

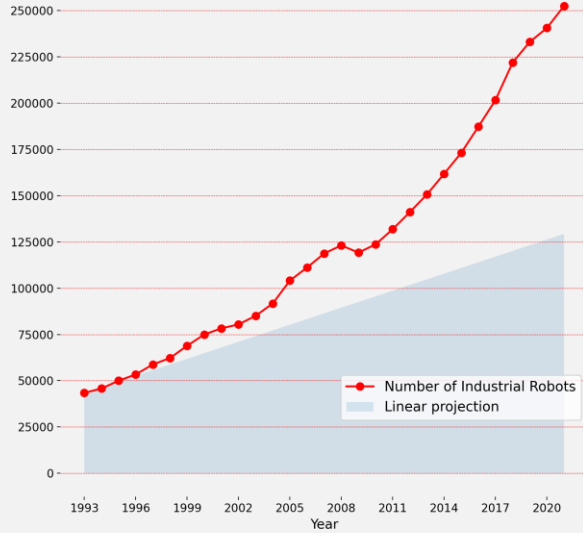
Are Employee-Owned Firms Luddites? Effects of Ownership on Adoption of Robots and Employment after Adoption

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Kelso Workshop
January 12-14, 2024

Stock of Industrial Robots in the US (1993-2021)



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The Robots Are Coming: Preparing For Job Transformation, Not Job Destruction



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May 16, 2023, 07:15am EDT

WORKPLACE DYNAMICS

The Robots Are Here: What Will It Mean for Job Security?

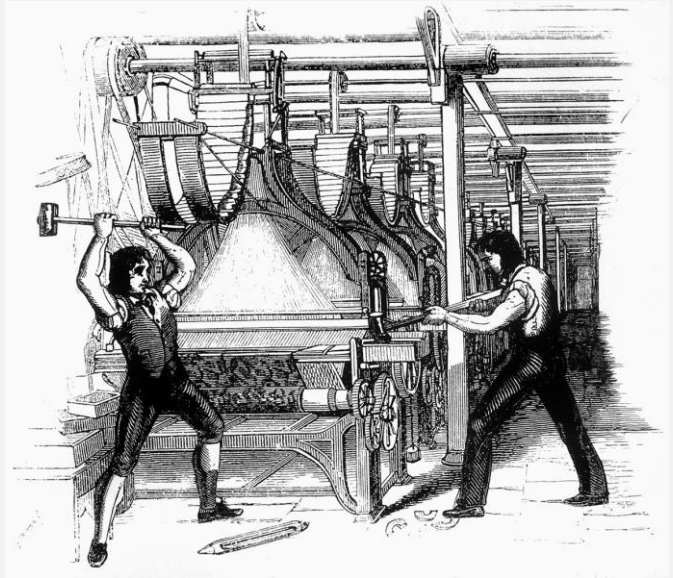
Job insecurity and dysfunctional behaviors in the robotic age.

Posted June 5, 2023 | Reviewed by Michelle Quirk



LUDDITE RIOTS

- Occurred in 19th century England, marked by significant industrialization in the textile industry
- Opposed the introduction of new machinery (automated looms, knitting frames) fearing they would replace traditional craft skills and lead to unemployment
- Contributed to the broader labor movement, fostering discussions on workers' rights and the need for collective bargaining



LABOR AND AUTOMATION

Historically, unions opposed manufacturing automation such as mechanization and early numerical control/CNC machines that threatened skilled jobs (Noble*)

There is very limited research on the effect of unions on adoption of automation

It appears that in countries with work councils, unions collaborate in the introduction of automation technologies**

There is no research evidence about the introduction of automation in firms with employee-owned firms (EOFs)***

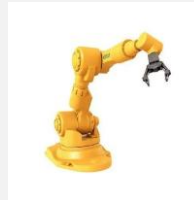
*Noble, D.F., 1986. Forces of production: A social history of industrial automation

**Haipeter, Thomas. "Digitalisation, unions and participation: the German case of 'industry 4.0'." *Industrial Relations Journal* 51.3 (2020): 242-260.

***During a recent visit to two Mondragon coops the CEOs argued that there is no opposition to automation because nobody would lose their job but will enjoy the benefits of greater productivity.

Industrial Robots

- **Articulated Robot Arms.** These are the most common. They have articulated arms with multiple joints: welding, assembly, material handling.
- **Collaborative Robots (Cobots).** Designed to work alongside humans in a collaborative manner. Equipped with sensors and safety features.
- **Delta Robots.** Used in high-speed assembly and packaging. Three arms connected to a central joint to move quickly and precisely.
- **SCARA Robots.** Selective Compliance Assembly Robot Arm. High speed accurate assembly tasks (screwdriving, pick-and-place)
- **Cartesian (Gantry) Robots.** Three linear axes (X, Y, Z) can move independently in a rectangular coordinate system. Used for precise repetitive movements (CNC machining and 3D printing).



[Delta robots in action video](#)



RESEARCH QUESTIONS

1. Do firms with employee ownership (EOFs) and conventional firms (CFs) differ in their propensity to adopt robots?
 - Do unions affect the difference, if any?
2. Do EOFs and CFc that adopt robots change their employment levels differently after they adopt robots?

Context:

US manufacturing

EOFs are firms with ESOPs

CFs are conventional firms

THEORETICAL CONSIDERATIONS 1

1. EOFs advance worker well-being more than CFs

Both production workers and managers enjoy greater well-being (Adrianto, Ben-Ner, Sockin and Urtasun 2024)

2. EOFs value employment stability (Kurtulus and Kruse, 2018)

3. EOFs provide greater workplace safety for production workers (Adrianto et al. 2024)

4. Therefore, if robots improve workers' well-being, particularly employment and safety, they are more likely to adopt them than peer CFs

THEORETICAL CONSIDERATIONS 2

Empirical findings at the firm and plant level suggest that adoption of robots is associated with an increase in employment of both high skill and low skill workers and raise productivity (Koch et al. 2021, Dixon et al. 2021, Acemoglu et al., 2023; Humlum, 2022, Adrianto, Ben-Ner & Urtasun 2024) and increase workplace safety (ABU in progress)

Therefore:

Hypothesis 1. EOFs are more likely to adopt robots than CFs facing similar circumstances (industry, size)

Hypothesis 2. Following robot adoption, EOFs will decrease less/increase more employment than peer CFs

OUR STUDY

1. We study the adoption of robots in US manufacturing plants **2010-2022**
2. We assess the change in hiring before/after adoption compared to similar non-adopters
3. Data: job postings (BGT), ESOPs (F5500), unions (NLRB)

Robot adoption = the first year a plant posts at least x technical workers jobs that require robots-related skills

Data and Sample

- Original dataset: 19,390,101 US manufacturing online job postings from 1.3 million establishments during 2010-2022
- We perform geolocation and firm name clean-ups
- How we identify manufacturing plants:
 - Job postings are grouped into occupations: high-technical, medium-technical, low-technical (including direct occupations), and others.
 - Direct occupations: assemblers, welders, painters, packagers, handlers
 - Recruiters and sparse plants (with three or more years of zero posting) are removed.
 - Variables:
 - Size proxy: Total number of job postings
 - I(Union): I = Unionized (combining NLRB and LM10)
 - I(Collective bargaining): I = Collectively-bargained EOF (NCEO)

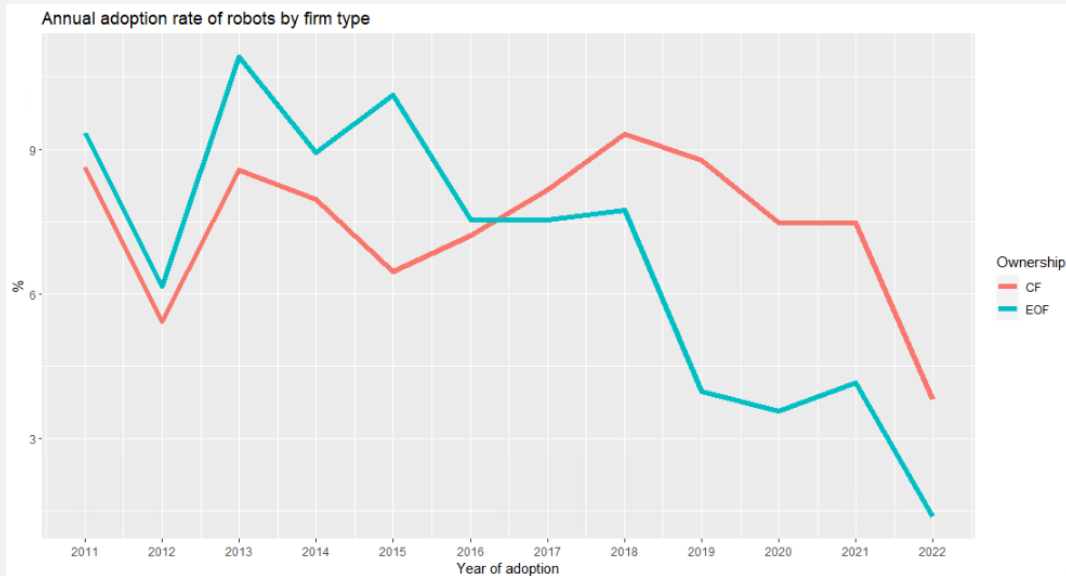
• Threshold:

Criterion	Threshold
% sales job postings	< 10%
% technical high-skill job postings	>= 2 postings
% technical low-skill job postings	>= 2 postings
Average annual number of postings	>= 7 postings

DESCRIPTIVE STATISTICS

	Total	CF		EOF	
		Nonrobotic	Robotic	Nonrobotic	Robotic
Number of firms	9,110	8,681 (95.3%)	711 (7.8%)	246 (2.7%)	88 (1.0%)
Number of plants	34,835	28,170 (80.9%)	1,471 (4.2%)	4,690 (13.5%)	504 (1.4%)
Plants/firm	3.82	3.25	2.07	19.07	5.73
Number of postings	8,790,233	4,508,090 (51.3%)	1,446,321 (16.5%)	1,589,568 (18.1%)	1,246,254 (14.2%)
Postings/plant	252.34	160.03	983.22	338.93	2,472.73

ADOPTION RATES BY OWNERSHIP TYPE



EMPIRICAL STRATEGY

Logistic regression

I. Are EOF more/less likely to adopt robots?

$$\text{logit}(P(1(\text{Robotic})_i = 1) = \beta_0 + \beta_1 \times 1(\text{EOF})_i + \beta_2 \times \text{size}_i + \beta_3 \times 1(\text{EOF})_i \times \text{size}_i \\ + \gamma_k + \sigma_s$$

Do unions affect this relationship? Does a CB EOF matter?

$$\text{logit}(P(1(\text{Robotic})_i = 1) = \beta_0 + \beta_1 \times 1(\text{Union})_i + \beta_2 \times \text{size}_i + \beta_3 \times 1(\text{Union})_i \times \text{size}_i \\ + \gamma_k + \sigma_s$$

$$\text{logit}(P(1(\text{Robotic})_i = 1) = \beta_0 + \beta_1 \times 1(\text{CB})_i + \beta_2 \times \text{size}_i + \beta_3 \times 1(\text{CB})_i \times \text{size}_i \\ + \gamma_k + \sigma_s$$

Difference-in-difference (Callaway and Sant'Anna, 2021)

Conditional on adopting robots, do EOF/CF change their hiring intensities?

$$ATT(g, t) = E[Y_t(g) - Y_t(0) | G_g = 1]$$

ARE EOF MORE/LESS LIKELY TO ADOPT ROBOTS?

Dependent Variable: Model:	(1)	(2)	1(Robotic)		(5)	(6)
			(3)	(4)		
<i>Variables</i>						
Constant	-2.952*** (0.0553)	-3.244*** (0.0613)	-3.295*** (0.0583)			
1(EOF)	0.7217*** (0.1270)	0.3051* (0.1736)	0.5048*** (0.1449)	0.5291*** (0.1629)	0.5414*** (0.1419)	0.5445*** (0.1590)
Total postings		0.0009*** (0.0001)	0.0011*** (0.0001)	0.0011*** (0.0001)	0.0011*** (0.0001)	0.0011*** (0.0001)
1(EOF) × Total postings			-0.0003* (0.0002)	-0.0004* (0.0002)	-0.0003 (0.0002)	-0.0003* (0.0002)
<i>Fixed-effects</i>						
3-digit NAICS				Yes		Yes
State					Yes	Yes
<i>Fit statistics</i>						
Number of plants	34,835	34,835	34,835	34,805	34,791	34,761
Squared Correlation	0.00533	0.10053	0.10198	0.11112	0.11560	0.12541
Pseudo R ²	0.01058	0.11356	0.11577	0.13367	0.13831	0.15610
BIC	15,032.9	13,481.0	13,457.8	13,381.9	13,634.3	13,560.2

Clustered (Firm) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Note: Sample limitation does not allow us to use NAICS × commuting zone fixed effects. This combination produces 4,674 fixed effects, among which 299 have more than 3 EOFs and CFs.

INTERPRETATIONS

- EOFs are more likely to adopt robots
- The results are robust after controlling for size, industry, and year
 - *Using NAICS + commuting zone fixed effects does not alter the results*

ARE EOF/CF WITH BETTER PARTICIPATIVE MECHANISMS MORE/LESS RECEPTIVE TO ROBOTS?

Dependent Variable:	1(Robotic)			
Sample:	EOF			CF
Model:	(1)	(2)	(3)	(4)
<i>Variables</i>				
1(Union)	-0.3741 (0.6690)		-0.2201 (0.6072)	0.2339 (0.4245)
1(Collective bargaining)		0.1636 (0.3461)	0.1571 (0.3513)	
Total postings	0.0008*** (0.0001)	0.0007*** (0.0002)	0.0007*** (0.0002)	0.0010*** (0.0001)
1(Union) × Total postings	-0.0002 (0.0004)		-0.0005 (0.0004)	-0.0005** (0.0002)
1(Collective bargaining) × Total postings		0.0004** (0.0002)	0.0004*** (0.0001)	
<i>Fixed-effects</i>				
3-digit NAICS	Yes	Yes	Yes	Yes
State	Yes	Yes	Yes	Yes
<i>Fit statistics</i>				
Number of plants	4,989	4,989	4,989	29,236
Squared Correlation	0.17665	0.18411	0.18493	0.07492
Pseudo R ²	0.20458	0.21167	0.21264	0.11892
BIC	2,816.5	2,796.4	2,810.7	10,150.2
<i>Clustered (3-digit NAICS) standard-errors in parentheses</i>				
<i>Signif. Codes: ***: 0.01, **: 0.05, *: 0.1</i>				

Note: Sample limitation does not allow us to use NAICS x commuting zone fixed effects. This combination produces 4,674 fixed effects, among which 299 have more than 3 EOFs and CFs.

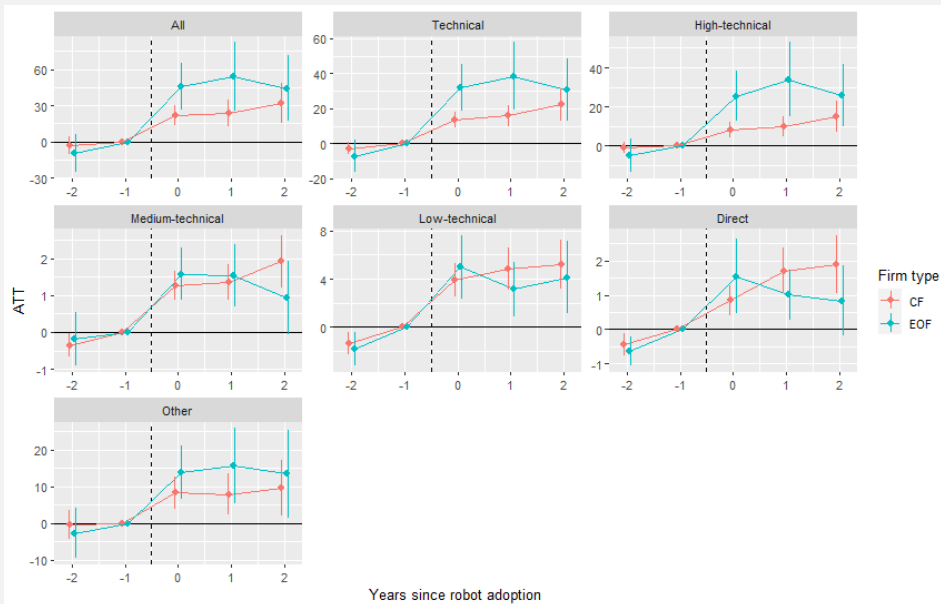
INTERPRETATIONS

- Unionized CFs are less likely to adopt robots
- No union effect on EOFs
- Collectively-bargained EOFs are more likely to adopt robots
 - Adding 1 (union) to column 3 increases the significance of 1 (Collective Bargaining)

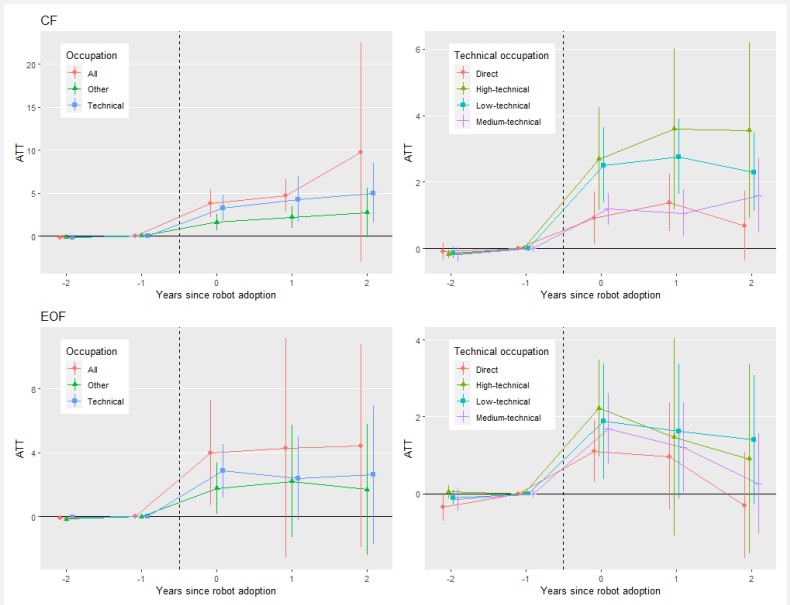
DO HIRING ACTIVITIES CHANGE FOLLOWING ROBOT ADOPTION?

Occupation	CF			EOF		
	Number of postings (1)	Normalized postings (2)	% Share of All (3)	Number of postings (4)	Normalized postings (5)	% Share of All (6)
All	25.79*** (5.36) [n=570]	6.07*** (2.19) [n=556]	-	48.05*** (10.88) [n=270]	4.22 (2.72) [n=267]	-
Technical	17.24*** (2.89) [n=570]	4.19*** (1.18) [n=533]	2.57** (1.28) [n=462]	33.78*** (7.44) [n=270]	2.62* (1.36) [n=261]	1.83 (1.67) [n=249]
High	11.05*** (2.60) [n=570]	3.28*** (1.07) [n=484]	-0.87 (1.11) [n=462]	28.35*** (6.93) [n=270]	1.53 (1.04) [n=253]	0.31 (1.62) [n=249]
Medium	1.53*** (0.23) [n=570]	1.28*** (0.32) [n=305]	1.16* (0.60) [n=462]	1.35*** (0.37) [n=270]	1.05** (0.49) [n=148]	1.24 (0.88) [n=249]
Low	4.66*** (0.71) [n=570]	2.52*** (0.50) [n=456]	2.29* (1.17) [n=462]	4.08*** (1.14) [n=270]	1.63** (0.80) [n=232]	0.28 (1.17) [n=249]
Direct	1.48*** (0.28) [n=570]	0.99** (0.40) [n=231]	0.81 (0.58) [n=462]	1.13*** (0.43) [n=270]	0.59 (0.60) [n=123]	0.17 (0.46) [n=249]
Other	8.55*** (2.63) [n=570]	2.17*** (0.66) [n=504]	-2.57** (1.28) [n=462]	14.27*** (4.24) [n=270]	1.89 (1.54) [n=257]	-1.83 (1.69) [n=249]

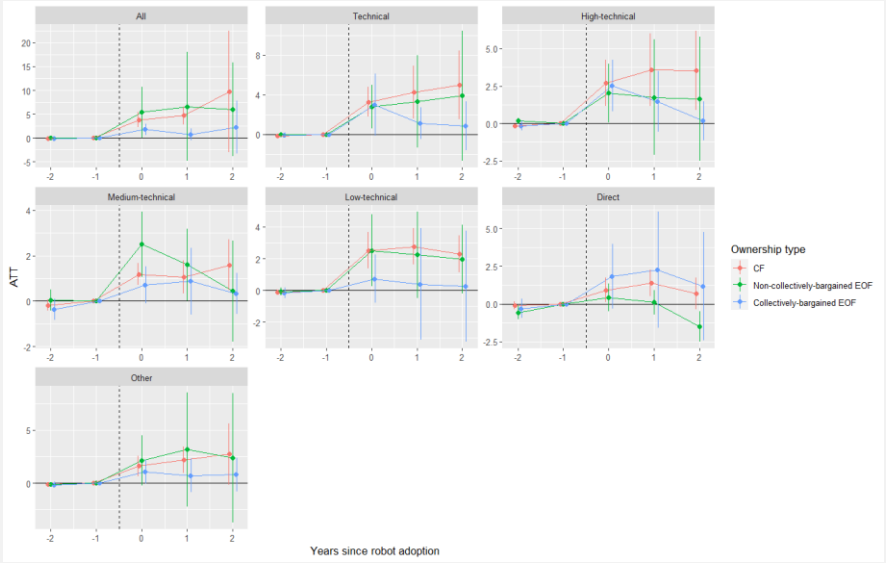
EVENT-STUDY ANALYSIS ON UNADJUSTED NUMBER OF POSTINGS



NORMALIZING POSTINGS TO REMOVE SIZE DIFFERENCES



SPLITTING EOF BY COLLECTIVE BARGAINING SHOWS NO SIGNIFICANT DIFFERENCE BUT, HIRING FROM COLLECTIVELY-BARGAINED EOF RESEMBLES CF



INTERPRETATIONS

- Robotic plants increase their hiring post-adoption
- Normalized postings indicate greater hiring in CF
- Non-collectively bargained EOF seems to follow the pattern of CF
 - Need to investigate this further, as the difference between CB—Non-CB is not significant

CONCLUSION: ARE EOF LUDDITES?

- When employees given better voice → more receptive to the adoption of technology
 - Firms with broad-based employee ownership are more likely to adopt robots
 - The presence of a union hinders adoption in CFs, but not EOFs
 - When EOF is introduced due to collectively bargaining between employers and employees, firms are more likely to adopt
- Robot adoption increases hiring in both types of firm
 - Indicating productivity and complementarity effects outweigh substitution effect
 - EOF preserving employment stability (Kurtulus and Kruse, 2018)

THANK YOU

ARE EOF/CF WITH BETTER PARTICIPATIVE MECHANISMS MORE/LESS RECEPTIVE TO ROBOTS? COMMUTING ZONES INSTEAD OF STATES

Dependent Variable:	1(Robotic)			
Sample:	EOF			
Model:	(1)	(2)	(3)	CF (4)
<i>Variables</i>				
1(Union)	-0.3178 (0.8760)		-0.1388 (0.7818)	0.0714 (0.3905)
1(Collective bargaining)		0.0508 (0.3716)	0.0425 (0.3752)	
Total postings	0.0008*** (0.0001)	0.0007*** (0.0002)	0.0007*** (0.0002)	0.0010*** (0.0001)
1(Union) × Total postings	-0.0002 (0.0005)		-0.0006 (0.0005)	-0.0004** (0.0002)
1(Collective bargaining) × Total postings		0.0005*** (0.0001)	0.0006*** (0.0001)	
<i>Fixed-effects</i>				
3-digit NAICS	Yes	Yes	Yes	Yes
Commuting zone	Yes	Yes	Yes	Yes
<i>Fit statistics</i>				
Observations	3,947	3,947	3,947	26,436
Squared Correlation	0.24550	0.25678	0.25786	0.09348
Pseudo R ²	0.26267	0.27262	0.27366	0.13852
BIC	3,367.4	3,342.1	3,356.0	11,639.6
<i>Clustered (3-digit NAICS) standard-errors in parentheses</i>				
<i>Signif. Codes: ***: 0.01, **: 0.05, *: 0.1</i>				

Note: Sample limitation does not allow us to use NAICS x commuting zone fixed effects. This combination produces 4,674 fixed effects, among which 299 have more than 3 EOFs and CFs.