( z \sim \Gamma_0(z) \)

  - fraction \( \varepsilon \) of start-up cost \( \chi_0 \) financed by equity

\[
-\varepsilon \chi_0 + V^i(0, -(1 - \varepsilon)\chi_0, z^*) = 0
\]
Entry, exit, hire/fire decisions

- **Entry decision**: $\lambda_0$ potential entrants drawing $z \sim \Gamma_0(z)$
  
  - Fraction $\varepsilon$ of start-up cost $\chi_0$ financed by equity
    
    $$-\varepsilon\chi_0 + V^i(0, -(1-\varepsilon)\chi_0, z^*) = 0$$

- **Stay as incumbent (and repay) or exit-repay or exit-default**
  
  $$V(n, a, z) = \max \{ V^i(n, a, z), a, 0 \}$$
Entry, exit, hire/fire decisions

• **Entry decision**: $\lambda_0$ potential entrants drawing $z \sim \Gamma_0(z)$

  ▶ fraction $\epsilon$ of start-up cost $\chi_0$ financed by equity

  $$-\epsilon \chi_0 + V^i(0, -(1 - \epsilon)\chi_0, z^*) = 0$$

• **Stay as incumbent (and repay) or exit-repay or exit-default**

  $$V(n, a, z) = \max \{ V^i(n, a, z), a, 0 \}$$

• **Incumbent: fire or hire**

  $$V^i(n, a, z) = \max \{ V^f(n, a, z), V^h(n, a, z) \}$$

Gavazza-Mongey-Violante, “What Shifts the Beveridge Curve?” p. 13/42
Incumbent firms’ decisions: fire

\[
\mathbb{V}^f(n, a, z) = \max_{n', b'} d^f + \beta(1 - \delta) \sum_{z' \in \mathcal{Z}} \mathbb{V}(n', a', z') \Gamma(z', z)
\]

s.t.

\[
n' \leq n
\]

\[
d^f \equiv a - w(z, n', b') n' - \chi + Q(n', b', z) b' \geq 0
\]

\[
a' = y(z, n') - b'
\]
Incumbent firms’ decisions: fire

\[ V^f(n, a, z) = \max_{n', b'} d^f + \beta (1 - \delta) \sum_{z' \in Z} V(n', a', z') \Gamma(z', z) \]

s.t.

\[ n' \leq n \]

\[ d^f \equiv a - w(z, n', b') n' - \chi + Q(n', b', z) b' \geq 0 \]

\[ a' = y(z, n') - b' \]

Note: wage determined by Nash bargaining (Stole-Zwiebel solution)
Incumbent firms’ decisions: hire

\[
\forall^h(n, a, z) = \max_{e \in [0,1], v > 0, b'} \ d^h + \beta(1 - \delta) \sum_{z' \in Z} \forall(n', a', z') \Gamma(z', z)
\]

s.t.

\[
n' - n = q(\theta^*)ev
\]

\[
d^h \equiv a - w(z, n', b')n' - \chi - C(e, v, n) + Q(n', b', z)b' \geq 0
\]

\[
a' = y(z, n') - b'
\]
Choice of functional form for $C(e, v, n)$

DFH: Log-linear relation btw job-filling rate $q(\theta^*)e$ and growth rate
Choice of functional form for $C(e, v, n)$

DFH: Log-linear relation btw job-filling rate $q(\theta^*)e$ and growth rate

Reverse engineer $C(\cdot)$ that yields the above relationship
Hiring problem

1. **Stage I**: Choose target employment level $n' > n$

2. **Stage II**: Choose max new positions $v$, and recruitment effort $e$
Hiring problem

1. **Stage I**: Choose target employment level \( n' > n \)

2. **Stage II**: Choose max new positions \( v \), and recruitment effort \( e \)

\[
C^*(n, n') = \min_{\substack{e \in [0,1], v > 0}} \left[ \frac{\kappa_1}{\gamma_1} e^{\gamma_1} + \frac{\kappa_2}{\gamma_2 + 1} \left( \frac{v}{n} \right)^{\gamma_2} \right] v \\
\text{s.t.} \\
n' - n = q(\theta^*) ev
\]

Gavazza-Mongey-Violante, “What Shifts the Beveridge Curve?”
Hiring problem

1. **Stage I**: Choose target employment level \( n' > n \)

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\]

s.t.

\[
n' - n = q(\theta^*)ev
\]

- The solution yields the job filling-rate:

\[
\log \left( \frac{h}{v} \right) = q(\theta^*)e = \Omega (\kappa_1, \kappa_2, \theta^*) + \frac{\gamma_2}{\gamma_1 + \gamma_2} \log \left( \frac{n' - n}{n} \right)
\]

Gavazza-Mongey-Violante, "What Shifts the Beveridge Curve?"
Why is recruiting effort increasing in the growth rate?

\[
\frac{n' - n}{n} = q(\theta^*) \cdot e \cdot \left( \frac{v}{n} \right)
\]

1. \( e \) and \( v/n \) are both inputs in the production of employment growth

\[
\frac{C}{v} = \left[ \frac{\kappa_1}{\gamma_1} e^{\gamma_1} + \frac{\kappa_2}{\gamma_2 + 1} \left( \frac{v}{n} \right)^{\gamma_2} \right]
\]

2. cost of creating a new position is increasing in both \( e \) and \( v/n \)

3. relative curvature of cost function \( C \) with respect to \( e \) and \( v/n \) determines their elasticity with respect to the desired growth rate
Banks

- Competitive sector with free entry
- Intermediate funds at cost \( \varphi > 0 \) (financial wedge)
- Pay risk-free return \( \bar{Q}^{-1} = \beta^{-1} \) on deposits
- Upon firm’s default, i.e., \( x^D(n', a', z') = 1 \), recover nothing
Banks

- Competitive sector with free entry
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- Upon firm’s default, i.e., $x^D(n', a', z') = 1$, recover nothing

**Equilibrium price** of a loan to a firm of type $(n', b', z)$:

$$Q(n', b', z) = \bar{Q}(1 - \varphi)(1 - \delta) \left[ 1 - \sum_{z' \in Z} x^D(\cdot)\Gamma(z', z) \right]$$
(Inverse of) price of debt for start-ups
Representative household

\[
W(U, T, M) = \max_{M', T'} C + \beta W(U', T', M')
\]

\[
s.t.
C + \bar{Q}M' + PT' = \int w(z, n', b') n' d\lambda + \omega U + (D + P)M + T
\]

\[
U' = U + \delta (1 - U) - \Phi V^\alpha U^{1-\alpha}
\]

- \(T\): household deposits
- \(M\): shares of the mutual fund owning all firms
- \(D\): average dividends paid by firms
Preliminary Parameterization
## Externally calibrated

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discount factor (monthly)</td>
<td>$\beta$</td>
<td>0.9967</td>
</tr>
<tr>
<td>Potential entrants</td>
<td>$\lambda_0$</td>
<td>0.02</td>
</tr>
<tr>
<td>Size of labor force</td>
<td>$\Lambda$</td>
<td>18.7</td>
</tr>
<tr>
<td>Nash bargaining share of workers</td>
<td>$\eta$</td>
<td>0.5</td>
</tr>
<tr>
<td>Elasticity of matching function wrt $V_t$</td>
<td>$\alpha$</td>
<td>0.5</td>
</tr>
<tr>
<td>Financial intermediation wedge (monthly)</td>
<td>$\varphi$</td>
<td>0.002</td>
</tr>
<tr>
<td>External equity share of start-up cost</td>
<td>$\varepsilon$</td>
<td>0.50</td>
</tr>
</tbody>
</table>

Model period is 1 month
# Externally calibrated

<table>
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<tr>
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<tr>
<td>Discount factor (monthly)</td>
<td>$\beta$</td>
<td>0.9967 Risk-free rate</td>
</tr>
<tr>
<td>Potential entrants</td>
<td>$\lambda_0$</td>
<td>0.02 Meas. of incumbents = 1</td>
</tr>
<tr>
<td>Size of labor force</td>
<td>$\Lambda$</td>
<td>18.7 Average firm size = 17.5</td>
</tr>
<tr>
<td>Nash bargaining share of workers</td>
<td>$\eta$</td>
<td>0.5</td>
</tr>
<tr>
<td>Elasticity of matching function wrt $V_t$</td>
<td>$\alpha$</td>
<td>0.5 Empirical estimates</td>
</tr>
<tr>
<td>Financial intermediation wedge (monthly)</td>
<td>$\varphi$</td>
<td>0.002 Excess bond premium</td>
</tr>
<tr>
<td>External equity share of start-up cost</td>
<td>$\varepsilon$</td>
<td>0.50 Kauffman Firm Survey</td>
</tr>
</tbody>
</table>

Model period is 1 month

Addition to the model: heterogeneity in DRS across firms
## Internally calibrated

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<tr>
<th>Parameter</th>
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<th>Target</th>
<th>Model</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow of home production</td>
<td>( \omega )</td>
<td>0.62</td>
<td>Monthly separ. rate</td>
<td>0.03</td>
</tr>
<tr>
<td>Scaling of match. funct.</td>
<td>( \Phi )</td>
<td>0.42</td>
<td>Monthly job finding rate</td>
<td>0.40</td>
</tr>
<tr>
<td>Midpoint DRS in prod.</td>
<td>( \nu )</td>
<td>0.70</td>
<td>Dividend share</td>
<td>0.06</td>
</tr>
<tr>
<td>High-Low DRS in prod.</td>
<td>( \Delta \nu )</td>
<td>0.20</td>
<td>Empl. share 500+</td>
<td>0.25</td>
</tr>
<tr>
<td>Persistence of ( z ) shocks</td>
<td>( \Gamma )</td>
<td>0.99</td>
<td>Annual (</td>
<td>g</td>
</tr>
<tr>
<td>SD of ( z ) shocks</td>
<td>( \Gamma )</td>
<td>0.11</td>
<td>(SD (g))</td>
<td>0.32</td>
</tr>
<tr>
<td>Cost elasticity wrt ( e )</td>
<td>( \gamma_1 )</td>
<td>3.74</td>
<td>Recr. int. small/large firms</td>
<td>1.23</td>
</tr>
<tr>
<td>Cost elasticity wrt ( v )</td>
<td>( \gamma_2 )</td>
<td>22.97</td>
<td>Elasticity of job. fill rate wrt ( g )</td>
<td>0.86</td>
</tr>
<tr>
<td>Cost shifter wrt ( e )</td>
<td>( \kappa_1 )</td>
<td>4.88</td>
<td>Hiring cost/monthly wage</td>
<td>0.03</td>
</tr>
<tr>
<td>Cost shifter wrt ( v )</td>
<td>( \kappa_2 )</td>
<td>0.08</td>
<td>Vac. share. of small firms</td>
<td>0.18</td>
</tr>
<tr>
<td>Entry cost</td>
<td>( \chi_0 )</td>
<td>0.28</td>
<td>Annual entry rate</td>
<td>0.09</td>
</tr>
<tr>
<td>(Exponential) distrib. of ( z_0 )</td>
<td>( \xi )</td>
<td>11.82</td>
<td>Share of JC by entrants</td>
<td>0.33</td>
</tr>
<tr>
<td>Operating cost</td>
<td>( \chi )</td>
<td>0.08</td>
<td>Survive ( \geq 5 ) years</td>
<td>0.62</td>
</tr>
<tr>
<td>Exogenous exit shock</td>
<td>( \delta )</td>
<td>0.008</td>
<td>Share of JD by exit</td>
<td>0.24</td>
</tr>
</tbody>
</table>

Gavazza-Mongey-Violante, “What Shifts the Beveridge Curve?”
“Up or out” dynamics of young firms
“Up or out” dynamics of young firms

A. Cohort job creation and destruction

B. Type of destruction

Gavazza-Mongey-Violante, “What Shifts the Beveridge Curve?”
Age distribution of recruiting intensity and vacancies

- Recruitment intensity
- Vacant positions

Gavazza-Mongey-Violante, “What Shifts the Beveridge Curve?”
Firms’ life-cycle (averages)

A. Size

B. Growth Rate

C. Recruitment Effort

D. Debt to Output Ratio

Gavazza-Mongey-Violante, “What Shifts the Beveridge Curve?”
DATA TO BE EXPLAINED
Data: 2001 vs 2008

A. Data 2001:01–2007:01

B. Data 2008:01–2014:01

- Vacancies
- Vacancy yield
- Unemployment
- Job finding rate
- Aggregate Recruitment Intensity

Gavazza-Mongey-Violante, “What Shifts the Beveridge Curve?”
EXPERIMENTS
Experiments

Trace *transitional dynamics* of the economy in response to:

- **2001 recession**
  - Aggregate productivity $Z \downarrow$ by 4% and recovers in 6 years
Experiments

Trace transitional dynamics of the economy in response to:

• 2001 recession
  ▶ Aggregate productivity $Z \downarrow$ by 4% and recovers in 6 years

• 2007-09 recession
  ▶ Same aggregate productivity $Z \downarrow$ combined with:
  ▶ Financial shock
    ■ Financial wedge $\varphi \uparrow$ and recovers in 6 years
    ■ Initial equity at start-up $\varepsilon \downarrow$ and recovers in 6 years
Model: 2001 vs. 2008

A. Model 2001:01–2007:01

B. Model 2007:01–2014:01

A: TFP Shock
Model: 2001 vs. 2008

B: TFP Shock + increase in intermediation wedge $\varphi$
Model: 2001 vs. 2008

A. Model 2001:01–2007:01

B. Model 2008:01–2014:01

A: TFP shock

Gavazza-Mongey-Violante, "What Shifts the Beveridge Curve?"
Model: 2001 vs. 2008

A. Model 2001:01−2007:01

B. Model 2008:01−2014:01

B: TFP shock + fall in share of entry cost financed by equity ($\varepsilon$)

Gavazza-Mongey-Violante, "WhatShifts the Beveridge Curve?"
Model: 2001 vs. 2008

A. Entry 2001:01−2007:01

B. Entry 2008:01−2014:01

A: TFP Shock

Gavazza-Mongey-Violante, “What Shifts the Beveridge Curve?”
Model: 2001 vs. 2008

A. Entry 2001:01–2007:01

B. Entry 2008:01–2014:01

B: TFP shock + fall in share of entry cost financed by equity ($\varepsilon$)
THANK YOU!
State-level regressions combining HWOL ads and QWI hires

<table>
<thead>
<tr>
<th></th>
<th>Log Vacancy Yield</th>
<th>Log Vacancy Yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>Share of Hires - Firm Age 0-1</td>
<td>0.233*** (0.702)</td>
<td>1.838** (0.908)</td>
</tr>
<tr>
<td>Share of Hires - Firm Age 2-3</td>
<td>0.417 (1.648)</td>
<td>0.355 (1.786)</td>
</tr>
<tr>
<td>Share of Hires - Firm Age 4-5</td>
<td>1.434 (1.835)</td>
<td>1.307 (1.883)</td>
</tr>
<tr>
<td>Share of Hires - Firm Age 6-10</td>
<td>-0.946 (1.312)</td>
<td>-1.090 (1.279)</td>
</tr>
<tr>
<td>Share of Hires - Firm Size 0-19</td>
<td>-0.395 (0.815)</td>
<td>0.231 (1.231)</td>
</tr>
<tr>
<td>Share of Hires - Firm Size 20-49</td>
<td>0.773 (1.900)</td>
<td>1.428 (2.087)</td>
</tr>
<tr>
<td>Share of Hires - Firm Size 250-499</td>
<td>-1.330 (1.648)</td>
<td>-1.815 (1.789)</td>
</tr>
<tr>
<td>Share of Hires - Firm Size 500+</td>
<td>0.244 (0.860)</td>
<td>0.469 (0.935)</td>
</tr>
<tr>
<td>Constant</td>
<td>0.369 (0.770)</td>
<td>0.183 (0.818)</td>
</tr>
</tbody>
</table>

Observations: 1,606
R-squared: 0.934

State FE: Yes
Quarter FE: Yes
Seasonally Adjusted: No

Gavazza-Mongey-Violante, “What Shifts the Beveridge Curve?” p. 39 /42
The Christiano-Eichenbaum-Trabandt critique

\[ U_{t+1} = U_t - \Phi_t V_t^\alpha U_t^{1-\alpha} + \delta (1 - U_t) \]

- One can explain joint dynamics of \( \{U_t, V_t\} \) w/o any change in \( \Phi_t \)
The Christiano-Eichenbaum-Trabandt critique

\[ U_{t+1} = U_t - \Phi_t V_t^\alpha U_t^{1-\alpha} + \delta(1 - U_t) \]

- One can explain joint dynamics of \( \{U_t, V_t\} \) w/o any change in \( \Phi_t \)
- Estimation yields \( \{\hat{V}_t, \hat{H}_t\} \), with \( \hat{H}_t = \hat{V}_t^\alpha U_t^{1-\alpha} \)
- Look at model’s implications for:
  1. Job-finding rate \( (\hat{H}_t/U_t) \)
  2. Vacancy yield \( (\hat{H}_t/\hat{V}_t) \)
The Christiano-Eichenbaum-Trabandt critique

- One can explain the “shift” without any change in $\Phi_t$
The Christiano-Eichenbaum-Trabandt critique

- One can explain the “shift” without any change in $\Phi_t$

- Fit for the vacancy yield is poor
The Christiano-Eichenbaum-Trabandt critique

- With $\Phi_t$ time-varying:

  - Fit for the vacancy yield much better