Measuring Mismatch in the U.S. Labor Market

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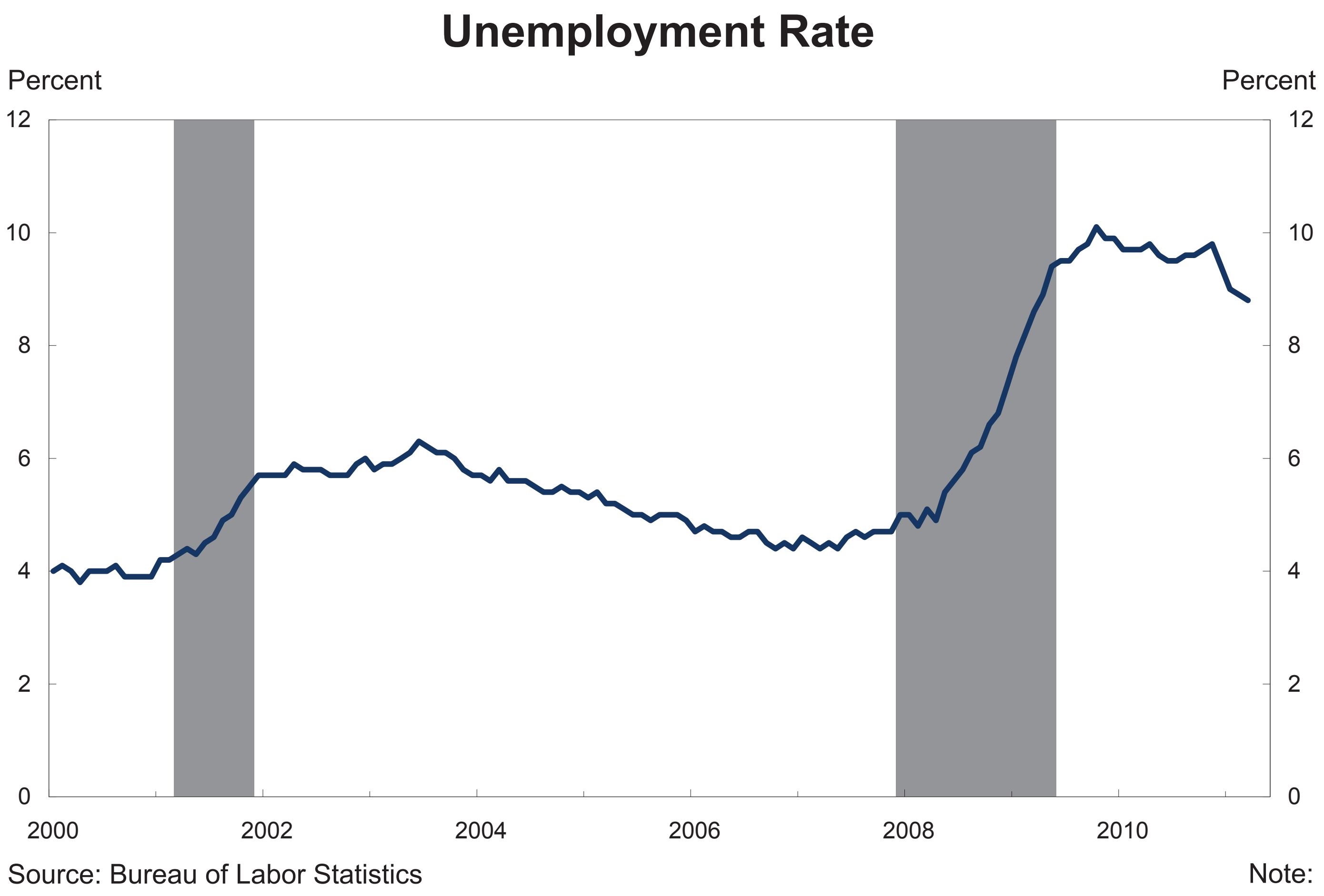
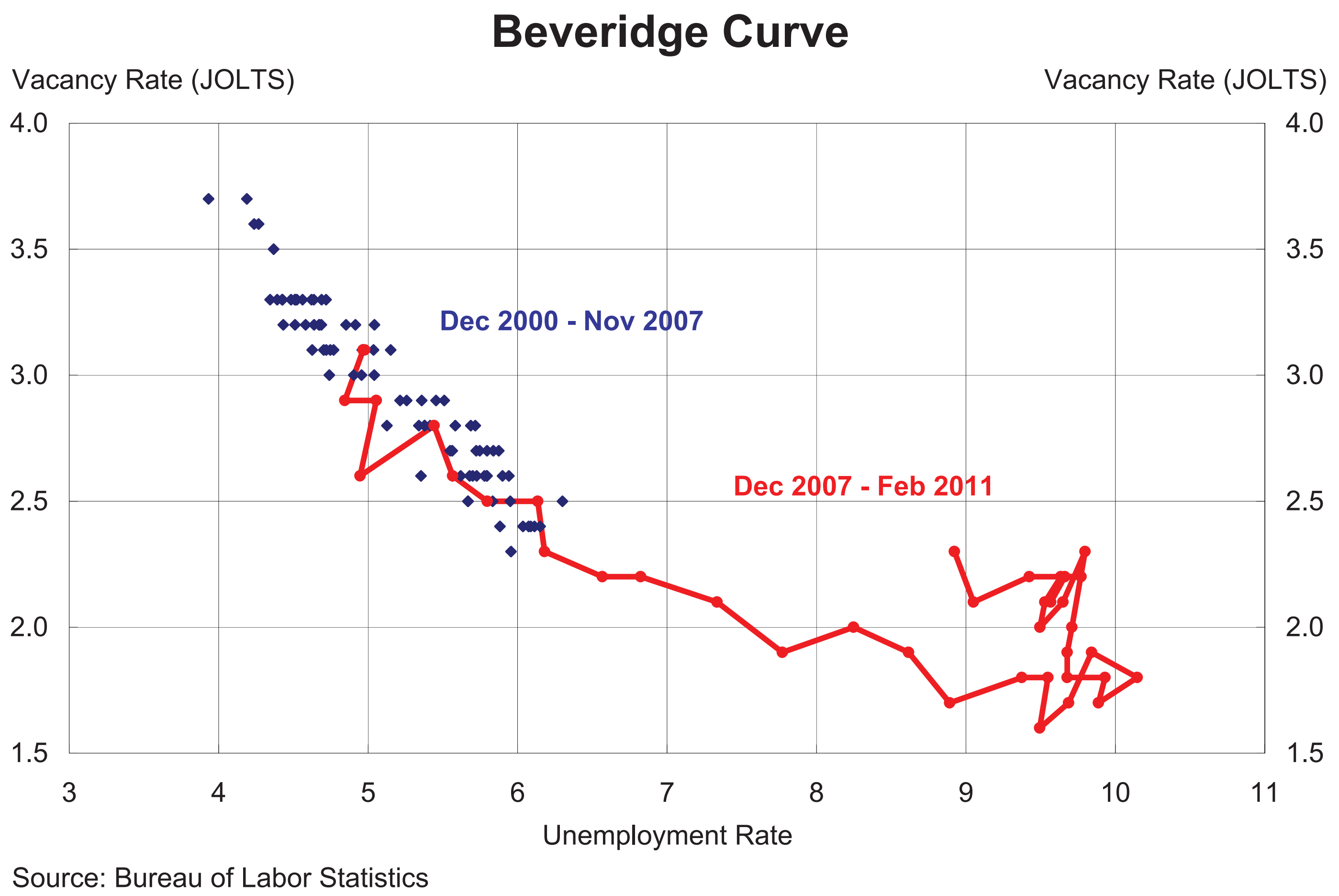
Motivation

- Recent surge in US unemployment sharp and persistent



Motivation

- High unemployment puzzling in light of recent rise in vacancies



Potential explanations

1. Lower workers' search effort (e.g., extension of UI benefits)

2. Lower employers' recruiting effort (e.g., high uncertainty)

3. Higher sectoral mismatch

   - skills/occupations/industries/locations of idle labor are poorly matched with those of job openings

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We develop a framework to measure:

1. how much of (the rise in) unempl. is due to (the rise in) mismatch
2. which dimensions of mismatch are the most important

Methodology

- Economy with I distinct frictional labor markets

- $\{u_i\}$: observed allocation

- $\{u_i^*\}$: allocation selected by a planner who can freely move unemployed across markets (constrained first-best)

- Difference between $\{u_i\}$ and $\{u_i^*\}$ $\rightarrow$ lower job finding rate $\rightarrow$ additional (mismatch) unemployment

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- Difference between $\{u_i\}$ and $\{u_i^*\}$ $\rightarrow$ lower job finding rate $\rightarrow$ additional (mismatch) unemployment
- Same insight as “misallocation” literature: distance from first-best
- Specifically, we build on Jackman-Roper (OBES, 1987)

What we don't do

1. We have little to say about the deep causes of mismatch:
    - moving/retraining costs
    - borrowing constraints
    - information imperfections
    - wage rigidity
    - government policies

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    - wage rigidity
    - government policies
2. We can’t tell whether mismatch is constrained efficient
    - need a model where mismatch is an equilibrium outcome
3. We abstract from the effect of mismatch on vacancy creation

From mismatch to unemployment: two channels

$$u = \frac{s}{s+f}$$

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2. Effect of higher sep. rate on u increasing in mismatch through f

$$\frac{du}{ds} = \frac{f}{(s+f)^2} > 0$$

$$\frac{d^2u}{dsdf} = \frac{s-f}{(s+f)^3} < 0 \text{ since } f \gg s$$

Outline of the rest of the talk

1. Environment and solution to planner's problem

2. Derivation of mismatch indexes and their interpretation

3. Explanation of counterfactuals

4. Results based on JOLTS vacancies

5. Results based on HWOL job advertisements

1. Economic Environment and Planner's Problem

Demographics, preferences and "geography"

- Measure one of ex-ante equal agents
- Individuals can be employed, unemployed, or OLF
- Linear utility over consumption, disutility of search effort ξ
- I distinct frictional labor markets (sectors)
- Free mobility of labor across sectors
- Aggregate labor force: $\ell = \sum_{i=1}^{I} (e_i + u_i) \leq 1$

Frictions, heterogeneity and uncertainty

- New production opportunities (vacancies) v_i arise exogenously in each market i
- Labor markets are frictional: $h_i = \Phi \phi_i m \left(u_i, v_i \right)$
- Existing matches in sector i produce Zz_i units of output
- Matches destroyed exogenously at common rate δ
- Employed workers can quit into unemployment/OLF

Timing of events

1. Exogenous states $\mathbf{S} = (Z, \delta, \Phi)$, and $\mathbf{s} = (\mathbf{v}, \phi, \mathbf{z})$ are observed. Endogenous states $\mathbf{e} = \{e_1, ...e_I\}$ and u also given.
2. Unemployed direct their job search towards sector $i \rightarrow \{u_i\}$
3. Matching process $\rightarrow h_i = \Phi \phi_i m(u_i, v_i)$ new hires
4. Production takes place in the $e_i + h_i$ matches
5. Fraction δ of matches destroyed and σ_i workers quit $\rightarrow \mathbf{e}'$
6. Labor force participation decision $\ell' \rightarrow u'$
7. New realizations of exogenous states

Planner's problem

$$V(u, \mathbf{e}; \mathbf{s}, \mathbf{S}) = \max_{\{u_i, \sigma_i, \ell'\}} \sum_{i=1}^{I} Z z_i (e_i + h_i) - \xi u + \beta \mathbb{E}\left[V(u', \mathbf{e}'; \mathbf{s}', \mathbf{S}')\right]$$

subject to: :

$$\sum_{i=1}^{I} u_i \leq u$$

$$h_i = \Phi \phi_i m(u_i, v_i)$$

$$e_i' = (1-\delta)(e_i + h_i) - \sigma_i$$

$$u' = \ell' - \sum_{i=1}^{I} e_i'$$

$$u_i \in [0, u], \ell' \in [0,1], \sigma_i \in [0, (1-\delta)(e_i + h_i)]$$

$$\Gamma_{Z,\delta,\Phi}(Z', \delta', \Phi'; Z, \delta, \Phi), \ \Gamma_{\mathbf{v}}(\mathbf{v}'; \mathbf{v}, Z', \delta', \Phi'), \Gamma_{\phi}(\phi'; \phi), \Gamma_{\mathbf{z}}(\mathbf{z}'; \mathbf{z})$$

Solution

The FOC wrt u_i yields:

$$Zz_i\Phi\phi_i m_u\left(\frac{v_i}{u_i}\right)+\beta\mathbb{E}\left[V_{e_i}\left(\cdot\right)-V_u\left(\cdot\right)\right]\left(1-\delta\right)\Phi\phi_i m_u\left(\frac{v_i}{u_i}\right)=\mu$$

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The FOC wrt ℓ' is:

$$\mathbb{E}\left[V_u\left(u',\mathbf{e}';\phi',\mathbf{z}',\mathbf{v}',Z',\delta',\Phi'\right)\right]=0$$

The Envelope condition wrt u is:

$$V_u\left(u,\mathbf{e};\phi,\mathbf{z},\mathbf{v},Z,\delta,\Phi\right)=\mu-\xi$$

Solution

The FOC wrt u_i simplifies to:

$$Zz_i\Phi\phi_i m_u\left(\frac{v_i}{u_i}\right)+\beta\mathbb{E}\left[V_{e_i}\left(u',\mathbf{e}';\mathbf{s}',\mathbf{S}'\right)\right](1-\delta)\,\Phi\phi_i m_u\left(\frac{v_i}{u_i}\right)=\mu$$

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The Envelope condition wrt e_i is:

$$V_{e_i}\left(u,\mathbf{e};\phi,\mathbf{z},\mathbf{v},Z,\delta,\Phi\right)=Zz_i+\beta(1-\delta)\mathbb{E}\left[V_{e_i}\left(u',\mathbf{e}';\phi',\mathbf{z}',\mathbf{v}',Z',\delta',\Phi'\right)\right]$$

Guess and verify that: $V_{e_i}\left(u,\mathbf{e};\phi,\mathbf{z},\mathbf{v},Z,\delta,\Phi\right)=z_i\Psi\left(Z,\delta,\Phi\right)$

Conjecture true if: $\mathbb{E}[z_i']=\rho z_i$

Solution

Using this result into the FOC wrt u_i:

$$Z\Phi z_i \phi_i m_u \left(\frac{v_i}{u_i}\right) + \beta(1-\delta)\rho\mathbb{E}\left[\Psi\left(Z', \delta', \Phi'\right)\right]\Phi z_i \phi_i m_u \left(\frac{v_i}{u_i}\right) = \mu$$

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which yields the generalized Jackman-Roper condition:

$$z_1\phi_1 m_u \left(\frac{v_1}{u_1^*}\right) = \ldots = z_i\phi_i m_u \left(\frac{v_i}{u_i^*}\right) = \ldots = z_I\phi_I m_u \left(\frac{v_I}{u_I^*}\right),$$

Convenient static condition to manipulate into “mismatch indexes"

2. Mismatch Indexes

Mismatch index $\mathcal{M}_t^u$

- At date t, $\{v_{it}\}$ and u_t given, hence $\theta_t = v_t/u_t$ given
- W/o heterogeneity in (z_i, ϕ_i), optimality requires $u_{it}^* = \frac{1}{\theta_t} v_{it}$

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- Number of mismatched unemployed:

$$u_t^M = \frac{1}{2}\sum_{i=1}^{I}|u_{it} - u_{it}^*| = \frac{1}{2}\sum_{i=1}^{I}|\frac{u_{it}}{u_t} - \frac{1}{\theta_t}\cdot\frac{v_{it}}{u_t}|u_t = \frac{1}{2}\sum_{i=1}^{I}|\frac{u_{it}}{u_t} - \frac{v_{it}}{v_t}|u_t$$

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- Mismatch unemployment as a share of total is:

$$\mathcal{M}_t^u \equiv \frac{u_t^M}{u_t} = \frac{1}{2}\sum_{i=1}^{I} |\frac{u_{it}}{u_t} - \frac{v_{it}}{v_t}|$$

which can be computed from observed distribution $\{u_{it}, v_{it}\}$

Mismatch index $\mathcal{M}_t^u$ (contd.)

- With heterogeneity in ϕ_i and $m(u_{it}, v_{it}) = \Phi_t \phi_i v_{it}^{\alpha} u_{it}^{1-\alpha}$:

$$\mathcal{M}_{\phi t}^{u} = \frac{1}{2} \sum_{i=1}^{I} \left| \frac{u_{it}}{u_t} - \left(\frac{\phi_i}{\bar{\phi}_t} \right)^{\frac{1}{\alpha}} \cdot \frac{v_{it}}{v_t} \right|$$

where

$$\bar{\phi}_t = \left[\sum_{i=1}^{I} \phi_i^{\frac{1}{\alpha}} \left(\frac{v_{it}}{v_t} \right) \right]^{\alpha}$$

- Similarly for the model with heterogeneous productivities $\rightarrow \mathcal{M}_{zt}^{u}$

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- Similarly for the model with heterogeneous productivities $\rightarrow \mathcal{M}_{zt}^u$
- $\mathcal{M}_t^u$: fraction of unemployed searching in the "wrong sector"
- Hence, index of misallocation of unemployed workers

Mismatch index $\mathcal{M}_t^h$

- Assume Cobb-Douglas matching function: $h_{it} = \Phi_t v_{it}^{\alpha} u_{it}^{1-\alpha}$
- Summing across sectors, aggregate hires equal:

$$h_t = \Phi_t v_t^{\alpha} u_t^{1-\alpha} \cdot \left[\sum_{i=1}^{I} \left(\frac{v_{it}}{v_t} \right)^{\alpha} \left(\frac{u_{i_t}}{u_t} \right)^{1-\alpha} \right]$$

and optimal aggregate hires are $h_t^* = \Phi_t v_t^{\alpha} u_t^{1-\alpha}$

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- Alternative mismatch index:

$$\mathcal{M}_t^h \equiv \frac{h_t^* - h_t}{h_t^*} = 1 - \sum_{i=1}^{I} \left(\frac{v_{it}}{v_t} \right)^{\alpha} \left(\frac{u_{it}}{u_t} \right)^{1-\alpha}$$

measures the fraction of hires lost because of misallocation

3. COUNTERFACTUALS

Explaining the shift in the Beveridge curve

- Aggregate matching function:

$$h_t = \left(1 - \mathcal{M}_t^h\right) \cdot \Phi_t \cdot v_t^{\alpha} u_t^{1-\alpha}$$

- Take logs:

$$\log h_t = \underbrace{\log\left[\left(1 - \mathcal{M}_t^h\right) \cdot \Phi_t\right]}_{\text{Aggr. matching efficiency } A_t} + \alpha \log v_t + (1-\alpha) \log u_t$$

- Estimate $\{A_t\}$ residually

- Given our estimate of $\{1 - \mathcal{M}_t^h\}$, we can measure how much of the observed shift in aggr. efficiency is due to increased mismatch

Counterfactual unemployment dynamics

- Observed unemployment dynamics

$$u_{t+1} = u_t + s_t \cdot (1 - u_t) - f_t \cdot u_t$$

Counterfactual unemployment dynamics

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- Aggregate job finding rate:

1. observed: $$f_t = (1 - \mathcal{M}_t^h) \cdot \Phi_t \cdot \left(\frac{v_t}{u_t}\right)^\alpha$$

2. no mismatch: $$f_t^* = \Phi_t \cdot \left(\frac{v_t}{u_t^*}\right)^\alpha = \frac{f_t}{(1-\mathcal{M}_t^h)} \cdot \left(\frac{u_t}{u_t^*}\right)^\alpha$$

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- Counterfactual unemployment dynamics in absence of mismatch:

$$u_{t+1}^* = u_t^* + s_t \cdot (1 - u_t^*) - f_t^* \cdot u_t^*$$

$\Delta u - \Delta u^*$: how much of the observed rise in unemployment is due to increased mismatch

4. Analysis Based on JOLTS

Sources of data

- Vacancies: JOLTS 2000:12 - 2011:2
  - Disaggregation: 16 industries in the private sector + government, and 4 Census regions
- Unemployment: Monthly CPS
  - Information on industry and occup. of last employment only
- Productivity: Average hourly earnings by industry (CES)

Matching function specification

- For 2-digit industries, we estimate CES matching function:

$$\ln\left(\frac{h_{it}}{u_{it}}\right) = \log\Phi_t + \log\phi_i + \frac{1}{\sigma}\log\left[\alpha\left(\frac{v_{it}}{u_{it}}\right)^{\sigma} + (1-\alpha)\right]$$

$\hat{\sigma}$	-0.074
95% Conf. Int.	$[-0.267, 0.081]$

- Recall: $\sigma \in (-\infty, 1)$, with $\sigma = 0$ for Cobb-Douglas

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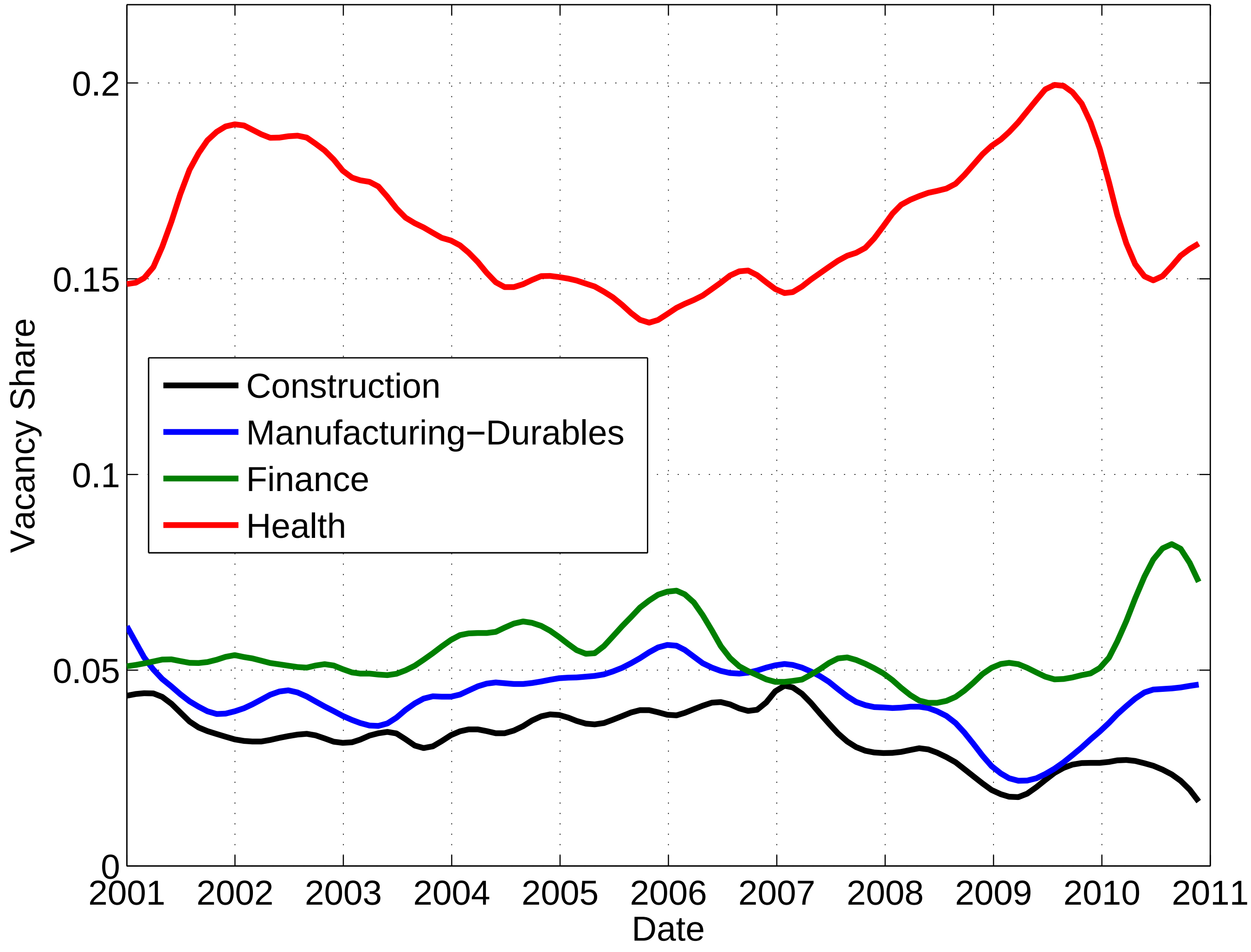
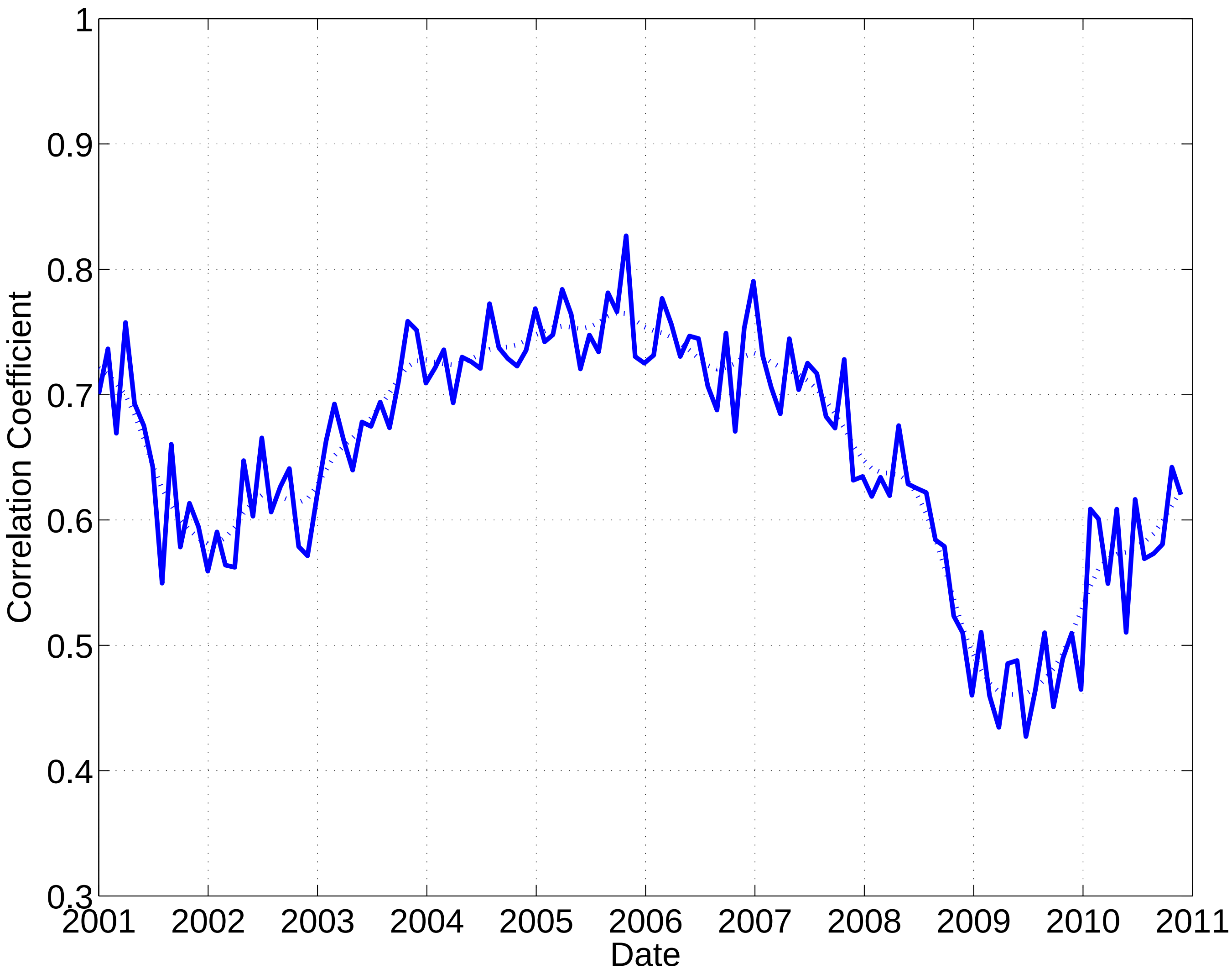
- When restricting to Cobb-Douglas:
  - we estimate $\hat{\alpha} = 0.60$ and $\hat{\phi}_i$ for each industry

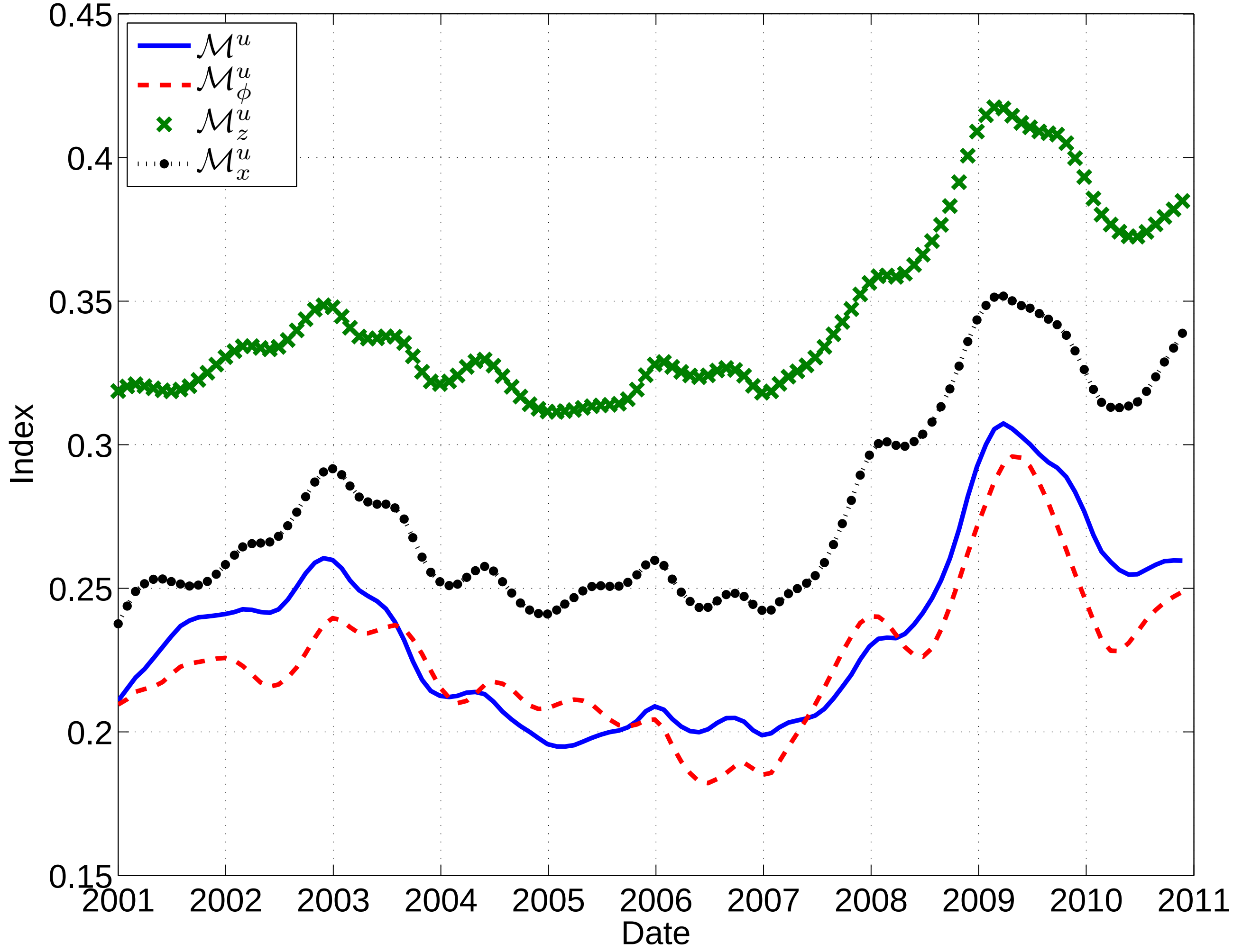
Labor demand shifts across industries



Correlation between (u, v) shares across industries

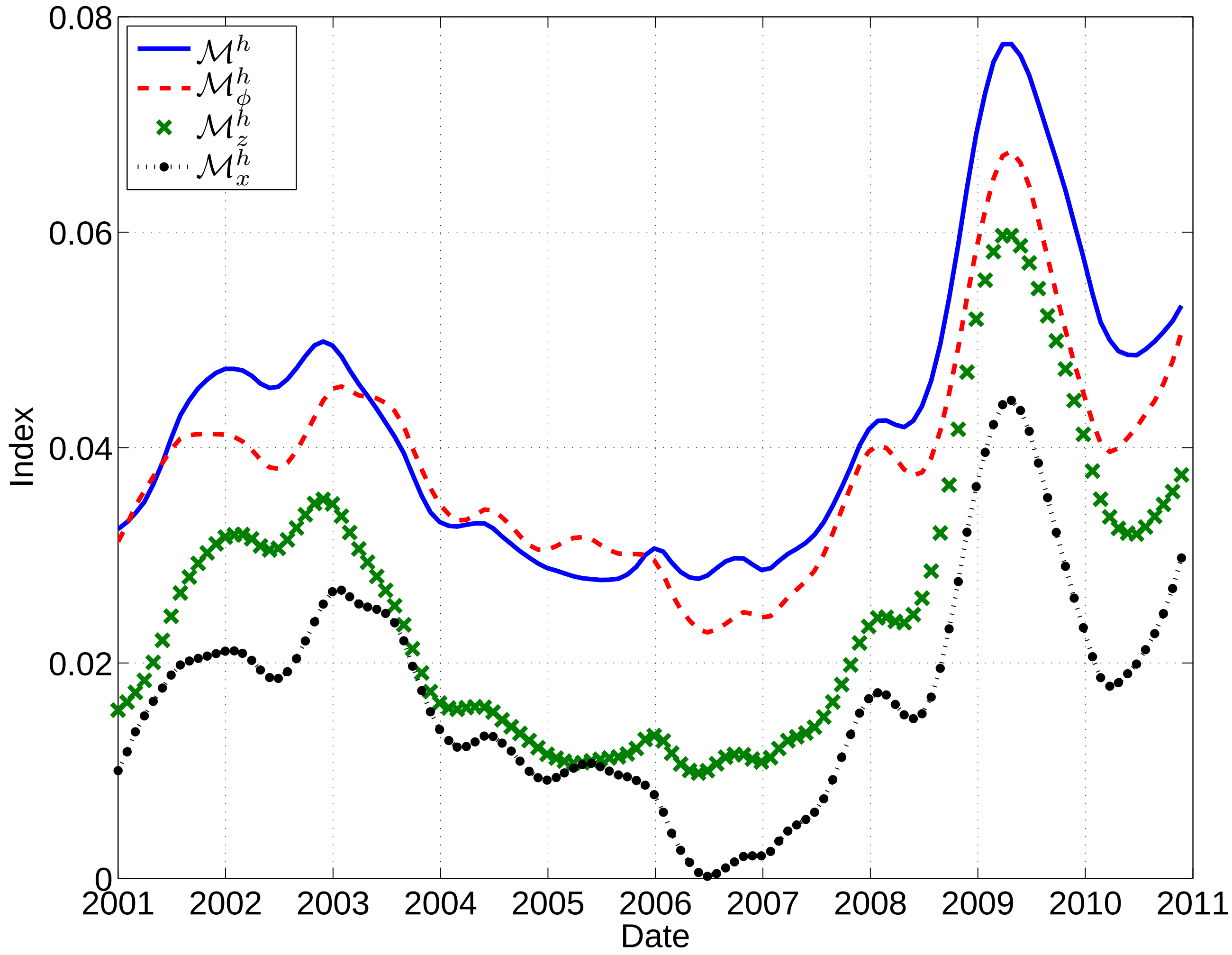


Mismatch index $\mathcal{M}_t^u$ (JOLTS)



After the recession: additional 5% of unemployed misallocated

Mismatch index $\mathcal{M}_t^h$ (JOLTS)



After the recession: additional 2% of monthly hires lost bc of mismatch

Accounting for shift in aggregate matching function

$$\log h_t = \log \left[\left(1 - \mathcal{M}_t^h\right) \cdot \bar{\phi}_{xt} \cdot \Phi_t \right] + \alpha \log v_t + (1-\alpha) \log u_t$$

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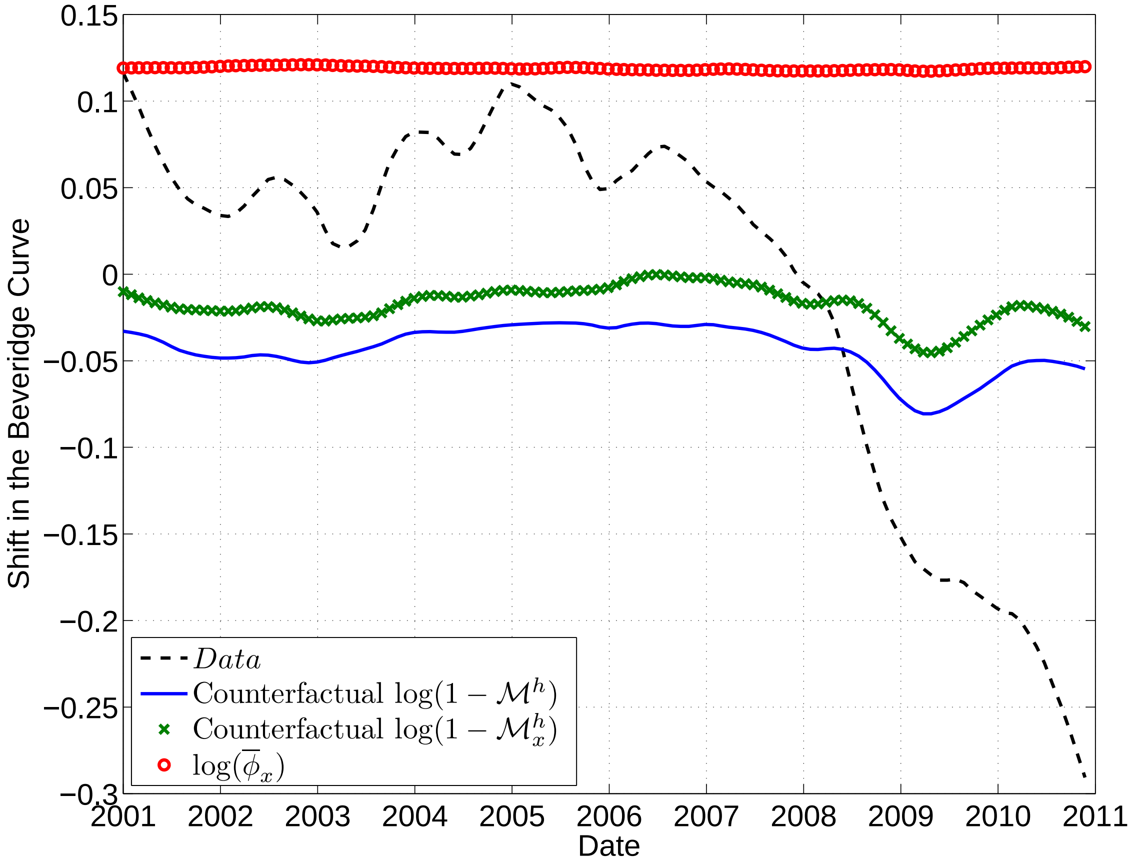
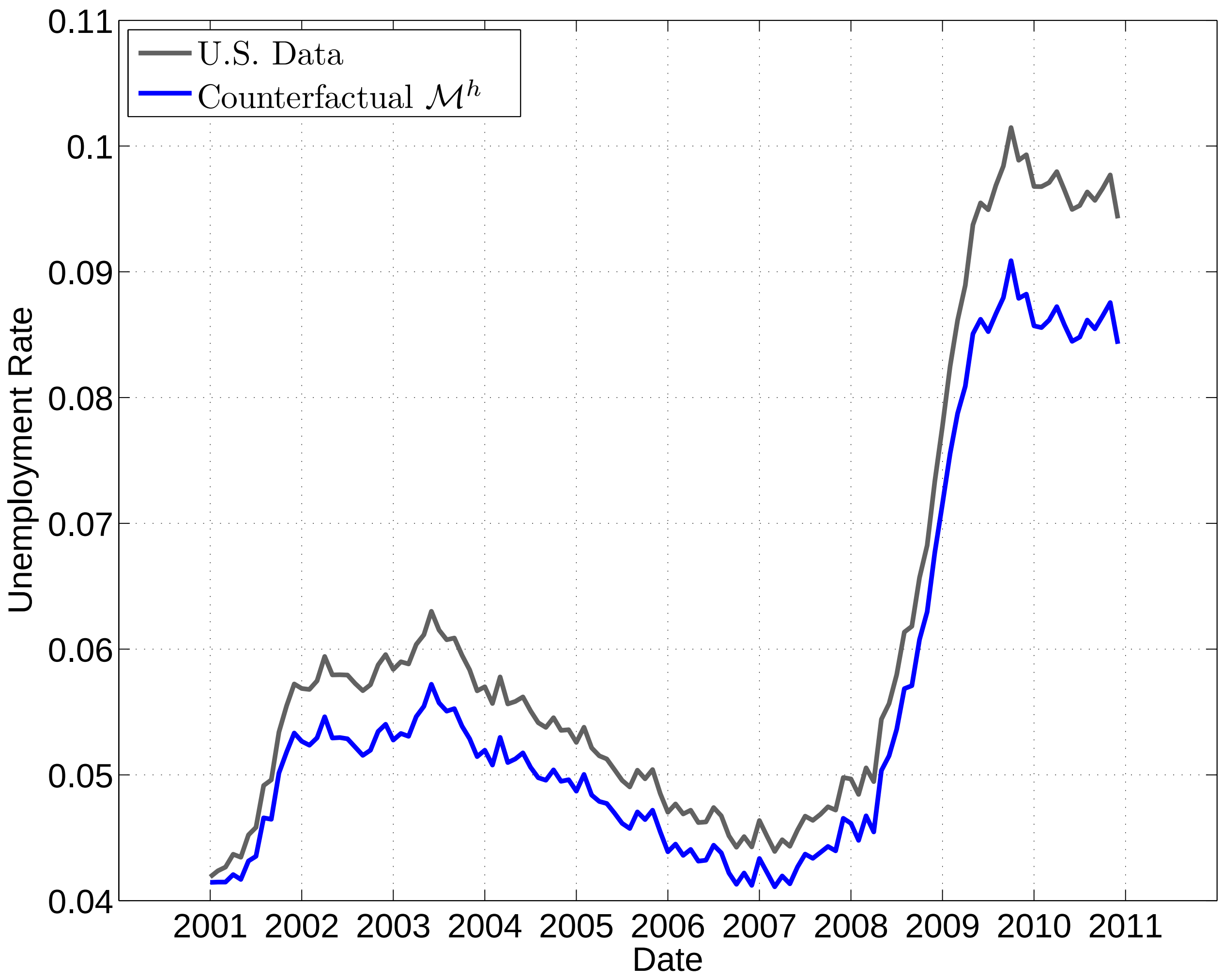


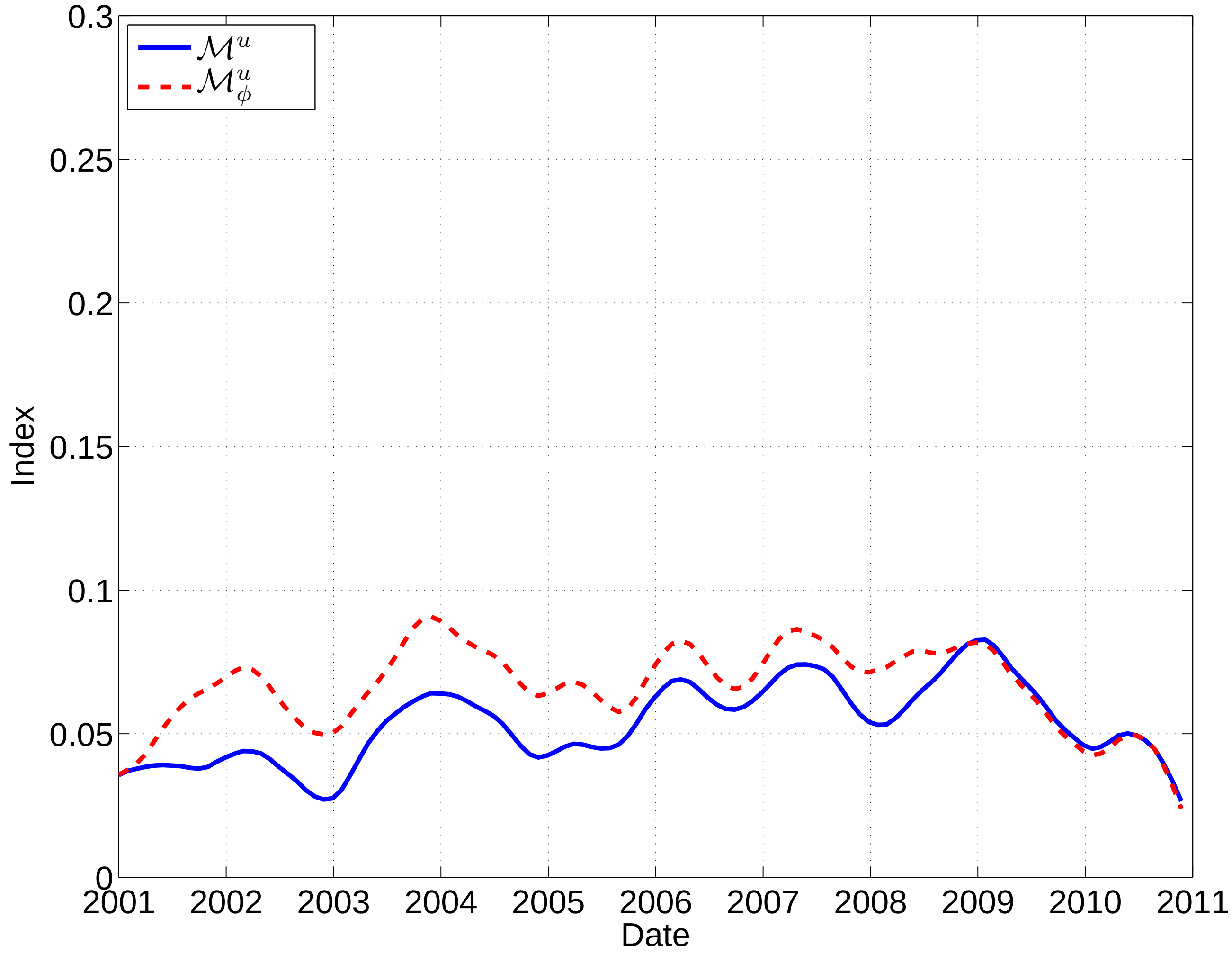
Industry mismatch explains a tiny fraction of the observed shift

Accounting for the rise in US unemployment



At most 0.7 pct points of rise in u explained by industry mismatch

Geographical mismatch (4 Census regions)



Geographical mismatch shows no significant trend

5. Analysis Based on HWOL

The HWOL data: July 2005-

- *“HWOL program is targeted to cover the full universe of all online advertised vacancies which are posted directly on internet job boards or through newspaper online ads”*
- Four million ads per month (four thousand in JOLTS)
- Unduplication algorithm to identify ads posted on multiple boards

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- Info by ad: Job board, Full/Part time, Location (county), SOC (6-digit), Education level, NAICS (6-digit), Salary (where available)

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- Unduplication algorithm to identify ads posted on multiple boards

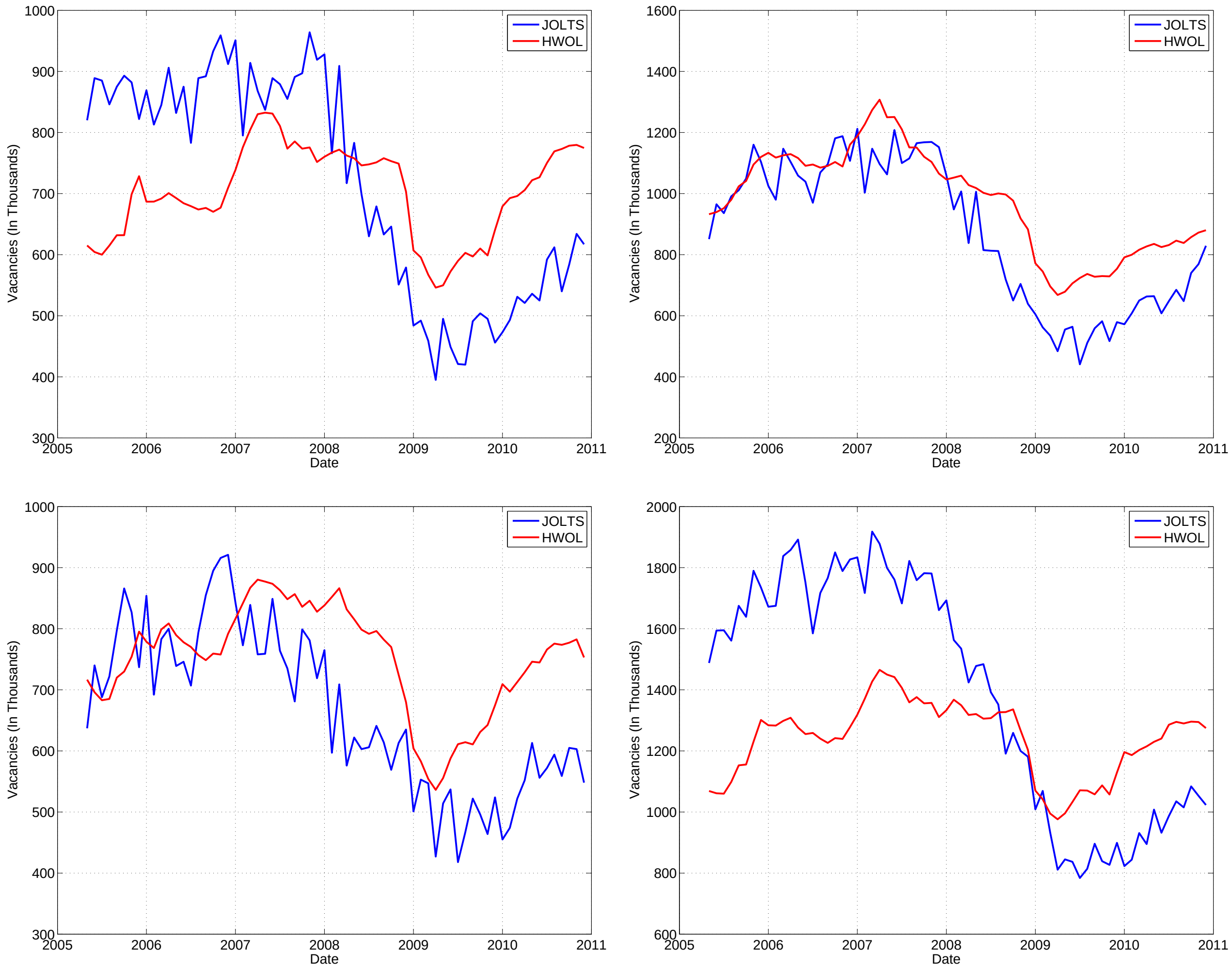
- Info by ad: Job board, Full/Part time, Location (county), SOC (6-digit), Education level, NAICS (6-digit), Salary (where available)

- Two major measurement issues:

  1. Upward trend in the use of online advertisement

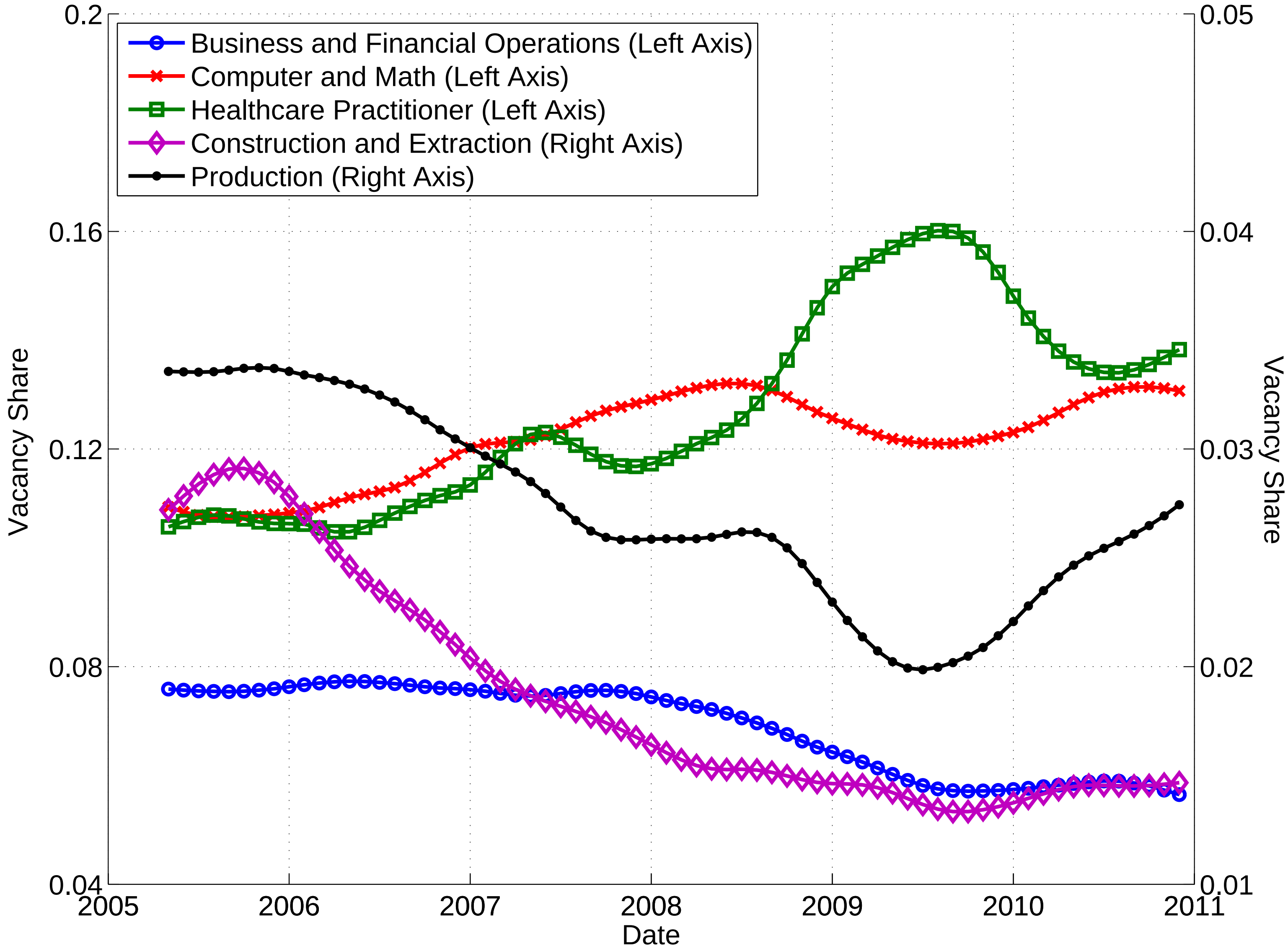
  2. Number of vacancies in each ad

JOLTS-HWOL comparison by Census region

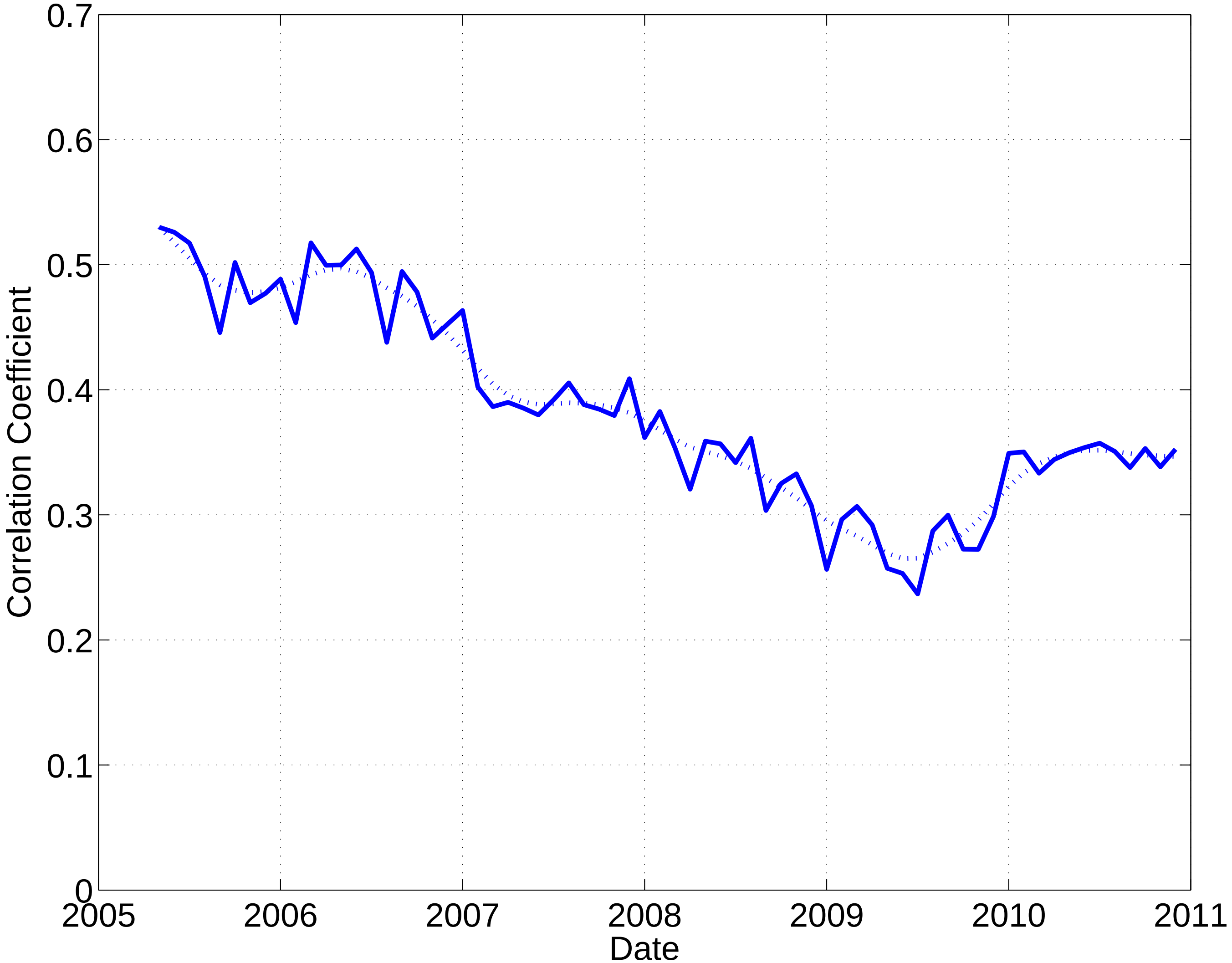


Correlation between aggregate time series is 0.91

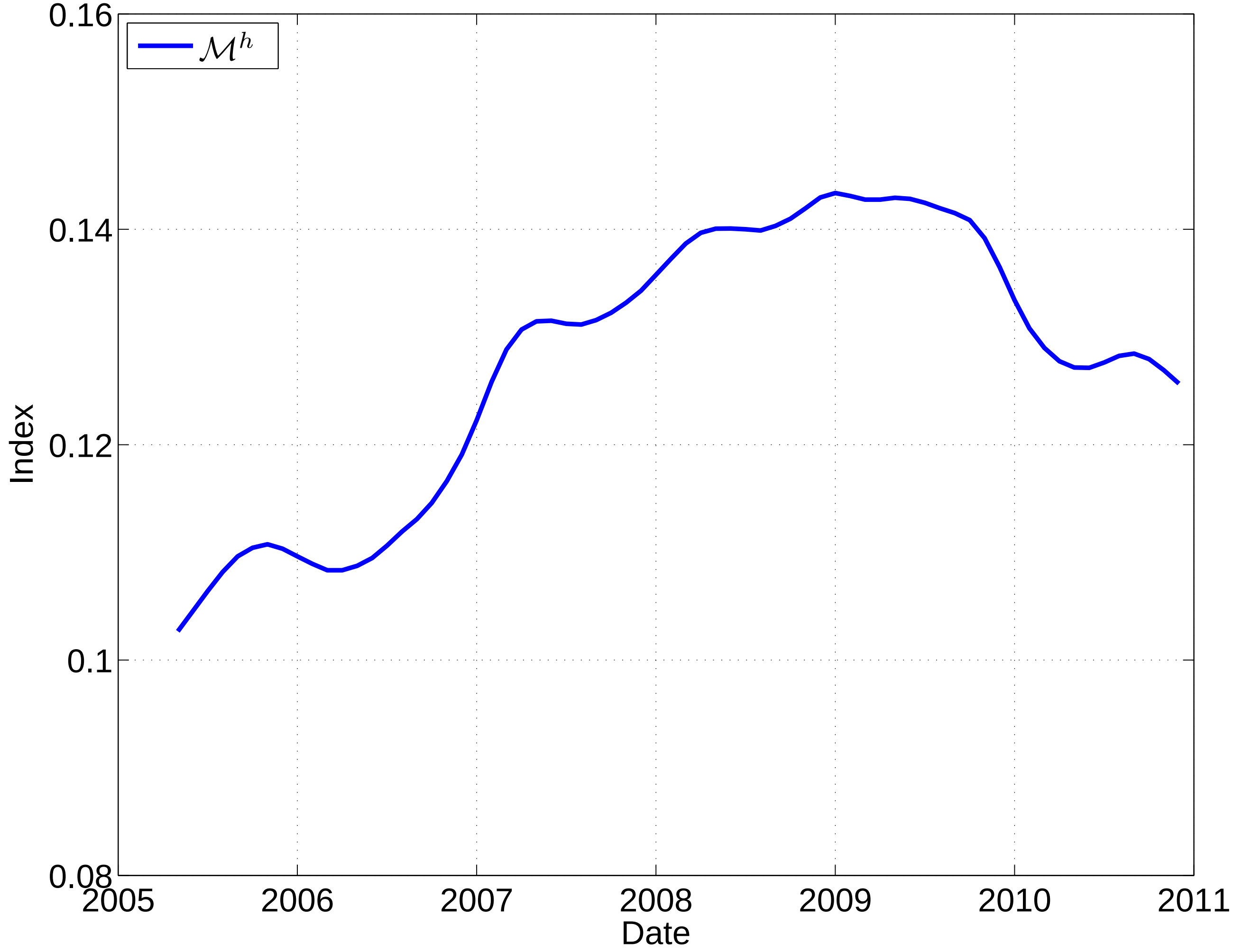
Labor demand shifts across occupations



Correlation between (u, v) shares across occupations



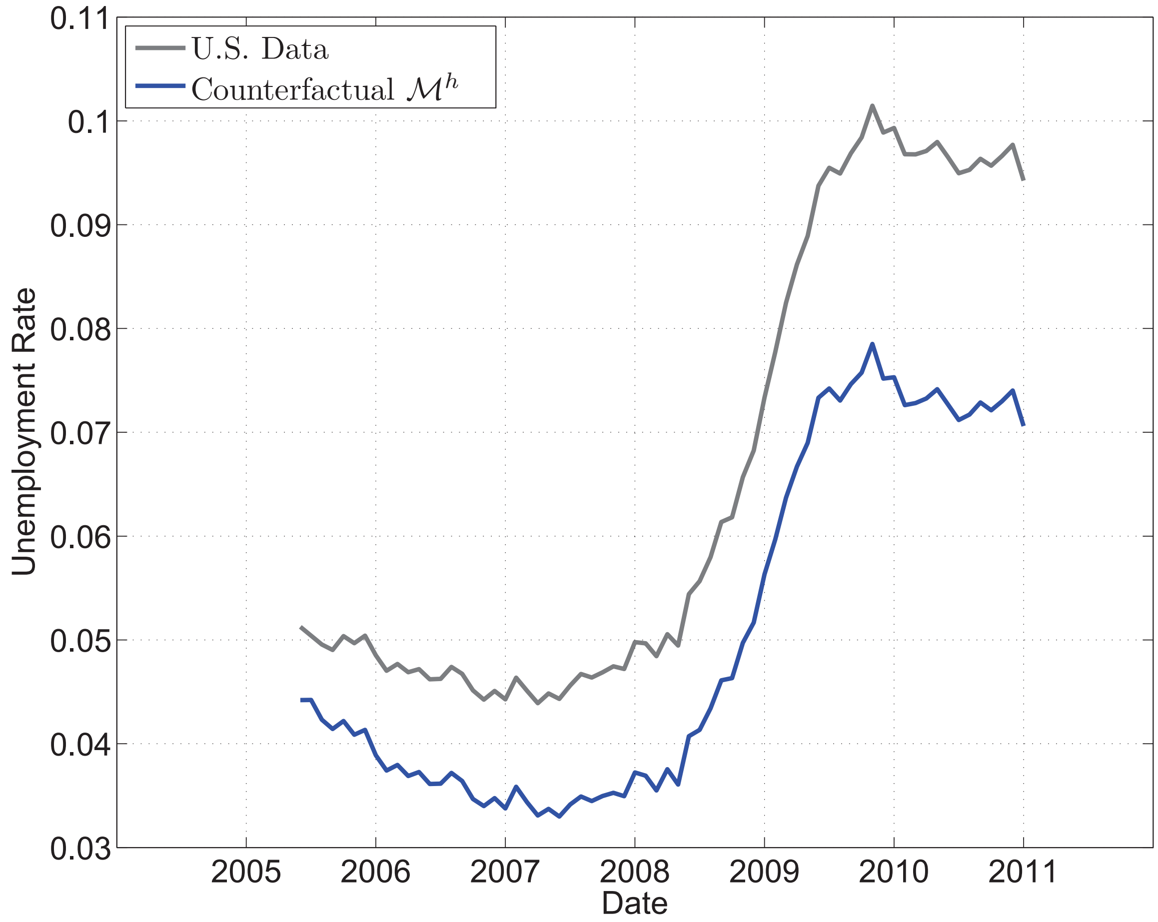
Mismatch index $\mathcal{M}_t^h$ (HWOL 2 digit occ.)



After the recession: additional 3% of monthly hires lost bc of mismatch

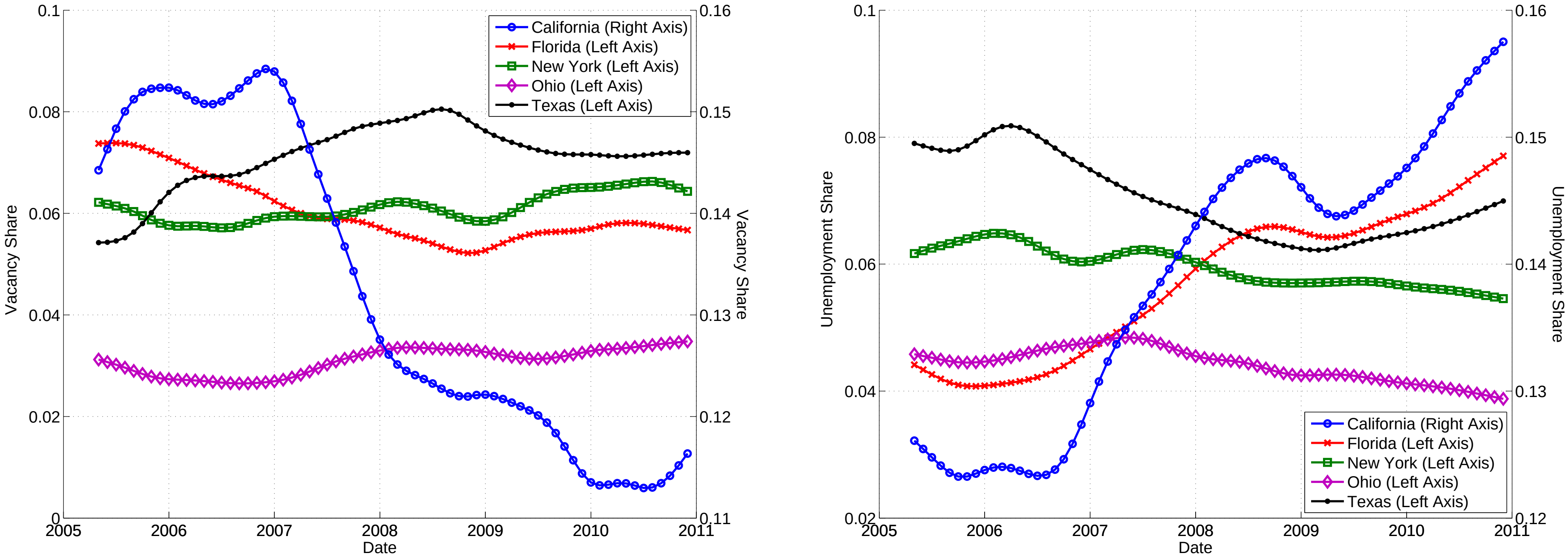
Accounting for the rise in US unemployment

2 Digit SOC (CF_HWOL_soc.eps)



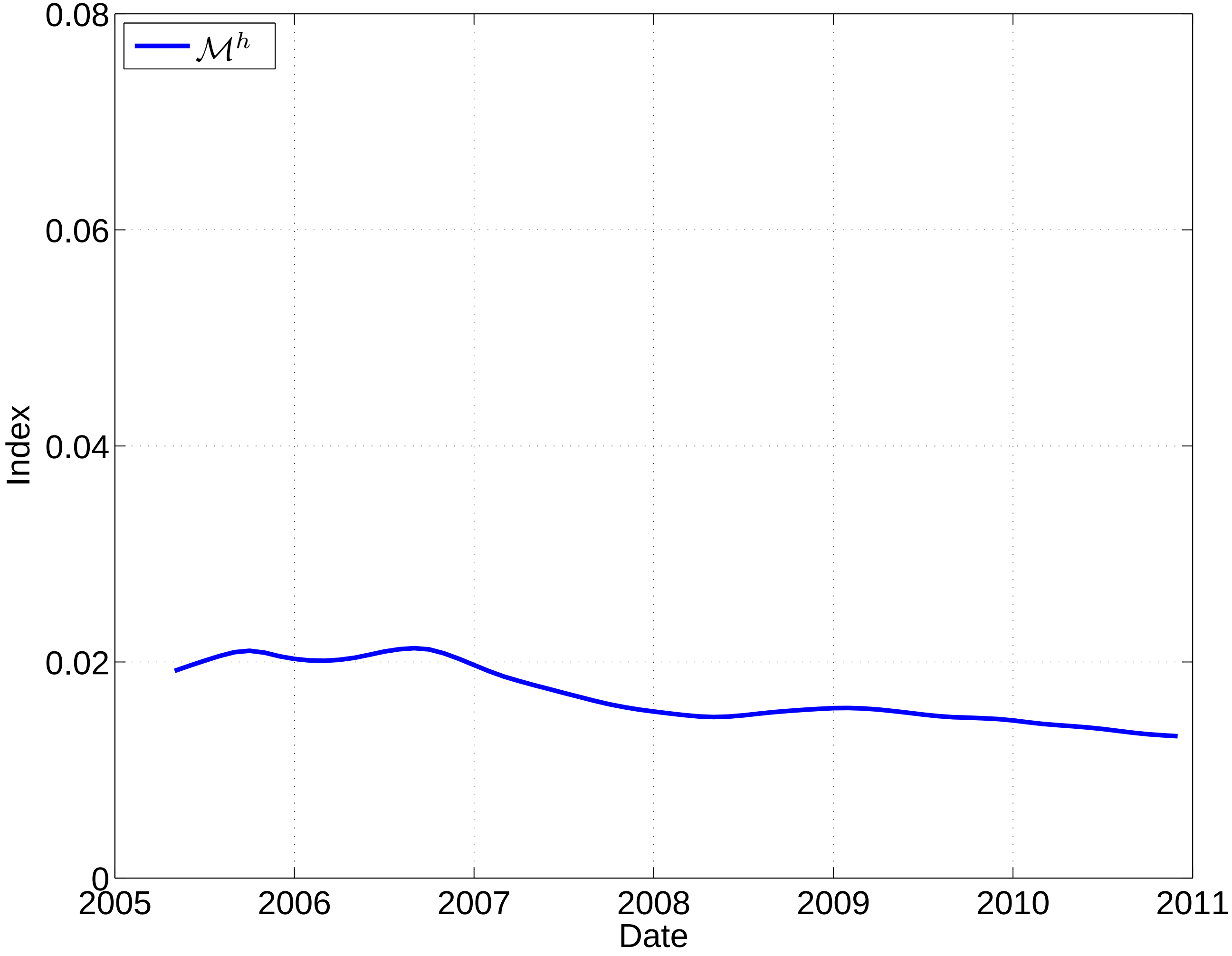
At most 1.3 pct points of rise in u explained by occupational mismatch

Vacancy and unemployment shares by state



Significant shifts for some big states, but small or no shifts for all others

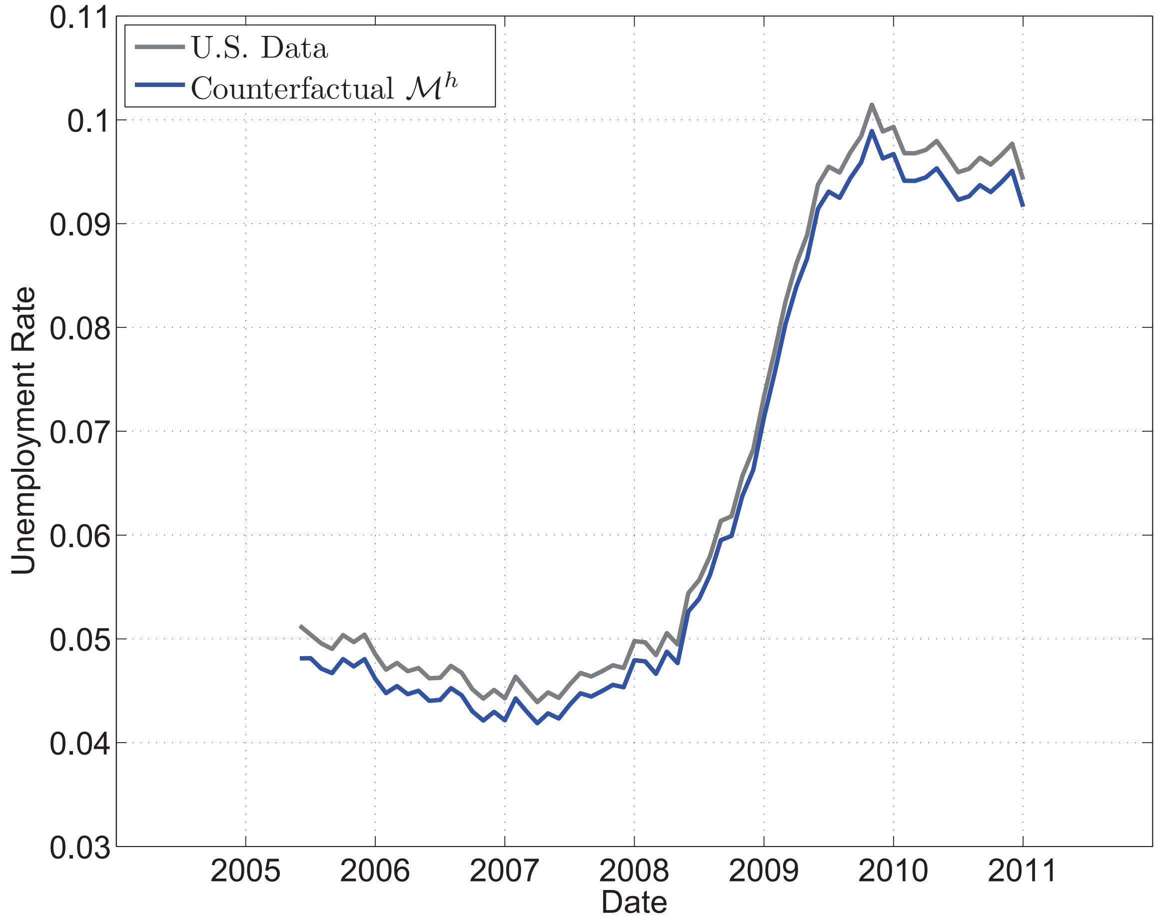
Geographical mismatch (50 states)



Geographical mismatch across states shows a slight decline

Accounting for the rise in US unemployment

State (CF_HWOL_State.eps)



Role of geographical mismatch appears irrelevant

Conclusions

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- Future work:
  - Correction for industries/occupation of unemployed
  - Mismatch indexes by education level
  - Access to UI records for selected states