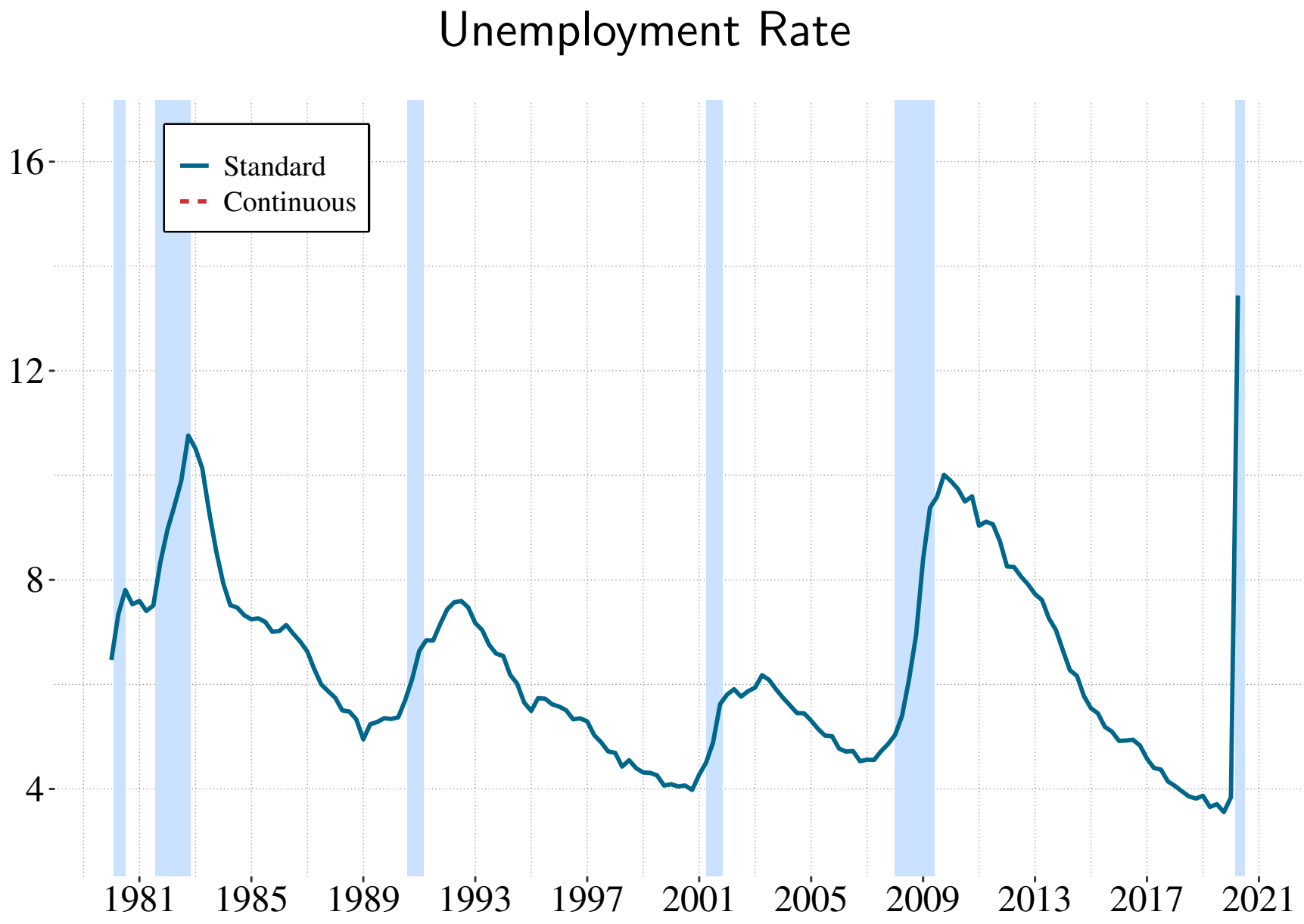
Revisiting Unemployment with an Intensive Margin

Christine Braun
University of Warwick

Motivation


Unemployment Rate
Standard
Continuous
16
12
8
4
1981
1985
1989
1993
1997
2001
2005
2009
2013
2017
2021

Standard Definition of Unemployment

- Unemployment is measured using "in or out" approach
  - one active effort to find job in past 4 weeks & available

Question Is the "in or out" approach a good measure of labor underutilization?

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Question Is the "in or out" approach a good measure of labor underutilization?

Status in previous month	Not seasonally adjusted			
	Status in current month			
	Employed	Unemployed	Not in labor force	Other outflows(1)
Total, 16 years and over				
Employed	152,964	1,296	4,193	25
Unemployed	1,402	2,686	1,375	2
Not in labor force	4,604	1,523	89,365	202
Other inflows(2)	96	5	336	-

- Two observations
  - (1) Large oscillations between U and O
  - (2) Large flows $O \to E$

Answer: no.

Standard Definition of Unemployment

- Unemployment is measured using "in or out" approach
  - one active effort to find job in past 4 weeks & available

Two Main Problems

1. Measurement Issues: misclassification between LM states
   - Solutions:
     (1) estimate misclassification probabilities and move people around Abowd & Zellner (1985), Poterba & Summers (1986), Feng & Hu (2013), Elsby, Hobijn & Sahin (2015), Krueger, Mas & Niu (2017), Shibata (2019WP), Ahn & Hamilton (2019WP) example
     (2) BLS broader measures of unemployment Definitions
   - Misses on Problem # 2

Standard Definition of Unemployment

- Unemployment is measured using "in or out" approach
  - one active effort to find job in past 4 weeks & available

Two Main Problems

2. No Heterogeneity: changes in the unemployment rate driven by compositional changes of the pool of unemployed
   - Solution:
     (1) adjust using labor force shift share Perry (1970), Gordon (1982), Summers (1986), Shimer (1998), Barnichon & Mesters (2018), Crump, Giannoni, Eusepi, & Sahin (2019)
   - Misses on Problem # 1

Continuous Definition of Labor Force Attachment

Discrete LF attachment

$$U_t = \sum_{i \in N_t} \mathbb{1}(\text{search \& avail.}) wgt_i$$

Continuous LF attachment

$$\tilde{U}_t = \sum_{i \in N_t} P_{it} wgt_i$$

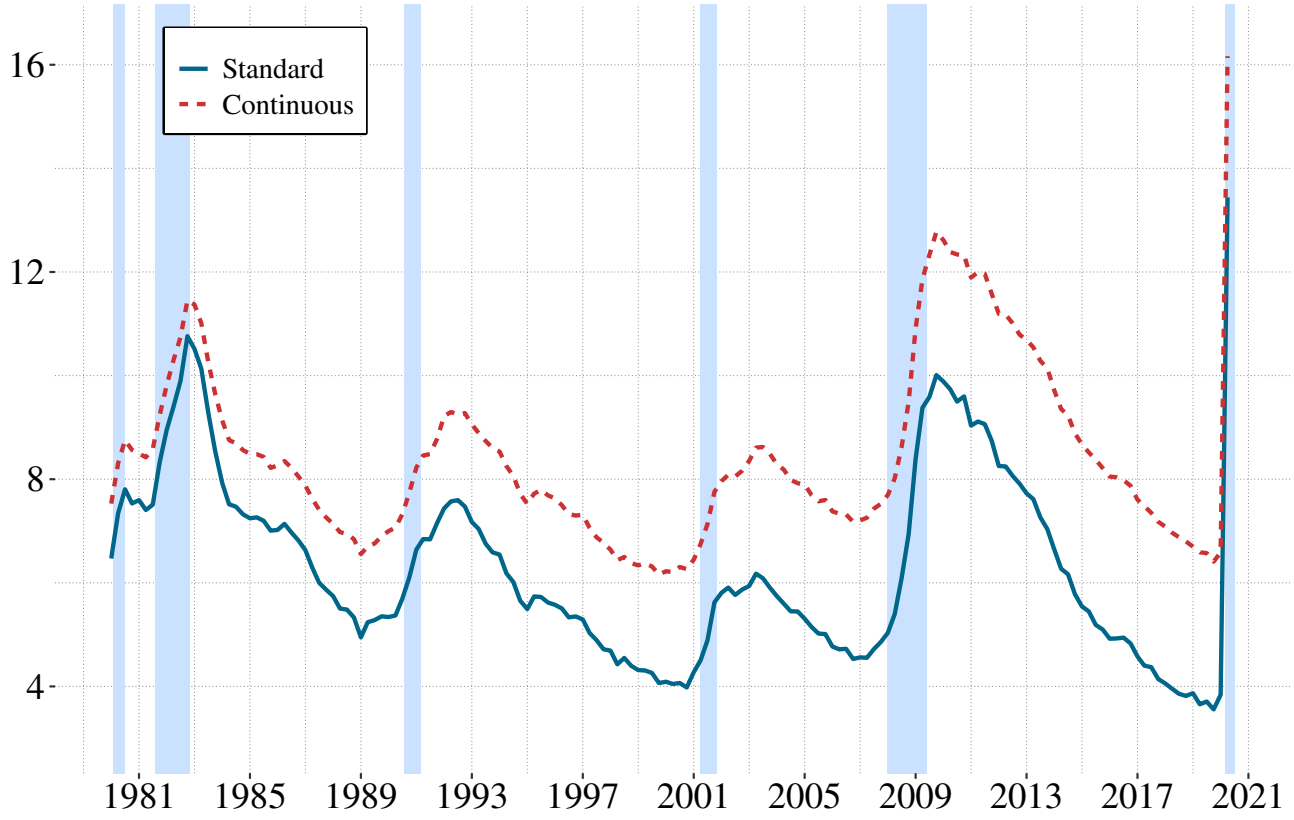
- N_t = not employed
- wgt_i = sampling weight
- P_{it} = estimated search effort
  - $P_{it} \in (0, 1)$
    - $\Rightarrow$ addresses Problem # 1
  - estimated using demographic characteristics
    - $\Rightarrow$ addresses Problem # 2
  - positively correlated with emp. prob. & hours worked

Note: we already do this for emp. (full/part time, total hours, full time equivalents)

How I do it

- **Data Sources**
  1. American time use survey (ATUS) 2003-2018
     - contains job search information for everyone
  2. Current Population Survey 1980-2018
     - used to calculate all aggregate labor market stats
- **Empirical Strategy**
  1. Machine Learning to best predict job search in ATUS
  2. Predict job search in CPS from 1980-2018
  3. Construct continuous labor market statistics

What Comes Out



- volatility of cont. unemployment rate is $\sim$ 30% less
- downward trend in unemployment rate
- Application: no flattening of Phillips Curve

Data

- American Time Use Survey 2003-2017
  - Interviews CPS respondents 2-5 months after CPS
  - Asks about labor force status again
    - categorizes identically to CPS
  - Asks people what, where, with whom, and how long they did activities throughout the day
    - job search activities

Who is Searching?

Search Effort by Labor Force Status

	Age 16+		
	Daily Probability	Monthly Probability	Minutes Per Day
Employed	0.6	16.8	113.4
Unemployed	17.1	99.6	145.8
Out of the Labor Force	0.4	11.9	132.9
N	189,314	189,314	2,122

	Age 25-55		
	Daily Probability	Monthly Probability	Minutes Per Day
Employed	0.6	15.5	123.2
Unemployed	23.0	99.9	155.2
Out of the Labor Force	1.0	25.4	136.3
N	108,505	108,505	1,506

Type of Search

Predicting Search Probability

- Logistic function for prob. job search ($y_i = 1$)

$$P(y_i = 1|x_i) = \frac{\exp(\beta_0 + x_i^T \beta)}{1 - \exp(\beta_0 + x_i^T \beta)}$$

- Net-elastic regularization

$$\min_{\beta_0, \beta} - \left[\frac{1}{N} \sum_{i=1}^{N} y_i (\beta_0 + x_i^T \beta) - \ln[1 - \exp(\beta_0 + x_i \beta)] \right] + \lambda \left[(1-\alpha) \sum_{k \in K} \beta_k^2 + \alpha \sum_{k \in K} |\beta_k| \right]$$

  - $\alpha = 0.95 \Rightarrow$ close to LASSO
  - λ chosen by cross validation of 10 folds to maximize the area under receiver operating characteristic curve
  - K is the set of predictors with penalty

- Estimated on each labor market state separately

Predicting Search Probability

- Predictors without penalty
  - Demographics: female, age, age^2, education, child, married, race, full/part time
  - Day of the week fixed effects
  - Economy variable and state fixed effects
- Interactions with penalty
  - female by demographic variables and economy
  - education by demographic variables and economy

Predicting Search Probability

- State coincidence index from the Philadelphia FED
  - combines 4 state-level labor market indicators into index
  - trend is set to match long term state level GDP growth
- Coincidence index per capita $cipc_{st}$

$$\ln cipc_{st} = \delta_s + \alpha_1 t + \alpha_2 t \times 1(S = s) + \varepsilon_{st}$$

- Final economy variable is the residual $\hat{\varepsilon}_{st}$

Predicting Search Probability

- Interactions included for Employed - 13

  Female $\times$ College, Female $\times$ Child, Female $\times$ Part Time, Some College $\times$ Economy, Less than HS $\times$ Married, College $\times$ Race - Other, Some College $\times$ Race - Other, High School $\times$ Race - White, High School $\times$ Child, Some College $\times$ Child, College $\times$ Part Time, High School $\times$ Part Time, Some College $\times$ Part Time

- Interactions included for Unemployed - 9

  Female $\times$ Some College, Female $\times$ Married, Economy $\times$ College, Economy $\times$ Less than HS, Some College $\times$ Married, College $\times$ Race - Other, High School $\times$ Race-Other, Some College $\times$ Race - Other, Some College $\times$ Child

- Interactions included for Out of the Labor Force - 16

  Female $\times$ Married, Female $\times$ Race - White Female $\times$ Child, Economy $\times$ College, Economy $\times$ Less than HS, Economy $\times$ High School, Economy $\times$ Some College, Less than HS $\times$ Married, Some College $\times$ Married, High School $\times$ Age^2, College $\times$ Race - Other, Less than HS $\times$ Race-Other, Some College $\times$ Race - Other, High School $\times$ Child, Less than HS $\times$ Child, Some College $\times$ Child

GOF

Predicted Probabilities

- Data: CPS 1980-2018
- Contains all the same demographic variables
- Predicted search probabilities
  - Daily probability

$$\hat{p}_d \text{ for Monday -Sunday}$$

  - Weekly probability

$$\hat{p}_i^w = 1 - \prod_{d=1}^{7}(1 - \hat{p}_d)$$

  - Monthly probability

$$\hat{P}_i = 1 - (1 - \hat{p}_i^w)^{4.17}$$

Predicted Probabilities

	Employed	Unemployed	Out of the Labor Force
5th Percentile	0.0051	0.7184	0.0000
10th Percentile	0.0180	0.8402	0.0000
25th Percentile	0.0459	0.9560	0.0012
50th Percentile	0.0924	0.9944	0.0239
75th Percentile	0.1633	0.9997	0.1261
90th Percentile	0.2668	1.0000	0.3097
95th Percentile	0.3690	1.0000	0.4695

Labor Force Attachment

- If P_{it} is a measurement for attachment
  - higher effort should imply more hours
  - more likely to work full time
  - higher job finding probability
- Subset all transition from non-employment to employment

$$y_{it} = \beta \hat{P}_{i,t-1} + \delta_t + \varepsilon_{it}$$

	Job Finding Prob.		Hours Worked		Change in Hours	
Search Probability	0.174	0.176	7.397	7.554	18.542	18.502
	(0.000)	(0.000)	(0.065)	(0.065)	(0.230)	(0.229)
Mean	0.037	0.037	30.33	30.33	0.33	0.33
Month × Year FE		✓		✓		✓
Observations	17608693	17608693	345967	345967	188130	188130
Sample	Full	Full	Nonemp. Job Finders	Nonemp. Job Finder	Emp. Job Switchers	Emp. Job Switchers

Total Number of Searchers

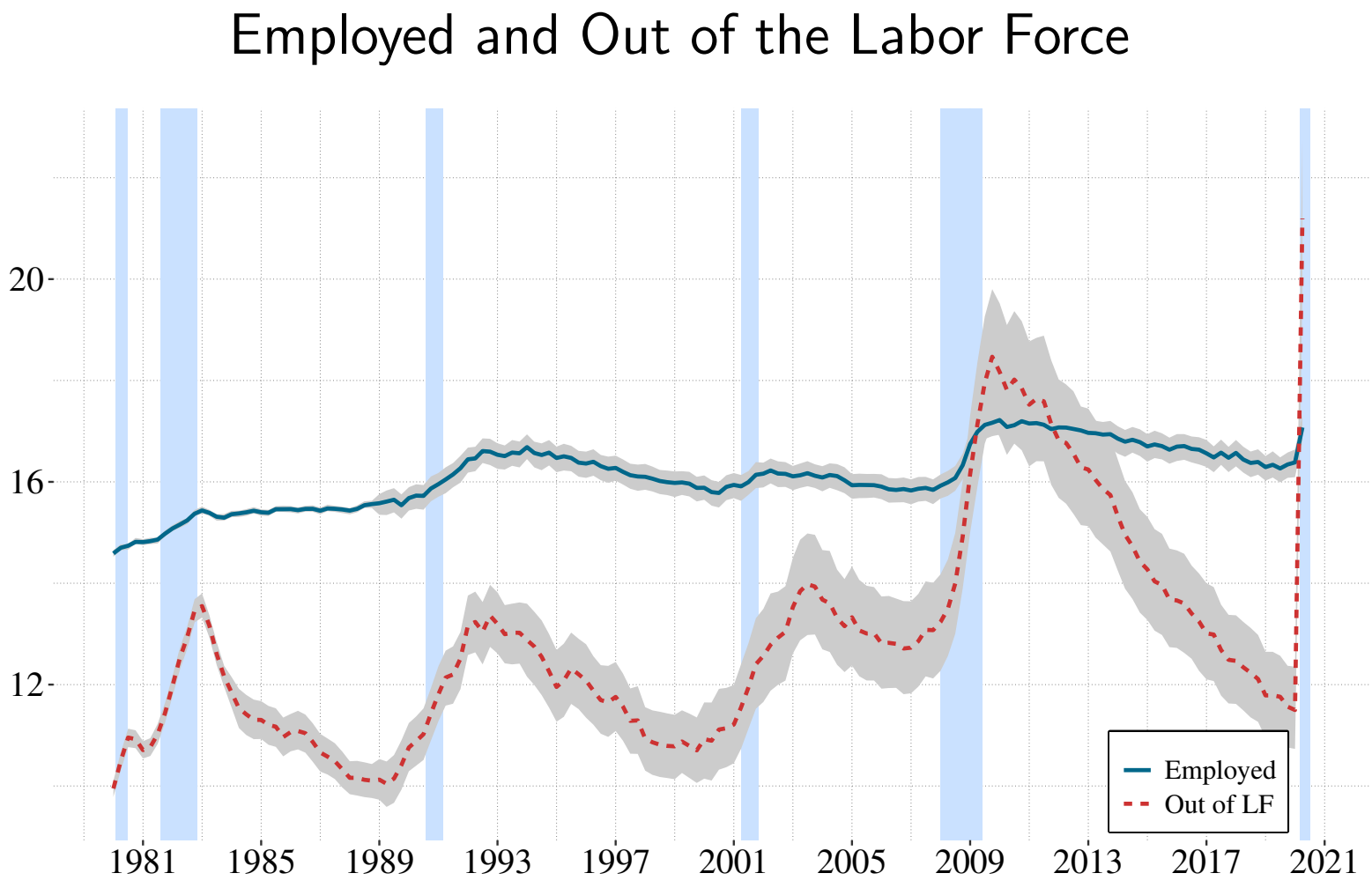
- Total number of searchers per BLS defined group

$$E_t^s = \sum_{i \in E_t} weight_{it} \times \hat{P}_{it}$$

$$U_t^s = \sum_{i \in U_t} weight_{it} \times \hat{P}_{it}$$

$$O_t^s = \sum_{i \in O_t} weight_{it} \times \hat{P}_{it}$$

Fraction of Searchers



- Fraction of unemployed searching is on average 96

Unemployment and Participation

- Standard Rates

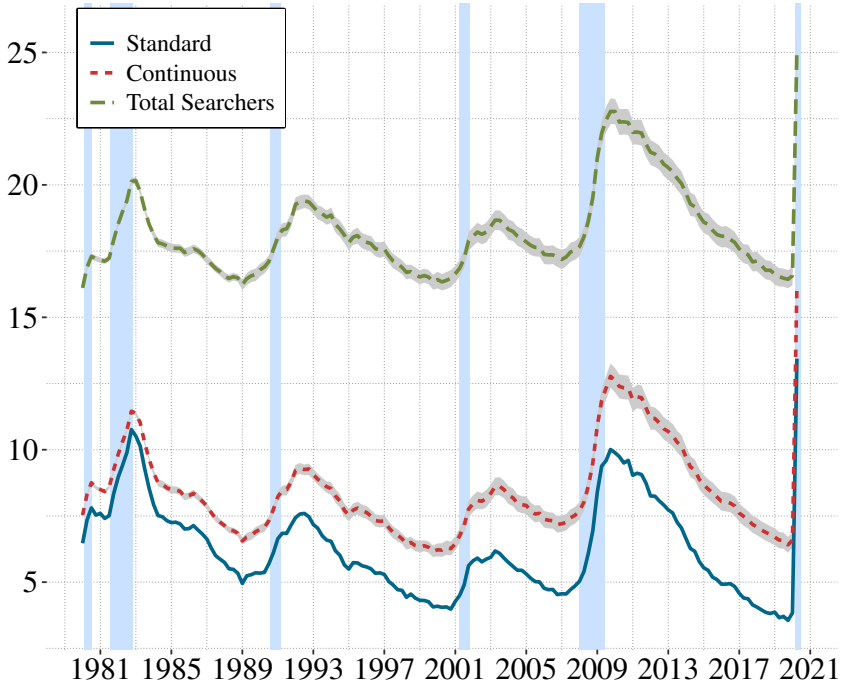
$$u = \frac{U}{U+E} \qquad p = \frac{U+E}{U+O+E}$$

- Continuous Rates

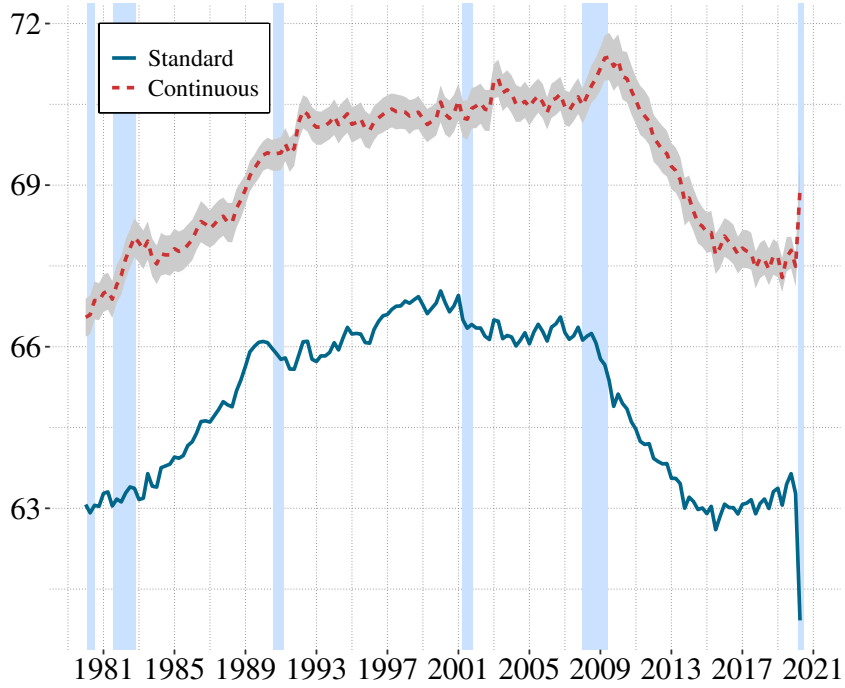
$$\tilde{u} = \frac{U^s + O^s}{U+O+E} \qquad \tilde{p} = \frac{U^s + O^s + E}{U+O+E} \qquad \tilde{s} = \frac{U^s + O^s + E^s}{U+O+E}$$

Unemployment and Participation

Unemployment Rate



Participation Rate



- Continuous unemployment rate is on average 2.1pp higher
- Counter cyclical participation

Alternatives

Application: Phillips Curve

- Estimate backward looking inflation Phillips Curve

Standard unemployment rate

$$\pi_t = \phi_1(u_t - u_t^*) + \gamma_1\bar{\pi}_t + \phi_2(u_t - u_t^*) \times Post + \gamma_2\bar{\pi}_t \times Post + \varepsilon_t$$

Continuous unemployment & total searcher rate

$$\pi_t = \alpha_1 + \phi x_t + \gamma_1\bar{\pi}_t + \phi_2 u_t \times Post + \gamma_2\bar{\pi}_t \times Post + \alpha_2 Post + \varepsilon_t$$

  - π_t: CPI annualized quarterly growth rate
  - u^*: Natural unemployment rate, CBO
  - $\bar{\pi}_t = \frac{1}{4}(\pi_{t-1} + \pi_{t-2} + \pi_{t-3} + \pi_{t-4})$
  - $Post = \mathbb{I}[t > 2007Q2]$

Application: Phillips Curve

- Estimate backward looking wage Phillips Curve

  Standard unemployment rate

$$\Delta w_t = \phi_1(u_t - u_t^*) + \gamma_1 \bar{\pi}_t + \phi_2(u_t - u_t^*) \times Post + \gamma_2 \bar{\pi}_t \times Post + \varepsilon_t$$

  Continuous unemployment & total searcher rate

$$\Delta w_t = \alpha_1 + \phi x_t + \gamma_1 \bar{\pi}_t + \phi_2 u_t \times Post + \gamma_2 \bar{\pi}_t \times Post + \alpha_2 Post + \varepsilon_t$$

  - Δw_t: annualized quarterly wage growth rate
  - π_t: PCE annualized quarterly growth rate
  - u^*: Natural unemployment rate, CBO
  - $\bar{\pi}_t = \frac{1}{4}(\pi_{t-1} + \pi_{t-2} + \pi_{t-3} + \pi_{t-4})$
  - $Post = \mathbb{I}[t > 2007Q2]$

Application: Phillips Curve

	1980Q1 - 2018Q4					
	Average Hourly Earnings			Consumer Price Index		
U-Gap	-0.072**			-0.309*		
	(0.033)			(0.177)		
U-Gap × Post	0.087*			0.755*		
	(0.051)			(0.398)		
$\tilde{U}$		-0.066***			-0.371**	
		(0.022)			(0.150)	
$\tilde{U}$× Post		0.011			0.066	
		(0.027)			(0.422)	
S			-0.061***			-0.595***
			(0.021)			(0.184)
S× Post			0.007			0.301
			(0.027)			(0.432)
$\bar{\pi}_{t-1}^{PCE}$	0.205***	0.076***	0.047*			
	(0.024)	(0.027)	(0.025)			
$\bar{\pi}_{t-1}^{PCE}$× Post	0.034	-0.071*	-0.042			
	(0.072)	(0.038)	(0.036)			
$\bar{\pi}_{t-1}^{CPI}$				0.971***	0.622***	0.566***
				(0.047)	(0.133)	(0.119)
$\bar{\pi}_{t-1}^{CPI}$× Post				-0.441	-0.878**	-0.822**
				(0.292)	(0.404)	(0.401)
Intercept		0.008***	0.014***		0.047***	0.126***
		(0.002)	(0.004)		(0.013)	(0.034)
Post		0.003	0.002		0.034	-0.016
		(0.002)	(0.005)		(0.048)	(0.091)

Summing Up

- Introduce continuous approach to classifying individuals
  - changes low and high frequency properties of urate
- Application to Phillips Curve - no change post-2007
- **Other Points in the Paper**
  - Labor market flows flows
  - Educational attainment is the main driver of the increase in OLF search Decomposition

Abowd & Zellner

- Abowd & Zellner (1985)
  - reinterview surveys to correct for misclassification
  - time invariant and at the aggregate level

Abowd and Zellner (1985) estimates of classification errors (%).

Original interview status	Status determined on reinterview		
	Employed	Unemployed	Non-participant
Employed	98.78	1.91	0.50
Unemployed	0.18	88.57	0.29
Non-participant	1.03	9.52	99.21

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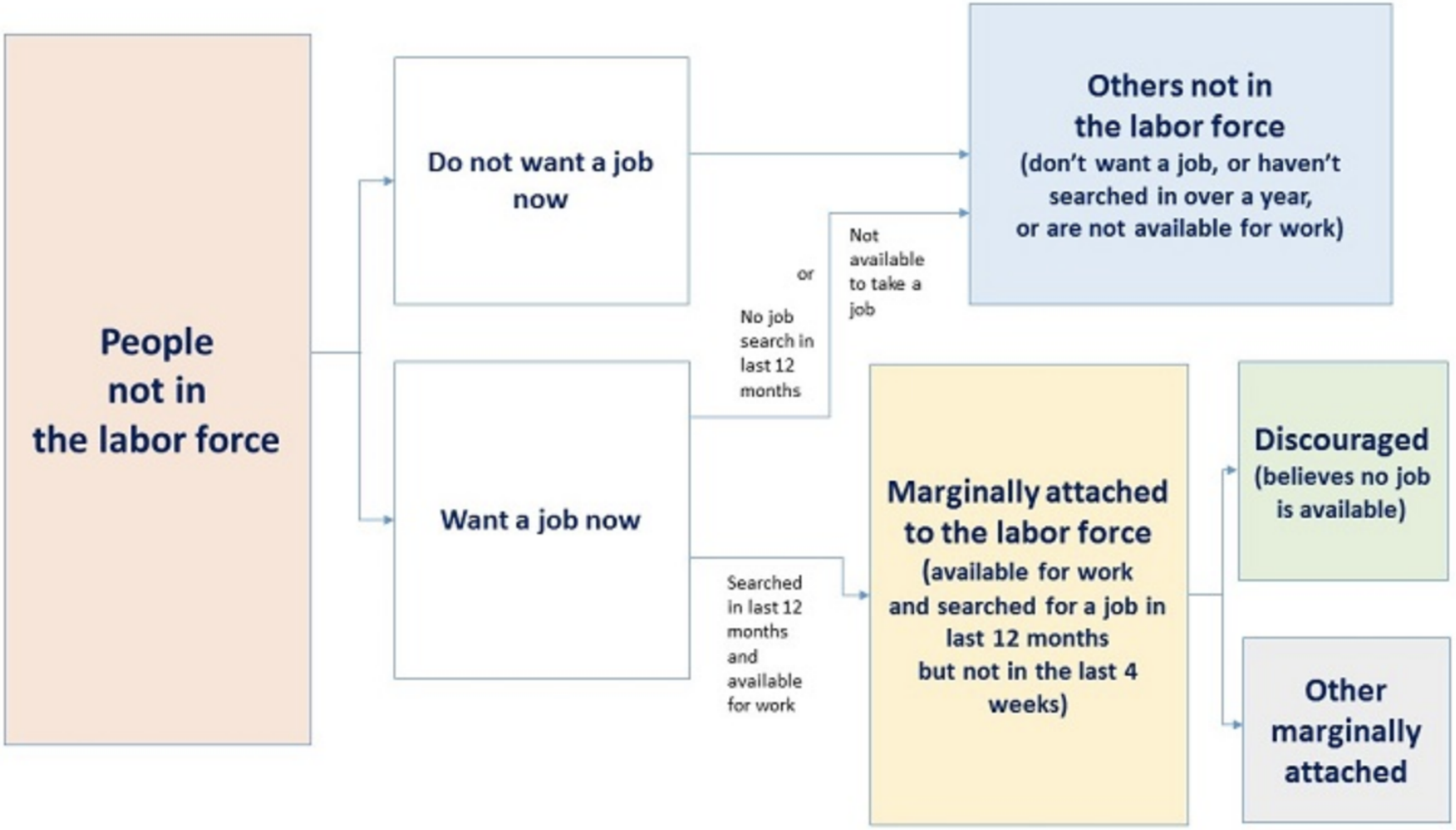
CPS Out of the Labor Force



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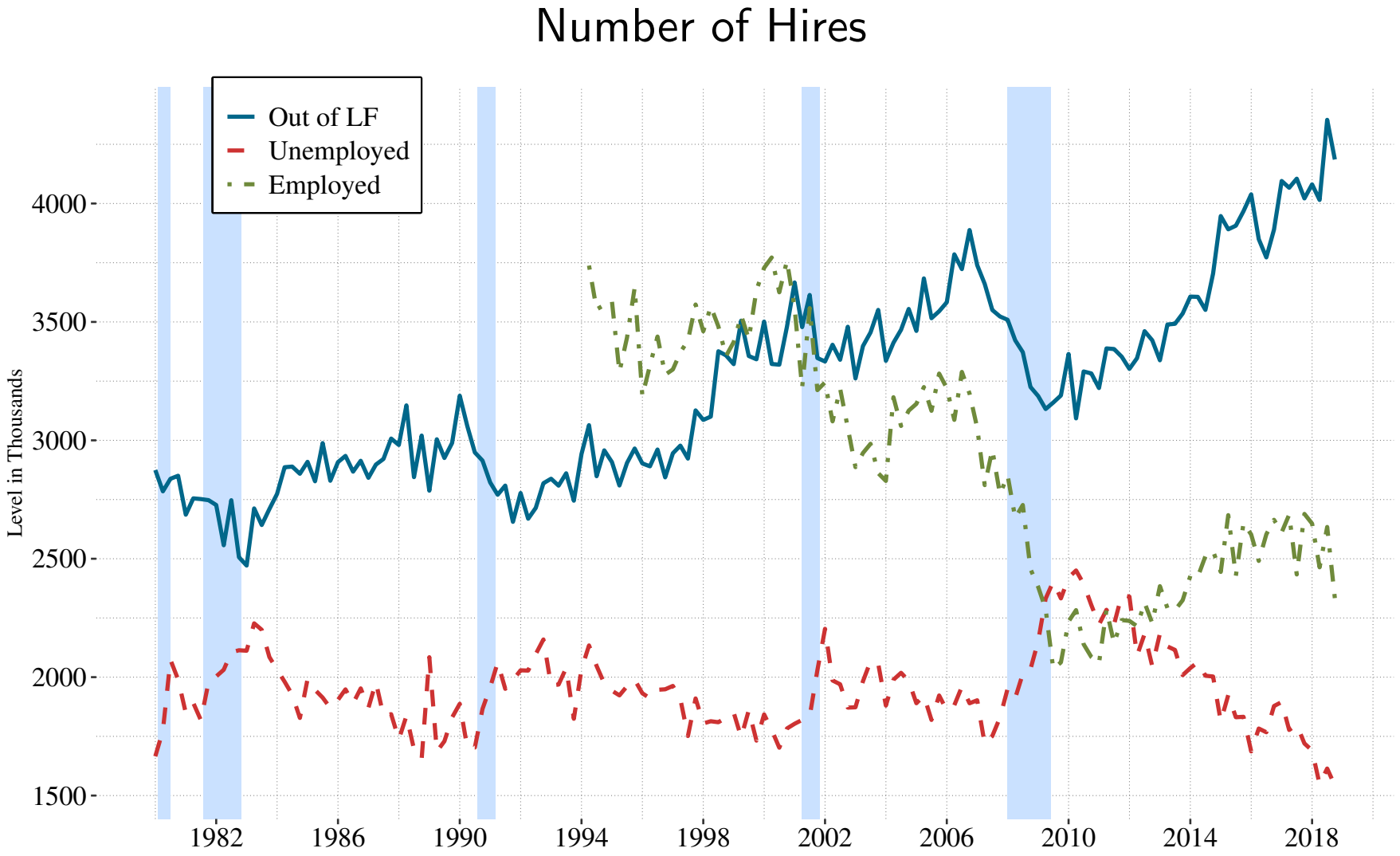
Labor Market Flows



Source: Matched monthly files from the Current Population Survey. Data is seasonally adjusted.

Decomposition Back

Decomposition of OLF Hires

Percent OLF hires by Demographics

	1980-1989	1990-1999	2000-2009	2010-2017
Men	38.6	41.1	42.7	44.7
Women	61.4	58.9	57.3	55.3
Age 16-24	41.1	38.5	36.8	34.4
Age 25-55	41.1	43.3	43.8	42.0
Age 56+	17.7	18.1	19.3	23.6
White	85.6	82.1	79.2	76.9
Black	11.3	12.8	13.6	13.7
Other	3.1	5.1	7.1	9.4
House	55.2	50.1	47.3	44.9
School	28.5	30.5	32.3	32.2
Retired	14.6	15.5	15.2	17.2
Disabled	1.7	4.0	5.3	5.7

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What are they doing?

Percent of Time by Activity

	Age 16+			**Age 25-55**		
	E	U	O	E	U	O
Active Job Search	81.8	91.1	85.8	82.2	92.8	89.7
Interviewing	14.9	6.8	9.7	14.2	5.1	5.4
Other	3.2	2.1	4.5	3.6	2.1	4.9
N	579	1,344	199	421	959	126

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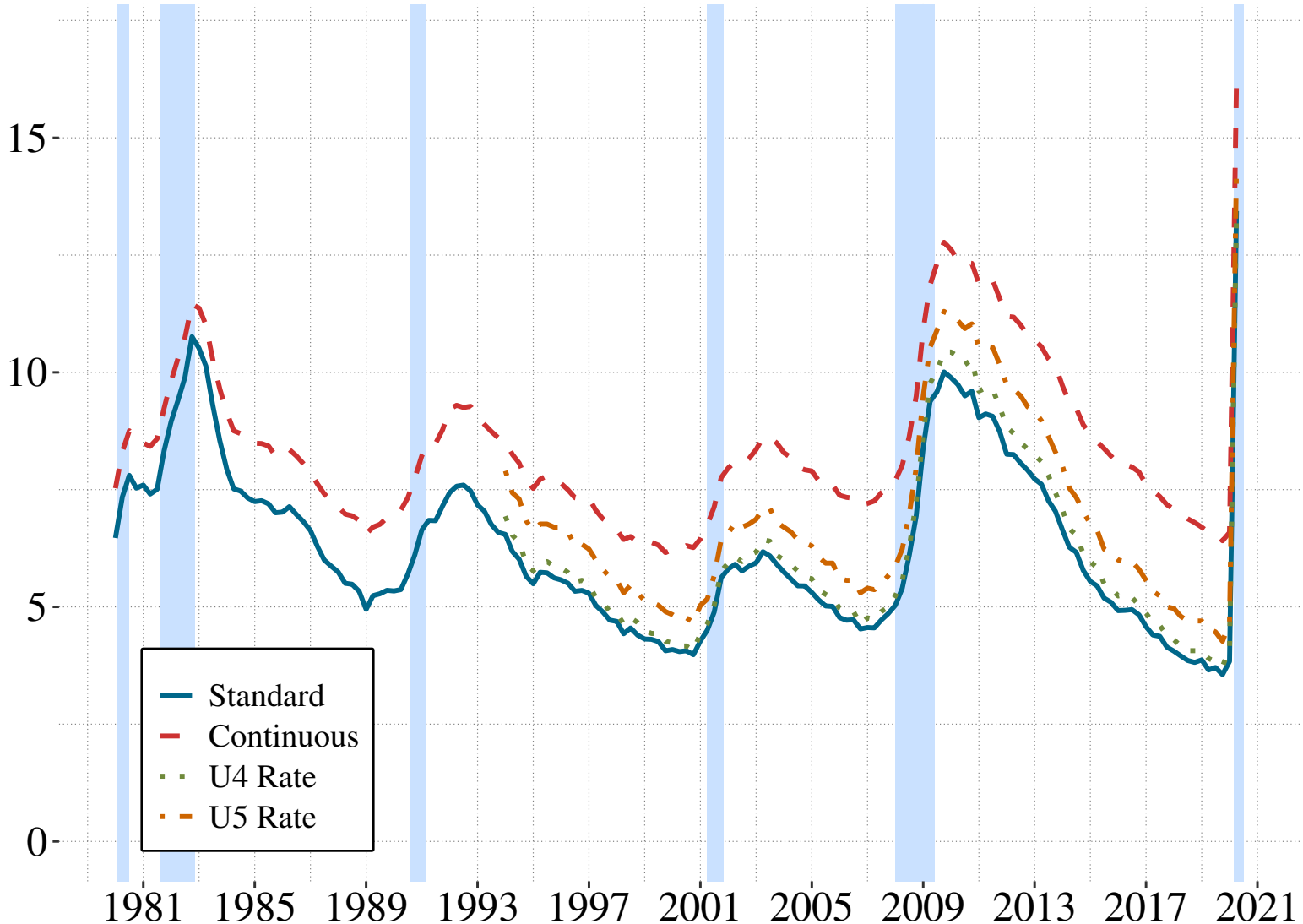
Unemployment Alternatives



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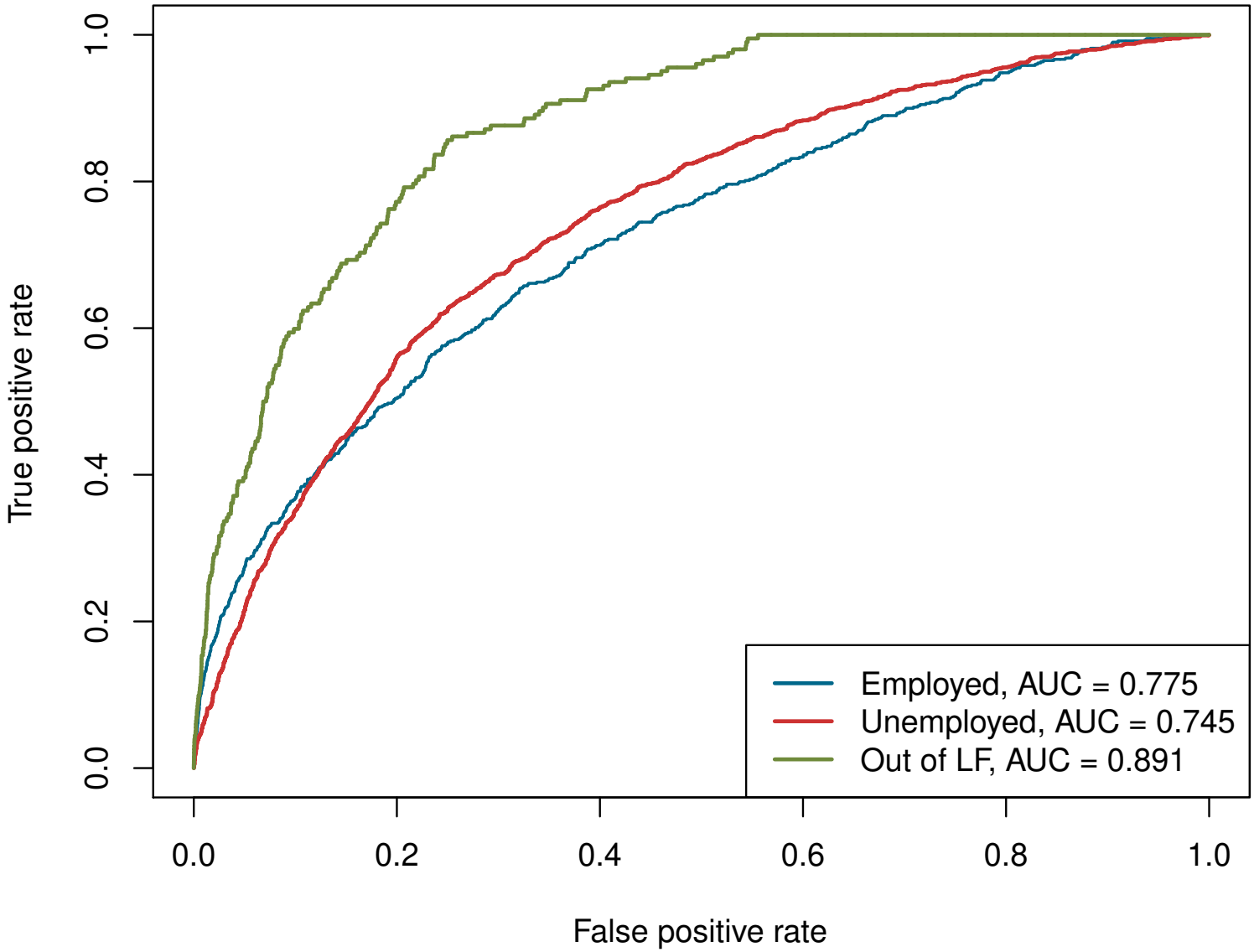
Goodness of Fit



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Margin Error Adjustment

- Define the following
  - $\tilde{U}_t = U_t^S + O_t^S$
  - $\tilde{O}_t = O_t - O_t^S$
  - $\Delta S_t = [E_t \;\; \tilde{U}_t]' - [E_{t-1} \;\; \tilde{U}_{t-1}]'$
- The write the change in the current state as

$$\Delta \mathbf{S}_t = \begin{bmatrix} -E_{t-1} & -E_{t-1} & \tilde{U}_{t-1} & 0 & 0 \\ E_{t-1} & 0 & -\tilde{U}_{t-1} & -\tilde{U}_{t-1} & \tilde{O}_{t-1} \end{bmatrix} \times \begin{bmatrix} p_{EU} \\ p_{EO} \\ p_{UE} \\ p_{UO} \\ p_{OU} \end{bmatrix}$$

$$\Delta \mathbf{S}_t = \mathbf{X}_{t-1}\mathbf{p}$$

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Margin Error Adjustment

- Let $\hat{\mathbf{p}}$ be the estimated transition probabilities and $\hat{\mathbf{W}}$ be the covariance matrix. Then apply weighted restricted least squares to solve for $\mathbf{p}$

$$\min(\mathbf{p}-\hat{\mathbf{p}})'\hat{\mathbf{W}}^{-1}(\mathbf{p}-\hat{\mathbf{p}}) \quad \text{s.t. } \Delta\mathbf{S}_t = \mathbf{X}_{t-1}\mathbf{p}$$

- The Lagrangian

$$\mathcal{L} = (\mathbf{p}-\hat{\mathbf{p}})'\hat{\mathbf{W}}^{-1}(\mathbf{p}-\hat{\mathbf{p}}) - 2\mu[\Delta\mathbf{S}_t - \mathbf{X}_{t-1}\mathbf{p}]$$

- Solution

$$\begin{bmatrix} p \\ \mu \end{bmatrix} = \begin{bmatrix} \hat{\mathbf{W}} & \mathbf{X}'_{t-1} \\ \mathbf{X}_{t-1} & 0 \end{bmatrix}^{-1} \times \begin{bmatrix} \hat{\mathbf{W}}\hat{\mathbf{p}} \\ \Delta\mathbf{S}_t \end{bmatrix}$$

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Labor Market Flows

- **Standard Calculation**: match CPS, count number of people that transition between states
- **New Calculation**: predict job search prop. $\hat{P}_{it}$ for $t = 1, 2$
  - Employment to
    - Unemployment: $weight_{it} \times \hat{P}_{i2}$
    - Out of the Labor Force: $weight_{it} \times (1 - \hat{P}_{i2})$
  - Not Employed
    - $U \to E$: $weight_{it} \times \hat{P}_{i1}$
    - $U \to O$: $weight_{it} \times |\min\{\hat{P}_{i2} - \hat{P}_{i1}, 0\}|$
    - $O \to U$: $weight_{it} \times \max\{\hat{P}_{i2} - \hat{P}_{i1}, 0\}$
    - $O \to E$: 0 by construction

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Labor Market Flows

1. Seasonally Adjusted: X13ARIMA

2. Margin Error Adjustment

    - restricts the estimated worker flows to be consistent with the evolution of the labor market stocks Math

4. Aggregate to quarterly

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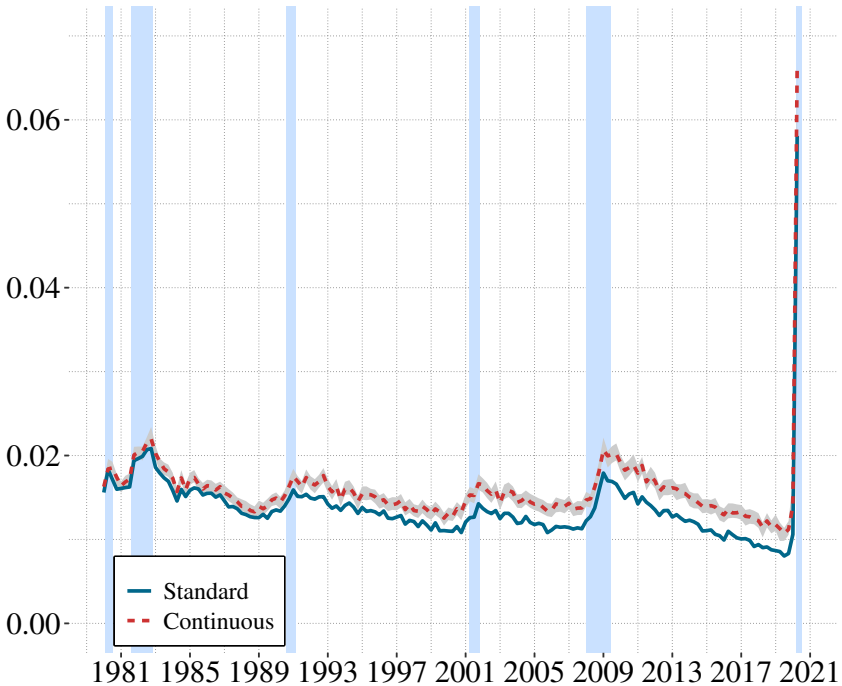
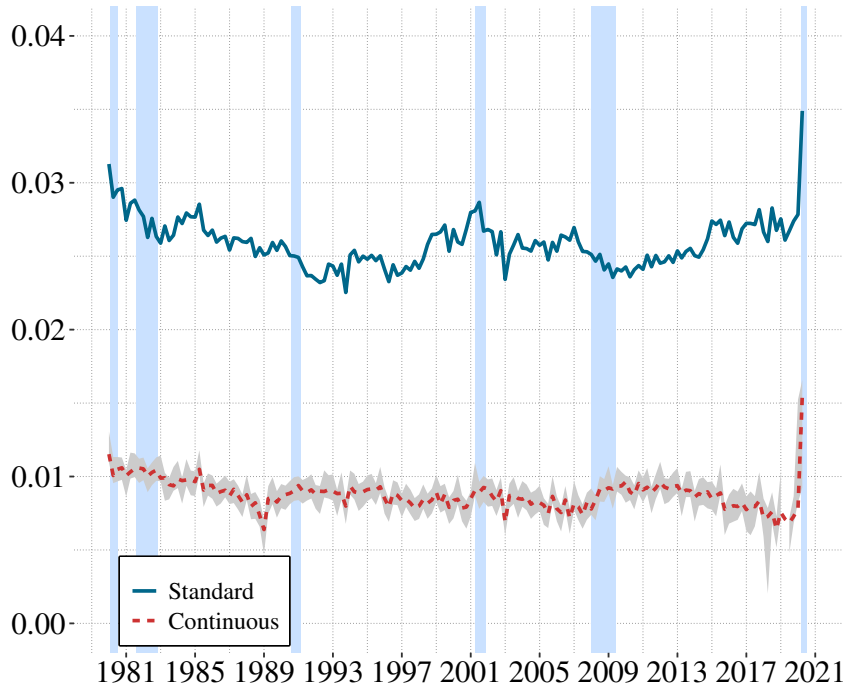
Labor Market Flows

Employment to

Unemployment



Out of the Labor Force



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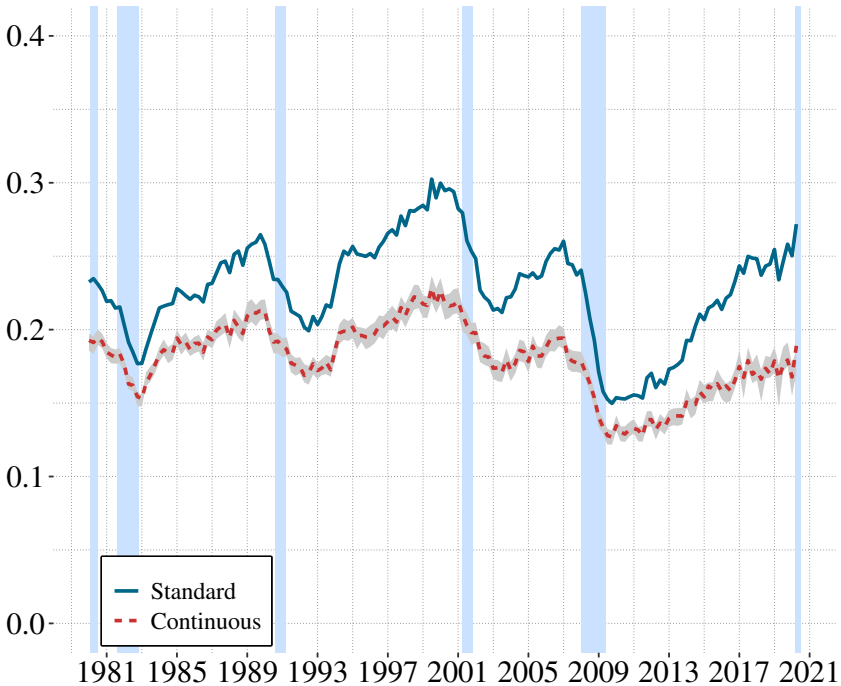
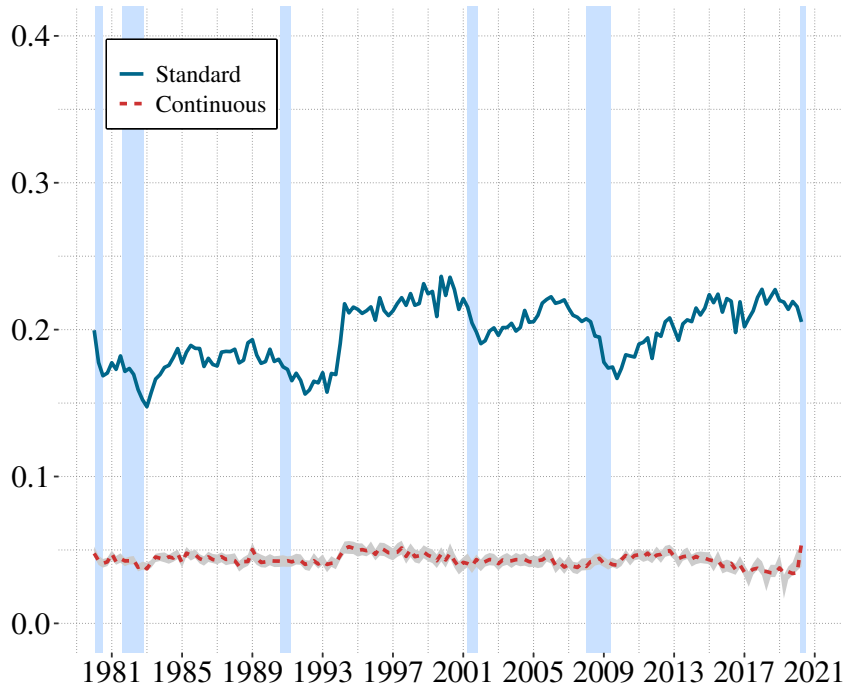
Labor Market Flows

Unemployment

Employment



Out of the Labor Force



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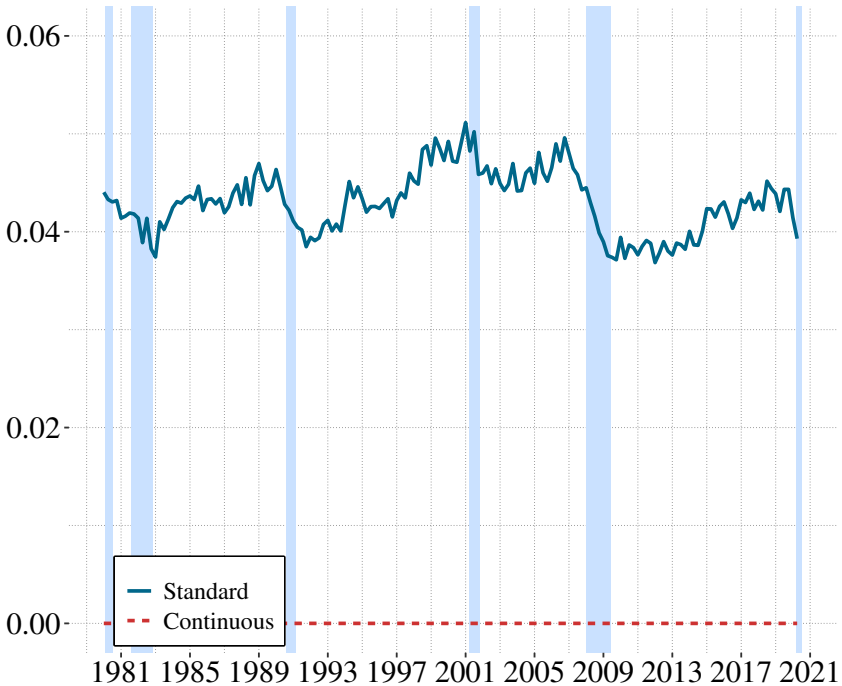
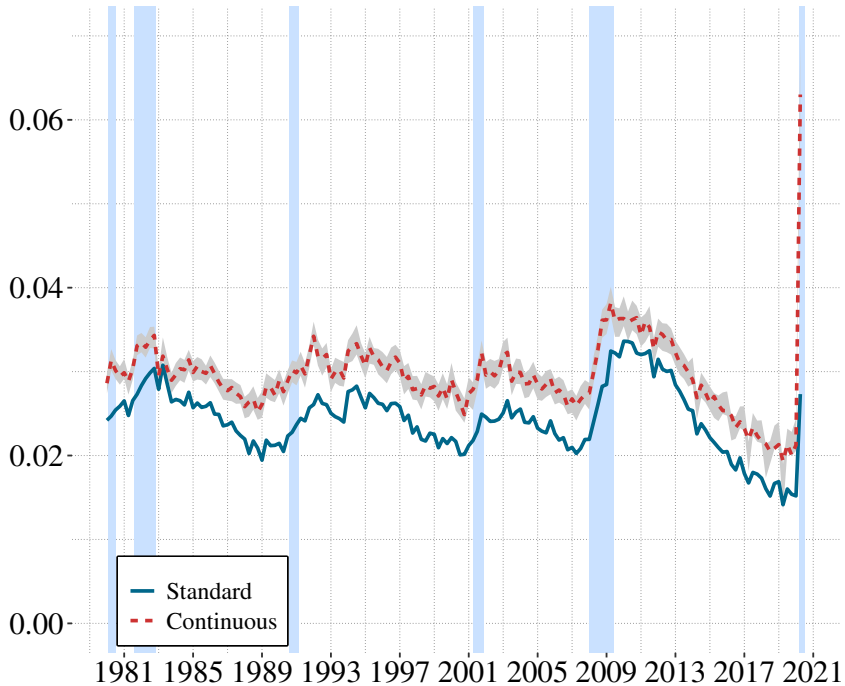
Labor Market Flows

Out of the Labor Force

Employment



Unemployment



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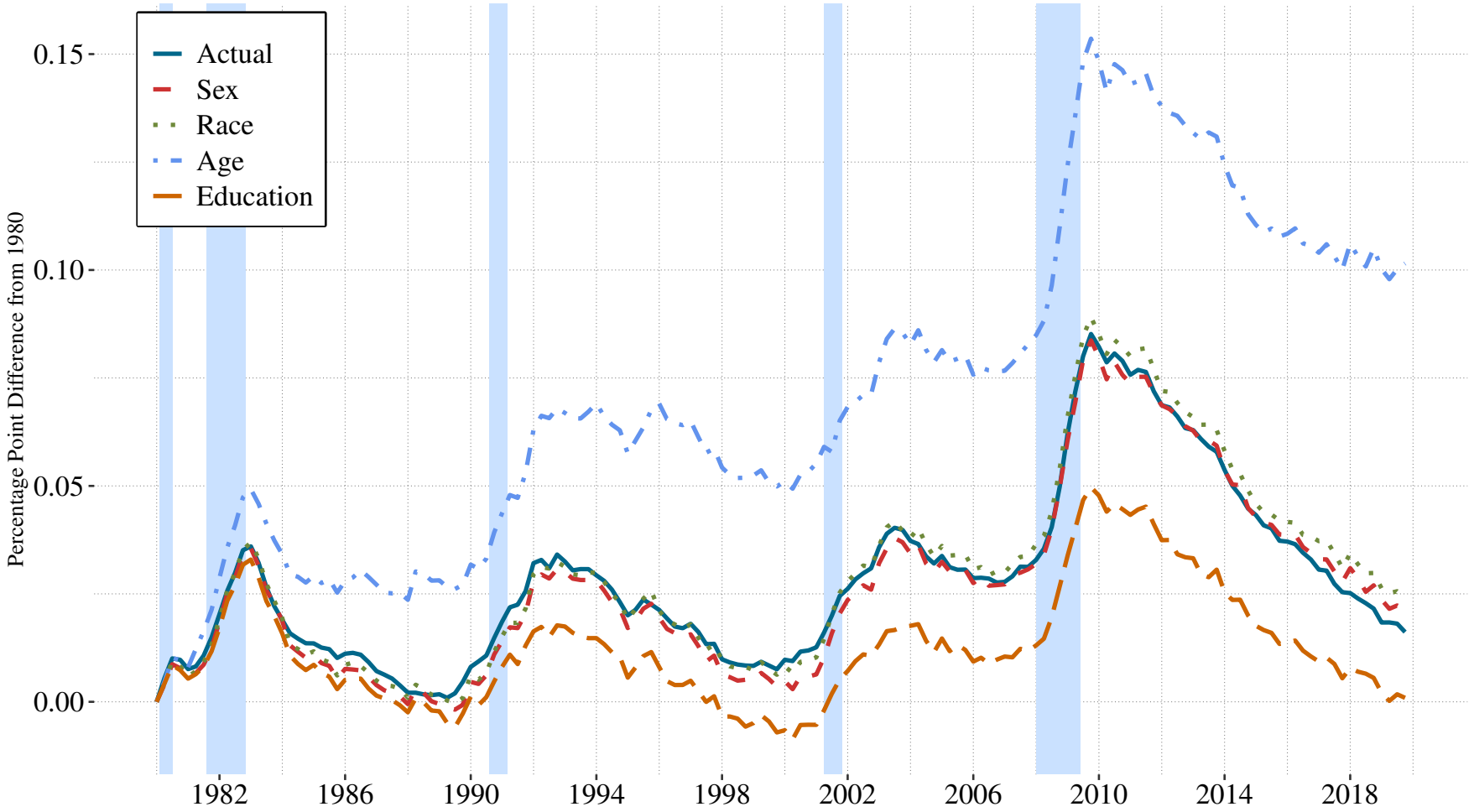
Fixed Demographic Shares OLF Search



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