THE CENTURY FOUNDATION

Appendix: The Impacts of Robots on the Labor Market Outcomes

SEPTEMBER XX, 2019 — WILLIAM M. RODGERS III AND RICHARD FREEMAN

APPENDIX TABLE 1

Robot Intensity in the Remaining Metropolitan Areas, 2004 to 2017 (Robots per Thousand Workers)				
			Instrumental Variables	
Rank	Metropolitan Area	United States	Germany	Japan
	Metro Area Unweighted Average	0.340	0.267	1.393
	Metro Area Unweighted Median	0.183	0.136	0.305
1	Los Angeles-Long Beach-Santa Ana, CA	6.910	5.442	13.285
2	Chicago-Naperville-Joliet, IL	6.015	4.544	11.106
3	Houston-Baytown-Sugar Land, TX	3.375	3.305	8.081
4	Phoenix-Mesa-Scottsdale, AZ	2.163	1.804	4.909
5	Detroit-Warren-Dearborn, MI	1.700	1.387	3.721
6	Milwaukee-Waukesha-West Allis, WI	1.629	1.297	3.258
7	Philadelphia-Camden-Wilmington, PA-NJ-DE-MD	1.505	1.127	2.582
8	San Jose-Sunnyvale-Santa Clara, CA	1.438	1.162	2.899
9	Indianapolis, IN	1.434	1.139	3.020
10	Cleveland-Elyria, OH	1.289	1.067	2.546
11	Sarasota-Bradenton-Venice, FL	1.214	0.914	2.262
12	Minneapolis-St. Paul-Bloomington, MN-WI	1.177	0.913	2.533
13	Charlotte-Gastonia-Concord, NC-SC	1.172	0.852	2.494

APPENDIX TABLE 1 CONTINUED

			Instrumental Variables	
Rank	Metropolitan Area	United States	Germany	Japan
14	Portland-Vancouver-Beaverton, OR-WA	1.046	0.860	2.170
15	Riverside-San Bernardino-Ontario, CA	1.042	0.847	2.600
16	Columbus, OH	1.031	0.719	2.081
17	San Antonio, TX	0.952	0.778	1.982
18	San Diego-Carlsbad-San Marcos, CA	0.950	0.763	2.262
19	Seattle-Tacoma-Bellevue, WA	0.821	0.654	1.796
20	Denver-Aurora, CO	0.817	0.643	1.777
21	Dallas-Fort Worth-Arlington, TX	0.796	0.632	1.804
22	Nashville-Davidson--Murfreesboro, TN	0.761	0.567	1.903
23	Jacksonville, FL	0.744	0.536	1.398
24	Baltimore-Towson, MD	0.738	0.566	1.236
25	Tulsa, OK	0.738	0.675	1.795
26	Toledo, OH	0.721	0.570	1.730
27	Elkhart-Goshen, IN	0.704	0.602	1.653
28	Fort Wayne, IN	0.676	0.552	1.666
29	Greensboro-High Point, NC	0.664	0.608	1.853
30	Akron, OH	0.650	0.476	1.732
31	Oklahoma City, OK	0.646	0.490	1.677
32	Fayetteville-Springdale-Rogers, AR-MO	0.609	0.327	0.700
33	Rockford, IL	0.596	0.521	1.390
34	Birmingham-Hoover, AL	0.593	0.463	1.067
35	Buffalo-Niagara Falls, NY	0.593	0.413	1.150
36	Canton-Massillon, OH	0.564	0.439	1.086
37	Allentown-Bethlehem-Easton, PA-NJ	0.523	0.367	0.983
38	El Paso, TX	0.521	0.417	1.344
39	Atlanta-Sandy Springs-Marietta, GA	0.514	0.345	0.943
40	New Orleans-Metairie-Kenner, LA	0.510	0.457	1.023
41	Fresno, CA	0.500	0.320	0.884
42	Amarillo, TX	0.490	0.307	0.654
43	South Bend-Mishawaka, IN-MI	0.489	0.415	1.184

APPENDIX TABLE 1 CONTINUED

			Instrumental Variables	
Rank	Metropolitan Area	United States	Germany	Japan
44	Austin-Round Rock, TX	0.477	0.381	1.064
45	Wichita, KS	0.473	0.456	1.267
46	Modesto, CA	0.447	0.251	0.639
47	Sacramento--Arden-Arcade--Roseville, CA	0.439	0.343	0.856
48	San Francisco-Oakland-Fremont, CA	0.437	0.294	0.677
49	Louisville, KY-IN	0.432	0.314	0.860
50	Green Bay, WI	0.383	0.309	0.661
51	Erie, PA	0.377	0.297	0.918
52	Kennewick-Richland-Pasco, WA	0.376	0.207	0.312
53	Winston-Salem, NC	0.374	0.250	0.681
54	Rochester, NY	0.364	0.301	1.354
55	Oxnard-Thousand Oaks-Ventura, CA	0.360	0.271	0.801
56	Stockton, CA	0.357	0.257	0.676
57	Colorado Springs, CO	0.353	0.297	0.742
58	Des Moines, IA	0.345	0.202	0.697
59	Corpus Christi, TX	0.345	0.473	0.896
60	Fort Smith, AR-OK	0.344	0.213	0.608
61	Tucson, AZ	0.343	0.282	0.858
62	Pittsburgh, PA	0.342	0.259	0.598
63	Evansville, IN-KY	0.339	0.244	0.789
64	Boise City-Nampa, ID	0.339	0.251	0.698
65	Boston-Cambridge-Nashua, MA-NH	0.339	0.267	0.669
66	Reading, PA	0.334	0.233	0.530
67	Beaumont-Port Arthur, TX	0.327	0.405	0.831
68	Eugene-Springfield, OR	0.326	0.313	0.938
69	Grand Rapids-Wyoming, MI	0.325	0.286	0.948
70	Las Vegas-Paradise, NV	0.320	0.240	0.683
71	Madison, WI	0.317	0.209	0.588
72	Hickory-Lenoir-Morganton, NC	0.315	0.347	1.164

APPENDIX TABLE 1 CONTINUED

			Instrumental Variables	
Rank	Metropolitan Area	United States	Germany	Japan
73	Racine, WI	0.309	0.252	0.739
74	Vallejo-Fairfield, CA	0.308	0.286	0.657
75	Waterloo-Cedar Falls, IA	0.307	0.236	0.957
76	Worcester, MA-CT	0.304	0.235	0.764
77	Shreveport-Bossier City, LA	0.303	0.272	0.754
78	Waterbury, CT	0.302	0.266	0.615
79	**Spokane, WA**	**0.299**	**0.256**	**0.632**
80	Bridgeport-Stamford-Norwalk, CT	0.298	0.237	0.756
81	Miami-Fort Lauderdale-West Palm Beach, FL	0.294	0.226	0.636
82	Little Rock-North Little Rock, AR	0.292	0.214	0.547
83	Vineland-Millville-Bridgeton, NJ	0.286	0.138	0.714
84	Cedar Rapids, IA	0.286	0.189	0.503
85	Baton Rouge, LA	0.284	0.272	0.604
86	Albuquerque, NM	0.283	0.219	0.639
87	College Station-Bryan, TX	0.282	0.214	0.429
88	Scranton--Wilkes-Barre--Hazleton, PA	0.280	0.194	0.584
89	Tampa-St. Petersburg-Clearwater, FL	0.280	0.198	0.518
90	Davenport-Moline-Rock Island, IA-IL	0.274	0.220	0.746
91	Raleigh, NC	0.273	0.197	0.514
92	Michigan City-La Porte, IN	0.272	0.240	0.625
93	Lexington-Fayette, KY	0.268	0.229	0.793
94	Decatur, IL	0.267	0.176	0.647
95	Sioux Falls, SD	0.261	0.158	0.460
96	Santa Rosa-Petaluma, CA	0.260	0.164	0.520
97	Lafayette-West Lafayette, IN	0.257	0.213	0.579
98	Dayton, OH	0.257	0.225	0.628
99	Urban Honolulu, HI	0.257	0.158	0.289
100	Springfield, MO	0.253	0.167	0.488
101	Odessa, TX	0.251	0.206	0.544

APPENDIX TABLE 1 CONTINUED

			Instrumental Variables	
Rank	Metropolitan Area	United States	Germany	Japan
102	Hartford-West Hartford-East Hartford, CT	0.246	0.216	0.606
103	Wichita Falls, TX	0.245	0.164	0.586
104	Salem, OR	0.243	0.184	0.462
105	Sherman-Denison, TX	0.241	0.175	0.425
106	Providence-Warwick, RI-MA	0.238	0.199	0.513
107	Fort Collins-Loveland, CO	0.235	0.171	0.511
108	Springfield, MA-CT	0.233	0.199	0.500
109	Florence-Muscle Shoals, AL	0.231	0.185	0.393
110	Richmond, VA	0.231	0.157	0.362
111	Mobile, AL	0.231	0.213	0.508
112	Tyler, TX	0.229	0.175	0.640
113	Augusta-Richmond County, GA-SC	0.228	0.172	0.420
114	Lancaster, PA	0.226	0.146	0.421
115	Montgomery, AL	0.223	0.163	0.431
116	York-Hanover, PA	0.223	0.176	0.484
117	Reno-Sparks, NV	0.220	0.171	0.572
118	Knoxville, TN	0.213	0.160	0.416
119	Salt Lake City, UT	0.209	0.168	0.471
120	Napa, CA	0.205	0.105	0.235
121	Lubbock, TX	0.205	0.152	0.464
122	Topeka, KS	0.198	0.106	0.364
123	Lincoln, NE	0.197	0.143	0.582
124	Longview, TX	0.196	0.161	0.402
125	Bakersfield, CA	0.193	0.184	0.429
126	Waco, TX	0.192	0.137	0.413
127	Syracuse, NY	0.192	0.155	0.441
128	Battle Creek, MI	0.190	0.116	0.253
129	Abilene, TX	0.187	0.134	0.282
130	Lansing-East Lansing, MI	0.187	0.153	0.398
131	Greeley, CO	0.184	0.101	0.254

APPENDIX TABLE 1 CONTINUED

			Instrumental Variables	
Rank	Metropolitan Area	United States	Germany	Japan
132	Durham, NC	0.182	0.132	0.328
133	Oshkosh-Neenah, WI	0.181	0.158	0.507
134	Jackson, MS	0.179	0.130	0.365
135	Visalia-Porterville, CA	0.178	0.117	0.292
136	Decatur, AL	0.178	0.131	0.340
137	Huntsville, AL	0.175	0.128	0.418
138	Roanoke, VA	0.173	0.141	0.452
139	Peoria, IL	0.167	0.168	0.899
140	Janesville, WI	0.167	0.125	0.425
141	Leominster-Gardner, MA	0.167	0.127	0.501
142	Kingsport-Bristol-Bristol, TN-VA	0.164	0.114	0.349
143	Provo-Orem, UT	0.159	0.125	0.292
144	Killeen-Temple-Fort Hood, TX	0.158	0.116	0.541
145	Appleton, WI	0.157	0.174	0.431
146	Springfield, OH	0.157	0.127	0.342
147	Charleston-North Charleston, SC	0.156	0.134	0.349
148	Brownsville-Harlingen, TX	0.154	0.115	0.316
149	Ogden-Clearfield, UT	0.154	0.114	0.276
150	Kalamazoo-Portage, MI	0.153	0.109	0.336
151	Fayetteville, NC	0.148	0.101	0.350
152	Albany-Schenectady-Troy, NY	0.148	0.110	0.372
153	Anniston-Oxford, AL	0.147	0.125	0.259
154	Wausau, WI	0.144	0.144	0.370
155	Deltona-Daytona Beach-Ormond Beach, FL	0.143	0.116	0.288
156	Flint, MI	0.142	0.109	0.349
157	Santa Cruz-Watsonville, CA	0.141	0.073	0.175
158	Victoria, TX	0.140	0.089	0.305
159	Lynchburg, VA	0.134	0.119	0.316
160	Jackson, MI	0.134	0.112	0.295
161	Palm Bay-Melbourne-Titusville, FL	0.133	0.111	0.304

APPENDIX TABLE 1 CONTINUED

			Instrumental Variables	
Rank	Metropolitan Area	United States	Germany	Japan
162	Bowling Green, KY	0.133	0.110	0.320
163	Terre Haute, IN	0.132	0.099	0.268
164	New Haven, CT	0.128	0.109	0.253
165	Cleveland, TN	0.128	0.099	0.226
166	Orlando, FL	0.124	0.082	0.259
167	Salinas, CA	0.124	0.077	0.188
168	Auburn-Opelika, AL	0.123	0.085	0.347
169	Pueblo, CO	0.121	0.101	0.314
170	Burlington, NC	0.118	0.083	0.270
171	Port St. Lucie-Fort Pierce, FL	0.118	0.083	0.241
172	Albany, GA	0.118	0.067	0.187
173	Joplin, MO	0.117	0.099	0.226
174	Bloomington, IL	0.116	0.073	0.199
175	Manchester, NH	0.115	0.094	0.337
176	Champaign-Urbana, IL	0.113	0.077	0.234
177	Lakeland, FL	0.111	0.071	0.197
178	Trenton-Ewing, NJ	0.111	0.080	0.273
179	Williamsport, PA	0.110	0.097	0.219
180	McAllen-Edinburg-Pharr, TX	0.108	0.086	0.214
181	Chambersburg-Waynesboro, PA	0.108	0.075	0.295
182	Tuscaloosa, AL	0.106	0.087	0.242
183	St. Cloud, MN	0.105	0.089	0.255
184	Yakima, WA	0.104	0.074	0.253
185	Savannah, GA	0.104	0.085	0.174
186	Eau Claire, WI	0.103	0.085	0.244
187	Idaho Falls, ID	0.100	0.061	0.143
188	Medford, OR	0.098	0.093	0.277
189	Lawton, OK	0.095	0.047	0.313
190	Mount Vernon-Anacortes, WA	0.094	0.102	0.206
191	Lake Charles, LA	0.094	0.119	0.250

APPENDIX TABLE 1 CONTINUED:

			Instrumental Variables	
Rank	Metropolitan Area	United States	Germany	Japan
192	Hanford-Corcoran, CA	0.093	0.047	0.131
193	Columbia, SC	0.092	0.070	0.182
194	Redding, CA	0.090	0.076	0.222
195	Johnson City, TN	0.089	0.073	0.219
196	Saginaw, MI	0.088	0.069	0.177
197	Merced, CA	0.084	0.040	0.092
198	Greenville, NC	0.082	0.063	0.202
199	Gulfport-Biloxi, MS	0.081	0.063	0.168
200	Washington-Arlington-Alexandria, DC-VA-MD-WV	0.081	0.075	0.124
201	Niles-Benton Harbor, MI	0.080	0.064	0.212
202	Springfield, IL	0.080	0.062	0.180
203	Altoona, PA	0.079	0.063	0.142
204	Greenville-Anderson-Mauldin, SC	0.079	0.059	0.264
205	Asheville, NC	0.077	0.061	0.232
206	Ann Arbor, MI	0.077	0.064	0.166
207	Portland-South Portland, ME	0.076	0.052	0.133
208	Lafayette, LA	0.076	0.065	0.162
209	New Bedford, MA	0.074	0.054	0.202
210	Utica-Rome, NY	0.074	0.055	0.158
211	Harrisburg-Carlisle, PA	0.072	0.048	0.147
212	Pensacola-Ferry Pass-Brent, FL	0.071	0.058	0.144
213	Salisbury, MD-DE	0.071	0.035	0.081
214	Duluth, MN-WI	0.070	0.059	0.149
215	Norwich-New London CT-RI (RI portion recoded to Providence NECTA)	0.068	0.051	0.129
216	Kahului-Wailuku-Lahaina, HI	0.066	0.030	0.046
217	Cape Coral-Fort Myers, FL	0.066	0.055	0.180
218	Hagerstown-Martinsburg, MD-WV	0.066	0.050	0.165
219	Spartanburg, SC	0.065	0.045	0.183
220	Boulder, CO	0.064	0.046	0.123
221	Bellingham, WA	0.060	0.070	0.162

APPENDIX TABLE 1 CONTINUED

			Instrumental Variables	
Rank	Metropolitan Area	United States	Germany	Japan
222	Charleston, WV	0.059	0.042	0.092
223	Kankakee-Bradley, IL	0.059	0.039	0.130
224	Chico, CA	0.058	0.044	0.116
225	Laredo, TX	0.057	0.042	0.114
226	Yuma, AZ	0.056	0.038	0.100
227	Madera, CA	0.055	0.036	0.141
228	Midland, TX	0.055	0.059	0.165
229	Panama City-Lynn Haven, FL	0.054	0.048	0.111
230	St. George, UT	0.052	0.043	0.100
231	Binghamton, NY	0.052	0.043	0.125
232	Anchorage, AK	0.051	0.044	0.104
233	Coeur d'Alene, ID	0.051	0.051	0.160
234	Burlington-South Burlington, VT	0.051	0.033	0.078
235	Las Cruces, NM	0.050	0.042	0.092
236	Ocala, FL	0.046	0.044	0.156
237	Prescott, AZ	0.046	0.041	0.091
238	Bloomington, IN	0.044	0.040	0.107
239	Tallahassee, FL	0.040	0.040	0.082
240	Monroe, LA	0.039	0.037	0.108
241	Santa Fe, NM	0.036	0.030	0.075
242	Gainesville, FL	0.035	0.034	0.074
243	Dover, DE	0.034	0.027	0.061
244	Johnstown, PA	0.034	0.030	0.062
245	Myrtle Beach-Conway-North Myrtle Beach,	0.034	0.027	0.083
246	Wilmington, NC	0.034	0.027	0.086
247	San Luis Obispo-Paso Robles, CA	0.033	0.022	0.054
248	Olympia, WA	0.032	0.027	0.085
249	Watertown-Fort Drum, NY	0.026	0.020	0.047
250	Morgantown, WV	0.024	0.019	0.036
251	Yuba City, CA	0.023	0.015	0.047

APPENDIX TABLE 1 CONTINUED

			Instrumental Variables	
Rank	Metropolitan Area	United States	Germany	Japan
252	East Stroudsburg, PA	0.023	0.019	0.032
253	Charlottesville, VA	0.022	0.019	0.046
254	Kingston, NY	0.020	0.016	0.046
255	Glens Falls, NY	0.019	0.018	0.043
256	Barnstable Town, MA	0.019	0.014	0.062
257	El Centro, CA	0.017	0.013	0.036
258	Bangor, ME	0.015	0.016	0.042
259	Bremerton-Silverdale, WA	0.015	0.013	0.037
260	Atlantic City, NJ	0.014	0.007	0.030
261	Naples-Marco Island, FL A	0.013	0.013	0.038
262	Punta Gorda, FL	0.002	0.002	0.005

Notes: The entries are annual averages of MSA-level estimates of robot intensity. We construct the intensity estimate as follows. The robot intensity for MSA *i* in year *t* is adapted from the commuter-based measure in Acemoglu and Restrepo (2017). MSA *i*'s exposure in year *t* is written as follows:

MSA's exposure to robots in year t=

$$\sum_{i \in I} l_{si}^{2000} \left(\frac{R_{i,t}^{US}}{L_{i,t}^{US}} \right),$$

Where l_{si}^{2000} corresponds to the 2000 share of MSA s employment in industry *i*, which we construct from the 2000 MORG files of the CPS. The term $R_{i,t}^{US}$ is the ith industry's robot intensity in year t at the U.S. level. This data comes from the IFR stock data base. The $L_{i,t}^{US}$ denotes at the national level, the ith industry's total employment in year *t*.

APPENDIX TABLE 2

Impact of Robot Intensity on Employment								
Panel A: Men								
	All				Manufacturing Only			
	OLS	IV	FE	IV-FE	OLS	IV	FE	IV-FE
Young, Less- Educated								
Robot Intensity	-0.005	0.011	-0.005	0.012	0.004	-0.011	0.004	-0.013
	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)	(0.012)	(0.003)	(0.013)
Area employment rate	-0.018	-0.014	-0.018	-0.014	-0.017	-0.030	-0.017	-0.030
	(0.002)	(0.002)	(0.002)	(0.002)	(0.004)	(0.008)	(0.004)	(0.008)
African American	-0.155	-0.149	-0.155	-0.149	-0.070	-0.071	-0.070	-0.071
	(0.006)	(0.007)	(0.006)	(0.007)	(0.027)	(0.028)	(0.027)	(0.027)
Latinx	-0.020	-0.005	-0.020	-0.005	0.003	0.005	0.003	0.005
	(0.007)	(0.007)	(0.007)	(0.007)	(0.017)	(0.019)	(0.016)	(0.019)
Young, Less-Educated Black and Latinx								
Robot Intensity	-0.004	0.019	-0.004	0.020	0.007	-0.004	0.006	-0.009
	(0.002)	(0.004)	(0.002)	(0.004)	(0.004)	(0.022)	(0.005)	(0.024)
Area employment rate	-0.015	-0.017	-0.015	-0.017	-0.015	-0.031	-0.015	-0.031
	(0.002)	(0.003)	(0.002)	(0.003)	(0.008)	(0.013)	(0.008)	(0.012)
African American	-0.121	-0.136	-0.121	-0.136	-0.070	-0.103	-0.071	-0.103
	(0.008)	(0.010)	(0.008)	(0.010)	(0.031)	(0.039)	(0.031)	(0.036)
All Less-Educated Adult								
Robot Intensity	(0.002)	0.001	0.002	0.001	0.004	-0.002	0.004	-0.002
	(0.001)	(0.002)	(0.002)	(0.002)	(0.001)	(0.004)	(0.001)	(0.004)
Area unemployment rate	-0.015	-0.013	-0.015	-0.013	-0.012	-0.018	-0.012	-0.018
	(0.001)	(0.002)	(0.002)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)
African American	-0.115	-0.019	-0.015	-0.019	-0.062	-0.069	-0.062	-0.069
	(0.005)	(0.006)	(0.005)	(0.006)	(0.008)	(0.008)	(0.008)	(0.008)
Latinx	0.014	0.012	0.014	0.012	-0.001	-0.006	-0.001	-0.006
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)

APPENDIX TABLE 2 CONTINUED

	All				Manufacturing Only			
	OLS	IV	FE	IV-FE	OLS	IV	FE	IV-FE
Adult, Less- Educated Black and Latinx								
Robot Intensity	0.004	0.002	0.005	0.003	0.005	0.002	0.005	0.002
	(0.002)	(0.002)	(0.002)	(0.003)	(0.001)	(0.004)	(0.001)	(0.004)
Area unemployment rate	-0.011	-0.011	-0.011	-0.011	-0.011	-0.014	-0.011	-0.014
	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.004)	(0.003)	(0.004)
African American	-0.017	-0.111	-0.017	-0.111	-0.055	-0.045	-0.055	-0.045
	(0.008)	(0.009)	(0.008)	(0.009)	(0.010)	(0.013)	(0.010)	(0.013)

Notes: Calculated from the U.S. Bureau of the Census Current Population Survey's Annual Merged Outgoing Rotation Group files, 2004 to 2017. The entries are coefficients from linear probability models which include year and MSA dummy variables, dummy variables for race and ethnicity, whether the respondent lives in a Right-to-Work state, their age, marital and veteran status and educational attainment, whether the live in an urban, suburban or rural area, whether the respondent is foreign born and a U.S. citizen, and the Metropolitan area's percent of employment that is in manufacturing. Robust standard errors are in parentheses. [a] 1 percent level of significance. [b] 5 percent level of significance. [c] 10 percent level of significance.

Panel B: Women								
	All				Manufacturing Only			
	OLS	IV	FE	IV-FE	OLS	IV	FE	IV-FE
Young, Less- Educated								
Robot Intensity	-0.007	0.003	-0.008	0.003	-0.001	-0.090	0.000	-0.074
	(0.002)	(0.003)	(0.002)	(0.003)	(0.014)	(0.045)	(0.013)	(0.048)
Area employment rate	-0.018	-0.007	-0.018	-0.007	-0.012	-0.007	-0.012	-0.007
	(0.003)	(0.002)	(0.003)	(0.002)	(0.007)	(0.017)	(0.007)	(0.015)
African American	-0.130	-0.114	-0.130	-0.114	-0.130	-0.145	-0.130	-0.145
	(0.007)	(0.007)	(0.007)	(0.007)	(0.041)	(0.055)	(0.041)	(0.050)
Latinx	-0.062	-0.045	-0.061	-0.045	-0.014	-0.012	-0.015	-0.011
	(0.005)	(0.005)	(0.005)	(0.005)	(0.036)	(0.041)	(0.035)	(0.037)
Young, Less-Educated Black and Latinx								
Robot intensity	-0.008	0.002	-0.008	0.002	0.008	-0.072	0.008	-0.051
	(0.001)	(0.002)	(0.002)	(0.002)	(0.010)	(0.074)	(0.009)	(0.072)
Area unemployment rate	-0.014	-0.005	-0.014	-0.005	-0.009	0.007	-0.009	0.007
	(0.002)	(0.003)	(0.002)	(0.003)	(0.009)	(0.029)	(0.009)	(0.025)
African American	-0.062	-0.064	-0.062	-0.064	-0.097	-0.176	-0.096	-0.176
	(0.007)	(0.009)	(0.007)	(0.009)	(0.039)	(0.067)	(0.038)	(0.057)

APPENDIX TABLE 2 CONTINUED

	All				Manufacturing Only			
	OLS	IV	FE	IV-FE	OLS	IV	FE	IV-FE
All Less- Educated Adult								
Robot intensity	-0.003	0.009	-0.003	0.010	0.002	-0.010	0.002	-0.010
	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)	(0.004)	(0.002)	(0.004)
Area unemployment rate	-0.013	-0.002	-0.013	-0.002	-0.014	-0.010	-0.014	-0.010
	(0.002)	(0.001)	(0.002)	(0.001)	(0.002)	(0.004)	(0.002)	(0.004)
African American	-0.044	-0.042	-0.044	-0.042	-0.035	-0.038	-0.035	-0.038
	(0.009)	(0.010)	(0.009)	(0.010)	(0.011)	(0.011)	(0.011)	(0.011)
Latinx	0.000	0.007	0.000	0.007	0.004	0.003	0.004	0.003
	(0.008)	(0.008)	(0.008)	(0.008	(0.010)	(0.011)	(0.010)	(0.011)
Adult, Less- Educated Black and Latinx								
Robot Intensity	-0.002	0.013	-0.003	0.014	0.003	-0.016	0.003	-0.016
	(0.002)	(0.003)	(0.002)	(0.004)	(0.004)	(0.005)	(0.005)	(0.005)
Area unemployment rate	-0.012	-0.006	-0.012	-0.006	-0.017	-0.013	-0.017	-0.013
	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.008)	(0.003)	(0.008)
African American	-0.033	-0.047	-0.034	-0.047	-0.036	-0.040	-0.036	-0.040
	(0.010)	(0.017)	(0.010)	(0.017)	(0.012)	(0.015)	(0.012)	(0.014)

Notes: Calculated from the U.S. Bureau of the Census Current Population Survey's Annual Merged Outgoing Rotation Group files, 2004 to 2017. The entries are coefficients from linear probability models which include year and MSA dummy variables, dummy variables for race and ethnicity, whether the respondent lives in a Right-to-Work state, their age, marital and veteran status and educational attainment, whether the live in an urban, suburban or rural area, whether the respondent is foreign born and a U.S. citizen, and the Metropolitan area's percent of employment that is in manufacturing. Robust standard errors are in parentheses. [a] 1 percent level of significance. [b] 5 percent level of significance. [c] 10 percent level of significance.

Panel C: East North Central Men and Women								
	All				Manufacturing Only			
	OLS	IV	FE	IV-FE	OLS	IV	FE	IV-FE
Young, Less- Educated								
Robot Intensity	-0.010	-0.002	-0.010	-0.002	-0.011	-0.036	-0.011	-0.035
	(0.002)	(0.004)	(0.002)	(0.004)	(0.008)	(0.013)	(0.008)	(0.013)
Area employment rate	-0.022	-0.013	-0.022	-0.013	-0.003	-0.006	-0.003	-0.006
	(0.005)	(0.005)	(0.005)	(0.004)	(0.011)	(0.019)	(0.011)	(0.018)
African American	-0.154	-0.151	-0.154	-0.151	-0.114	-0.109	-0.114	-0.109
	(0.010)	(0.010)	(0.010)	(0.010)	(0.067)	(0.069)	(0.065)	(0.066)

APPENDIX TABLE 2 CONTINUED

	All				Manufacturing Only			
	OLS	IV	FE	IV-FE	OLS	IV	FE	IV-FE
Latinx	-0.008	-0.007	-0.008	-0.007	0.044	0.054	0.043	0.054
	(0.011)	(0.011)	(0.010)	(0.011)	(0.062)	(0.059)	(0.060)	(0.056)
All Less- Educated Adult								
Robot intensity	0.003	0.001	0.003	0.001	0.006	0.001	0.006	0.001
	(0.001)	(0.002)	(0.001)	(0.002)	(0.002)	(0.005)	(0.002)	(0.005)
Area unemployment rate	-0.025	-0.007	-0.025	-0.007	-0.021	-0.032	-0.021	-0.032
	(0.002)	(0.004)	(0.002)	(0.004)	(0.003)	(0.005)	(0.003)	(0.005)
African American	-0.098	-0.093	-0.098	-0.093	-0.073	-0.077	-0.073	-0.077
	(0.007)	(0.008)	(0.007)	(0.008)	(0.010)	(0.010)	(0.010)	(0.009)
Latinx	0.036	0.039	0.036	0.039	0.000	0.000	0.000	0.000
	(0.012)	(0.012)	(0.012)	(0.012)	(0.007)	(0.008)	(0.007)	(0.007)
Adult Less Educated Black and Latinx								
Robot intensity	0.000	0.001	0.000	0.001	0.009	0.006	0.009	0.006
	(0.002)	(0.004)	(0.002)	(0.004)	(0.002)	(0.010)	(0.002)	(0.010)
Area unemployment rate	-0.022	-0.003	-0.022	-0.003	-0.030	-0.027	-0.030	-0.027
	(0.003)	(0.006)	(0.003)	(0.006)	(0.003)	(0.008)	(0.003)	(0.008)
African American	-0.104	-0.107	-0.104	-0.107	-0.050	-0.055	-0.050	-0.055
	(0.011)	(0.011)	(0.011)	(0.010)	(0.017)	(0.017)	(0.017)	(0.017)

Notes: Calculated from the U.S. Bureau of the Census Current Population Survey's Annual Merged Outgoing Rotation Group files, 2004 to 2017. The entries are coefficients from linear probability models which include year and MSA dummy variables, dummy variables for race and ethnicity, whether the respondent lives in a Right-to-Work state, their age, marital and veteran status and educational attainment, whether the live in an urban, suburban or rural area, whether the respondent is foreign born and a U.S. citizen, and the Metropolitan area's percent of employment that is in manufacturing. Robust standard errors are in parentheses. [a] 1 percent level of significance. [b] 5 percent level of significance. [c] 10 percent level of significance.

APPENDIX TABLE 3

Impact of Robot Intensity on Wages								
Panel A: Men								
	All				Manufacturing Only			
	OLS	IV	FE	IV-FE	OLS	IV	FE	IV-FE
Young, Less- Educated								
Robot Intensity	0.002	0.005	0.002	0.006	0.004	-0.008	0.006	0.001
	(0.002)	(0.005)	(0.002)	(0.005)	(0.009)	(0.032)	(0.010)	(0.036
Area employment rate	-0.004	-0.008	-0.004	-0.008	-0.011	-0.011	-0.012	-0.011
	(0.002)	(0.003)	(0.002)	(0.005)	(0.009)	(0.032)	(0.010)	(0.036)
African American	-0.087	-0.084	-0.088	-0.084	-0.061	-0.057	-0.061	-0.057
	(0.005)	(0.005)	(0.005)	(0.005)	(0.020)	(0.021)	(0.019)	(0.021)
Latinx	-0.021	-0.023	-0.021	-0.023	-0.043	-0.039	-0.044	-0.039
	(0.007)	(0.006)	(0.007)	(0.006)	(0.019)	(0.020)	(0.019)	(0.019)
Young, Less-Educated Black and Latinx								
Robot Intensity	0.006	0.015	0.001	0.017	0.001	-0.010	-0.003	0.001
	(0.005)	(0.006)	(0.002)	(0.007)	(0.036)	(0.035)	(0.009)	(0.040)
Area employment rate	-0.008	-0.005	-0.004	-0.005	-0.011	-0.004	-0.010	-0.004
	(0.003)	(0.004)	(0.003)	(0.004)	(0.008)	(0.013)	(0.007)	(0.012)
African American	-0.084	-0.057	-0.066	-0.057	-0.057	-0.012	-0.019	-0.012
	(0.005)	(0.009)	(0.008)	(0.008)	(0.021)	(0.031)	(0.024)	(0.029)
All Less-Educated Adult								
Robot Intensity	0.007	-0.007	0.008	-0.005	0.003	0.006	0.004	0.007
	(0.004)	(0.006)	(0.004)	(0.007)	(0.006)	(0.006)	(0.007)	(0.007)
Area unemployment rate	-0.004	-0.002	-0.004	-0.002	-0.001	0.001	-0.001	0.001
	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)
African American	-0.201	-0.211	-0.201	-0.211	-0.175	-0.182	-0.175	-0.182
	(0.006)	(0.006)	(0.006)	(0.006)	(0.013)	(0.013)	(0.013)	(0.013)
Latinx	-0.093	-0.097	-0.093	-0.097	-0.090	-0.104	-0.090	-0.104
	(0.009)	(0.007)	(0..009)	(0.007)	(0.012)	(0.011)	(0.012)	(0.011)

APPENDIX TABLE 3

	All				Manufacturing Only			
	OLS	IV	FE	IV-FE	OLS	IV	FE	IV-FE
Adult Less- Educated Black and Latinx								
Robot Intensity	0.001	0.000	0.002	0.004	0.000	0.014	0.002	0.015
	(0.004)	(0.011)	(0.005)	(0.013)	(0.006)	(0.007)	(0.008)	(0.007)
Area employment rate	-0.007	-0.007	-0.007	-0.007	-0.007	-0.005	-0.007	-0.005
	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)	(0.005)	(0.004)	(0.005)
African American	-0.110	-0.113	-0.110	-0.113	-0.091	-0.093	-0.090	-0.093
	(0.010)	(0.008)	(0.010)	(0.007)	(0.015)	(0.017)	(0.015)	(0.016
Notes: Calculated from the U.S. Bureau of the Census Current Population Survey's Annual Merged Outgoing Rotation Group files, 2004 to 2017. The entries are coefficients from linear probability models which include year and MSA dummy variables, dummy variables for race and ethnicity, whether the respondent lives in a Right-to-Work state, their age, marital and veteran status and educational attainment, whether the live in an urban, suburban or rural area, whether the respondent is foreign born and a U.S. citizen, and the Metropolitan area's percent of employment that is in manufacturing. Robust standard errors are in parentheses. [a] 1 percent level of significance. [b] 5 percent level of significance. [c] 10 percent level of significance.								
Panel B: Women								
	All				Manufacturing Only			
	OLS	IV	FE	IV-FE	OLS	IV	FE	IV-FE
Young, Less- Educated								
Robot Intensity	0.005	0.018	0.005	0.020	0.001	0.023	0.001	0.018
	(0.002)	(0.005)	(0.002)	(0.005)	(0.005)	(0.039)	(0.005)	(0.035)
Area employment rate	-0.004	-0.009	-0.004	-0.009	-0.010	-0.018	-0.010	-0.018
	(0.003)	(0.003)	(0.003)	(0.003)	(0.006)	(0.014)	(0.006)	(0.012)
African American	-0.023	-0.009	-0.023	-0.009	-0.084	-0.109	-0.084	-0.109
	(0.007)	(0.005)	(0.007)	(0.005)	(0.035)	(0.045)	(0.034)	(0.040)
Latinx	0.009	0.006	0.009	0.006	0.005	0.019	0.005	0.019
	(0.008)	(0.006)	(0.008)	(0.006)	(0.023)	(0.029)	(0.023)	(0.026)
Young, Less-Educated Black and Latinx								
Robot Intensity	0.020	0.024	0.004	0.025	0.018	0.048	-0.006	0.038
	(0.005)	(0.006)	(0.003)	(0.006)	(0.035)	(0.044)	(0.005)	(0.040)
Area employment rate	-0.009	-0.009	-0.004	-0.009	-0.018	-0.007	-0.014	-0.007
	(0.003)	(0.003)	(0.003)	(0.003)	(0.012)	(0.021)	(0.005)	(0.017)
African American	-0.009	-0.021	-0.033	-0.021	-0.109	-0.120	-0.083	-0.119
	(0.005)	(0.009)	(0.010)	(0.009)	(0.040)	(0.075)	(0.034)	(0.062)

APPENDIX TABLE 3 CONTINUED

	All				Manufacturing Only			
	OLS	IV	FE	IV-FE	OLS	IV	FE	IV-FE
All Less-Educated Adult								
Robot Intensity	0.002	-0.008	0.003	-0.006	0.002	-0.007	0.002	-0.005
	(0.004)	(0.005)	(0.004)	(0.006)	(0.005)	(0.010)	(0.006)	(0.012)
Area employment rate	-0.004	0.00	-0.004	0.000	-0.007	0.003	-0.007	0.003
	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.005)	(0.003)	(0.005)
African American	-0.066	-0.068	-0.066	-0.068	-0.113	-0.106	-0.113	-0.106
	(0.008)	(0.005)	(0.008)	(0.005)	(0.017)	(0.017)	(0.017)	(0.017)
Latinx	-0.043	-0.050	-0.043	-0.050	-0.098	-0.105	-0.099	-0.105
	(0.010)	(0.006))	(0.010)	(0.006)	9).015)	(0.014)	(0.015)	(0.014)
Adult, Less-Educated Black and Latinx								
Robot Intensity	-0.001	0.002	-0.001	0.006	-0.004	-0.016	-0.004	-0.015
	(0.003)	(0.009)	(0.003)	(0.011)	(0.004)	(0.011)	(0.004)	(0.012)
Area employment rate	-0.006	-0.005	-0.006	-0.005	-0.010	0.007	-0.010	0.007
	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)	(0.006)	(0.004)	(0.006)
African American	-0.022	-0.016	-0.022	-0.016	-0.005	0.000	-0.005	0.000
	(0.012)	(0.009)	(0.012)	(0.009)	(0.024)	(0.028)	(0.024)	(0.027)

Notes: Calculated from the U.S. Bureau of the Census Current Population Survey's Annual Merged Outgoing Rotation Group files, 2004 to 2017. The entries are coefficients from linear probability models which include year and MSA dummy variables, dummy variables for race and ethnicity, whether the respondent lives in a Right-to-Work state, their age, marital and veteran status and educational attainment, whether the live in an urban, suburban or rural area, whether the respondent is foreign born and a U.S. citizen, and the Metropolitan area's percent of employment that is in manufacturing. Robust standard errors are in parentheses. [a] 1 percent level of significance. [b] 5 percent level of significance. [c] 10 percent level of significance.

Panel C: ENC Men and Women								
Wages	All				Manufacturing Only			
	OLS	IV	FE	IV-FE	OLS	IV	FE	IV-FE
Young, Less- Educated								
Robot Intensity	-0.010	-0.002	-0.010	-0.002	-0.011	-0.036	-0.011	-0.035
	(0.002)	(0.004)	(0.002)	(0.004)	(0.008)	(0.013)	(0.008)	(0.013)
Area employment rate	-0.022	-0.013	-0.022	-0.013	-0.003	-0.006	-0.003	-0.006
	(0.005)	(0.005)	(0.005)	(0.004)	(0.011)	(0.019)	(0.011)	(0.018)

APPENDIX TABLE 3

Wages	All				Manufacturing Only			
	OLS	IV	FE	IV-FE	OLS	IV	FE	IV-FE
African American	-0.056	-0.053	-0.056	-0.053	-0.096	-0.093	-0.096	-0.093
	(0.010)	(0.011)	(0.010)	(0.010)	(0.032)	(0.035)	(0.031)	(0.033)
Latinx	0.001	0.002	0.001	-0.002	-0.018	-0.015	-0.018	-0.015
	(0.007)	(0.006)	(0.007)	(0.006)	(0.028)	(0.034)	(0.027)	(0.032)
Young, Less-Educated Black and Latinx								
Robot Intensity	-0.001	0.009	0.009	0.010	-0.041	-0.048	-0.006	-0.050
	(0.005)	(0.009)	(0.002)	(0.008)	(0.013)	(0.023)	(0.008)	(0.020)
Area employment rate	-0.002	0.007	-.0004	0.007	0.016	0.051	0.021	0.051
	(0.008)	(0.009)	(0.005)	(0.009)	(0.019)	(0.034)	(0.014)	(0.029)
African American	-0.053	-0.067	-0.074	-0.067	-0.093	-0.112	-0.114	-0.112
	(0.010)	(0.014)	(0.013)	(0.014)	(0.033)	(0.059)	(0.039)	(0.052)
All Less-Educated Adult								
Robot Intensity	0.014	-0.009	0.014	-0.009	0.004	-0.002	0.005	-0.002
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.005)	(0.002)	(0.005)
Area employment rate	-0.005	0.002	-0.006	0.002	0.006	0.002	0.006	0.002
	(0.004)	(0.004)	(0.004)	(0.004)	(0.007)	(0.007)	(0.006)	(0.007)
African American	-0.144	-0.148	-0.145	-0.148	-0.156	-0.160	-0.56	-0.160
	(0.018)	(0.019)	(0.018)	(0.019)	(0.028)	(0.028)	(0.028)	(0.028)
Latinx	-0.046	-0.050	-0.046	-0.050	-0.065	-0.064	-0.066	-0.064
	(0.013)	(0.014)	(0.013)	(0.014)	(0.015)	(0.018)	(0.015)	(0.018)
Adult, Less-Educated Black and Latinx								
Robot Intensity	0.007	-0.006	0.007	-0.006	-0.015	-0.011	-0.015	-0.011
	(0.003)	(0.006)	(0.003)	(0.006)	(0.006)	(0.011)	(0.005)	(0.011)
Area employment rate	-0.001	-0.002	-0.001	-0.002	0.014	-0.003	0.014	-0.003
	(0.007)	(0.006)	(0.007)	(0.006)	(0.011)	(0.013)	(0.011)	(0.013)
African American	-0.114	-0.110	-0.114	-0.110	-0.112	-0.122	-0.112	-0.122
	(0.017)	(0.018)	(0.017)	(0.018)	(0.032)	(0.031)	(0.031)	(0.031

Notes: Calculated from the U.S. Bureau of the Census Current Population Survey's Annual Merged Outgoing Rotation Group files, 2004 to 2017. The entries are coefficients from linear probability models which include year and MSA dummy variables, dummy variables for race and ethnicity, whether the respondent lives in a Right-to-Work state, their age, marital and veteran status and educational attainment, whether the live in an urban, suburban or rural area, whether the respondent is foreign born and a U.S. citizen, and the Metropolitan area's percent of employment that is in manufacturing. Robust standard errors are in parentheses. [a] 1 percent level of significance. [b] 5 percent level of significance. [c] 10 percent level of significance.

APPENDIX TABLE 4

Changes in Employment-Population Ratios					
	Actual Robot Intensity Change	Coef. From Table 6	Predicted Change in EPOP due to Increase in Robot Intensity	2009 Emploment-Population Ratio	Actual Change in EPOP
Young, Less- Educated Men					
All	1.022	0.012	0.012	0.388	0.042
Black	0.766	0.020	0.015	0.239	0.118
Latinx	1.436	0.020	0.029	0.457	-0.006
Adult, Less-Educated Women					
All	1.061	0.010	0.011	0.568	-0.004
Black	0.789	0.014	0.011	0.550	0.022
Latinx	1.531	0.014	0.021	0.500	0.031
Young, Less- Educated Women					
All	1.014	-0.074	-0.075	0.347	0.039
Black	0.834	-0.051	-0.042	0.268	0.111
Latinx	1.396	-0.051	-0.071	0.333	0.028
Adult Women					
All	1.061	-0.010	-0.011	0.568	-0.004
Black	0.789	-0.016	-0.012	0.550	0.022
Latinx	1.531	-0.016	-0.024	0.500	0.031
ENC Young, Less-Educated					
Men	1.531	-0.035	-0.054	0.356	0.107
Women	1.388	-0.035	-0.049	0.338	0.112
Black men	1.189	-0.037	-0.044	0.200	0.099
Latino men	2.274	-0.037	-0.085	0.478	0.073
Black women	1.351	-0.037	-0.050	0.219	0.160
Latinx	-0.093	-0.097	-0.093	-0.097	

Notes: The first column corresponds to the actual change in robot intensity that a particular demographic group experience from 2009 to 2016. The second column corresponds to the coefficients from the linear probability models presented in Table 6. All are measured with precision. The third column is the predicted change in the probability of employment. It is constructed by taking a demographic group's estimates in columns 1 and 2, and multiplying them. The fourth column is the actual change in a particular demographic group's employment population ratio. For ease of interpretation the last three columns can be multiplied by 100.