Heterogeneous Job Polarization in the US

James Lake*

Southern Methodist University

Daniel L. Millimet†

Southern Methodist University & IZA

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Abstract
We investigate job polarization in the US. Significant heterogeneity is found across sectors, with the tradable goods sector exhibiting anti-polarization. This is consistent with the theoretical trade model of Grossman and Maggi (2000).

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*James Lake, Department of Economics, Box 0496, Southern Methodist University, Dallas, TX 75275-0496, USA. E-mail: jlake@smu.edu.

† Corresponding author: Department of Economics, Southern Methodist University, Box 0496, Dallas, TX, 75205-0496. Email: millimet@smu.edu.

1 Introduction

Concern regarding disappearing middle-class jobs dates back until at least the 1980s (Goos and Manning 2007). This apparent disappearance, along with the relative rise in employment of low-skill and high-skill jobs, has been labelled the 'dumbbell' or 'hourglass' economy in various forums and job polarization in formal circles (Goos and Manning 2007; Samuel 2014). Acemoglu and Autor (2011, p. 1046) review the literature, stating that US and European Union labor markets have undergone "systematic, non-monotonic shifts in the composition of employment across occupations" resulting in "rapid simultaneous growth of both high education, high wage occupations and low education, low wage occupations."

Since skill-biased technological change (SBTC) cannot explain the rise in low-skill jobs, Autor and Dorn (2013), building on Autor et al. (2003) and others, formulate a task-based jobs definition with middle-skill jobs entailing more 'routine' tasks. Thus, falling automation costs may explain the elimination of many middle-skill jobs. This routine task (RT) explanation has received widespread attention and support.[1] Alternative explanations based on trade liberalization and offshoring have been relegated to the background or rejected (Goos and Manning 2007; Autor and Dorn 2013; Goos et al. 2014; Michaels et al. 2014).

Here, we investigate the role of globalization and job polarization of the US labor market in a simple way. Specifically, we examine heterogeneity in job polarization over the 1990-2010 period across three broad sectors: tradable goods, tradable services, and nontradables. Our analysis yields three salient findings. First, the nontradables sector has experienced job polarization, con-

[1] See `http://blogs.wsj.com/economics/tag/decline-of-routine/`.

sistent with the RT explanation. Second, the tradable services sector has experienced *greater* job polarization than the nontradables sector. Finally, we find declining overall employment in the tradable goods sector, with larger declines in the *tails* of the job quality distribution. Thus, *anti*-polarization characterizes the tradable goods sector. The greater job polarization in the tradable services sector (relative to the nontradables sector) and the anti-polarization in the tradable goods sector is consistent with the theoretical trade model of Grossman and Maggi (2000). We elaborate on this below.

2 Empirics

2.1 Model

To assess job polarization, we extend the empirical framework in Goos and Manning (2007) along two dimensions. First, we focus on changes in local labor markets (as in, e.g., Autor et al. (2013)), rather than national labor markets, controlling for possible local determinants of job polarization. Second, we allow for heterogeneity in job polarization across three broad sectors: tradable goods, tradable services, and nontradables.

Specifically, we estimate variants of the following specification:

$$\Delta n_{jsc} = \beta_{0s} + \beta_{1s} w_{js} + \beta_{2s} w_{js}^2 + x_c \theta_{0s} + \Delta x_c \theta_{1s} + \varepsilon_{jsc}, \tag{1}$$

where Δn_{jsc} is the change in the employment share or population share for job j from 1990-2010 in sector s and local labor market c, w_{js} is a national measure of the 'quality' of job j in 1990, x_c is a vector of local labor market attributes in 1990, Δx_c is the change in x_c from 1990-2010, and ε_{jsc} is a mean zero error

term. Employment shares necessarily sum to one within a local labor market. Population shares do not, thereby incorporating the decline in US labor force participation since the 1990s.[2] Job polarization is synonymous with $\beta_1 < 0$ and $\beta_2 > 0$. In addition, we formally test the presence of a non-monotonic relationship using the test in Lind and Mehlum (2010).

2.2 Data

We utilize data from the 5% sample of the 1990 US Census and 1% sample of the 2010 American Community Survey.[3] Estimating (1) requires job type definitions, job quality measurements, local labor market definitions, and measurable attributes of local labor markets.

Jobs are typically given by occupation-industry pairs (e.g., Goos and Manning 2007). Here, we use the six occupation groups of Autor and Dorn (2013) (managers/professionals, transport/construction/mechanical, production/craft, machine operators/assemblers, clerical/retail, and low skill services) and 244 industries from the 1990 Census. Of the 1464 possible jobs, we observe 1444 in at least one labor market after excluding military occupations.

We divide jobs into three mutually exclusive sectors. Tradable goods sector jobs are those in the 84 Census industries covered by the Harmonized System (HS) classification that governs tariffs on goods and goods trade flows.[4] Since the HS classification does not cover services, we use the Bureau of Economic Analysis' 1997 Import Matrix to examine imports according to the 1997 North

[2] See `http://data.bls.gov/timeseries/LNS11300000`.

[3] Data obtained from `https://usa.ipums.org/usa/`.

[4] We then use concordances to go from HS to Standard Industrial Classification (SIC) to Census industries.

American Industry Classification System (NAICS) classification.[5] Tradable service sector jobs are those in industries with positive imports per the BEA, but not previously classified as tradable goods sector jobs. Remaining jobs are assigned to the nontradables sector.[6]

Table 1 provides a sectoral breakdown. 504 jobs are in the tradable goods sector, 180 in the tradable services sector, and 760 in the nontradables sector. Despite relatively few jobs in the tradable services sector, aggregate population and employment shares are slightly larger here compared to the tradable goods sector. Table 2 lists the ten largest industries (in terms of aggregate population shares) in the tradable goods and services sectors.

We follow McLaren and Hakobyan (2010) and define local labor markets using the Census' Consistent Public Use Microdata Areas (ConsPUMAs). 543 ConsPUMAs comprise the entire US, do not cross state lines, and are consistently defined over time. Our unit of observation is a ConsPUMA-job. The total sample size is $543 \times 1444 = 784,092$.

To construct Δn_{jsc}, we first compute the number of individuals aged 25 to 64 – not currently enrolled in school, institutionalized, or listing their occupation as military – employed in each job j within a ConsPUMA c in 1990 and 2010 (using the appropriate Census weights). We convert these to population or employment shares using either total population or total employment aged 25-64. Changes in population and employment shares are computed over the 1990-2010 period.

To measure job quality, w_{js}, we construct the (national) Nam-Powers-Boyd

[5] We then use a concordance from the 1997 NAICS to Census industries.

[6] To be clear, the simultaneous presence of j and s in the subscripts in (1) is redundant in that the definition of a job j is an industry-occupation pair which, in turn, defines the sector s. However, s is included in order to make clear the level at which the parameters of model vary.

(NPB) measure of socioeconomic standing for each job in the baseline period, 1990. This measure varies from zero to 100, taking into account both the median wage and education level in a job. It is interpreted as the approximate percentage of the labor force in a job with a lower combination of wage and education (Nam and Boyd 2004). While we prefer a measure of quality that incorporates education (see, e.g., Autor et al. 2006), we also follow Goos and Manning (2007) and use the median (national) wage in each job.

Lastly, we control for local labor market attributes in 1990 and the change in attributes from 1990-2010. The attributes include mean age, distribution of education (across eight categories), distribution of marital status (across four categories), racial breakdown (across six categories), distribution of household size (across eight categories), distribution of English speaking ability (three categories), distribution of the number of children under the age 18 within households (six categories), distribution of the number of children under the age 5 within households (four categories), percentage of individuals who are US born, percentage of individuals who are homeowners, and percentage of bilingual individuals. In addition, x may include state and one-digit industry fixed effects. Table 3 provides summary statistics for Δn_{jsc} and w_{js}. Table A1 in the Appendix provides summary statistics for ConsPUMA level covariates.

3 Results

Table 4 contains our preferred results.[7] Panel I (Panel II) measures Δn_{jsc} using population (employment) shares. All specifications use the NPB measure

[7] Tables A2 and A3 in the Appendix provide additional results varying the covariates and/or using the median wage to measure job quality. The basic results are unchanged, with the exception of no longer finding evidence of polarization in the nontradables sector when using the full covariate set and measuring job quality using the median wage.

of job quality. Within each sector, the first specification includes only w_{js} and w_{js}^2 as covariates. The second specification adds x_c and Δx_c. In addition, we provide results from the standard joint test of significance of β_1 and β_2, the Lind and Mehlum (2010) test of a non-monotonic relationship, the estimated peak or trough if the relationship is non-monotonic, and the Fieller 95% confidence interval around this value. Finally, we list the sum of squared errors (SSE) used to conduct a Chow test of poolability across sectors.

Three salient findings emerge. First, β_1 and β_2 are always individually and jointly statistically significant. The Lind and Mehlum (2010) test confirms the non-monotonic relationship in each case. Second, the overall US labor market experienced job polarization over this time period; shares *decline* in the middle of the job quality distribution and *rise* in the tails. Third, there exists economically and statistically meaningful sectoral heterogeneity. Most importantly, while job polarization characterizes the tradable services and nontradable sectors, *anti*-polarization characterizes the tradable goods sector.[8] A Chow test easily rejects poolability of the three sectors at the $p < 0.01$ level. Moreover, the tradable services sector experienced *greater* polarization than the nontradables sector. In particular, we find $|\widehat{\beta}_{i,TS}| > |\widehat{\beta}_{i,NT}|$, $i = 1, 2$, where TS (NT) indexes the tradable services (nontradables) sector. A Chow test also rejects poolability of the tradable services and nontradable sectors at the $p < 0.01$ level.[9]

The greater job polarization in the tradable services sector (relative to the nontradables sector) and the anti-polarization in the tradable goods sector represent, to our knowledge, two new and striking findings. A cohesive

[8] Figures A1-A4 in the Appendix plot the relationships using the results from columns (2), (4), (6), and (8), evaluated at the sample mean of x and Δx.

[9] See also Figures A3 and A4 for visual evidence.

explanation for both findings can be found in the theoretical trade model of Grossman and Maggi (2000). The model considers two 'products', e.g. a good and a service, with the US having a comparative advantage (disadvantage) in the service (good) produced using technology exhibiting submodularity (supermodularity). A production function exhibits submodularity (supermodularity) if labor inputs of heterogeneous (homogeneous) skill levels are complements.[10] The US exports (imports) the service (good) because, as argued by the authors, the US population has relatively heterogeneous skill levels.[11] According to the model, globalization induces a reallocation of workers in the US from the goods sector to the services sector. Moreover, since the service sector values heterogenous skills more than the goods sector, due to its submodular technology, workers in the tails of the job quality distribution in the goods sector will be the first to move to the services sector.

These predictions of the Grossman and Maggi (2000) model are consistent with both findings uncovered here.[12] Globalization over the time period analyzed, brought about in part by trade liberalization via declining tariffs, induces an overall employment decline in the US comparative disadvantage sector (i.e., tradable goods), with relatively larger declines for low- and high-skill

[10] Grossman and Maggi (2000, p. 1257) state that submodularity "may characterize some production processes, especially those requiring creativity or problem solving." The authors state (p. 1256) that supermodularity may better describe other "activities—complicated manufacturing processes being a prime example—where workers performing different tasks are highly complementary" and "a production unit is only as strong as its weakest link." Thus, broadly speaking, we plausibly treat the service sector as characterized by submodularity and the goods sector as characterized by supermodularity.

[11] While the US runs a trade deficit overall ($80,864m in 1990 and $494,658m in 2010), it runs a trade deficit in goods ($111,037m in 1990 and $648,678m in 2010) but a trade surplus in services ($30,173m in 1990 and $154,020m in 2010). All figures obtained from `http://www.census.gov/foreign-trade/statistics/historical/gands.pdf`.

[12] Also see Morrow (2009) for a generalized version of the Grossman and Maggi (2000) model and supporting empirical evidence of the model.

jobs.[13] The comparative advantage sector in the US (i.e., tradable services) expands overall, but with relatively larger gains in low- and high-skill jobs due to the reallocation of workers from the tradable goods sector combined with the falling costs of automation. The nontradables sector experiences less polarization than the tradable services sector since it is only affected by the falling cost of automation leading to a reduction in jobs entailing routine tasks.

4 Conclusion

Job polarization is regarded as an empirical fact in the US and other developed countries. Disappearing routine, middle-skill jobs due to falling automation costs is the dominant explanation. Globalization is typically regarded as a trivial factor. However, automation is not the entire story. Significant heterogeneity characterizes the *existence* and *extent* of job polarization across broad sectors of the US economy. Polarization characterizes the tradable services sector, whereas anti-polarization characterizes the tradable goods sector. The anti-polarization in the tradable goods sector and the greater polarization in the tradable services sector relative to the nontradables sector suggests globalization may reallocate labor from low- and high-skill jobs in the goods sector to the services sector, consistent with the theory developed in Grossman and Maggi (2000).

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Table 1. Number and Size of Jobs by Sector in 1990

Sector	Number of Jobs	Aggregate Population Share	Aggregate Employment Share
Tradable Goods	504	18.32%	20.90%
Tradable Services	180	19.13%	21.82%
Nontradable	760	50.21%	57.28%

Notes: A Job is defined as a 1990 Census industry X occupational group. Shares are based on non-institutionalized individuals aged 25-64, who are not self-employed, in school, or in the military. Data are from the 1990 Decennial Census.

Table 2. Ten Largest Industries in the Tradable Goods and Services Sectors

Industry	Aggregate Population Share
I. Tradable Goods Sector	
Printing, publishing, and allied industries, except newspapers	1.11%
Motor vehicles and motor vehicle equipment	1.10%
Electrical machinery, equipment, and supplies, n.e.c.	0.90%
Machinery, except electrical, n.e.c.	0.85%
Apparel and accessories, except knit	0.76%
Aircraft and parts	0.59%
Agricultural production, crops	0.55%
Industrial and miscellaneous chemicals	0.48%
Furniture and fixtures	0.45%
Computers and related equipment	0.45%
II. Tradable Services Sector	
Hospitals	4.35%
Insurance	1.96%
Banking	1.71%
Colleges and universities	1.59%
Trucking service	1.43%
Legal services	0.80%
Business services, n.e.c.	0.79%
Miscellaneous entertainment and recreation services	0.67%
Air transportation	0.64%
Electric light and power	0.62%

Notes: Shares are based on non-institutionalized individuals aged 25-64, who are not self-employed, in school, or in the military. n.e.c. = not elsewhere classified. Data are from the 1990 Decennial Census.

Table 3. Summary Statistics

Variable	Mean	SD	Min	Max
Δ Population Share	-0.001	0.143	-9.372	5.650
Δ Employment Share	0.000	0.168	-11.507	6.727
Nam-Powers-Boyd Index	0.518	0.183	0.001	0.992
Median Wage Rank	0.446	0.267	0.000	1.000

Notes: N=784,092. An observation is a PUMA-job combination. Change in population and employment shares are computed for 1990-2010. Job quality measures are from 1990. 1990 data is from the Decennial Census. 2010 data is from the American Community Survey.

Table 4. Job Polarization By Sector

	All Sectors		Tradable Goods		Tradable Services		Nontradable	
Variable	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
I. Change in Population Shares: 1990-2010								
Job Quality	-0.1145*	-0.0632*	0.0729*	0.0782*	-0.4097*	-0.3572*	-0.1124*	-0.0883*
	(0.0054)	(0.0053)	(0.0126)	(0.0126)	(0.0181)	(0.0179)	(0.0054)	(0.0051)
$(\text{Job Quality})^2$	0.1264*	0.1005*	-0.0493*	-0.0544*	0.4620*	0.4454*	0.1328*	0.1338*
	(0.0053)	(0.0051)	(0.0093)	(0.0093)	(0.0198)	(0.0194)	(0.0059)	(0.0059)
Baseline Covariates	N	Y	N	Y	N	Y	N	Y
Change in Covariates	N	Y	N	Y	N	Y	N	Y
Industry FEs	N	Y	N	Y	N	Y	N	Y
State FEs	N	Y	N	Y	N	Y	N	Y
N	784092	784092	273672	273672	97740	97740	412680	412680
Number of Covariates	3	133	3	118	3	127	3	131
SSE	10642.18	10371.97	2808.99	2789.73	2093.33	2018.85	5592.08	5411.22
Joint Significance	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00
H_0: U-/Inverted U- Test	t = 21.35	t = 11.92	t = 3.34	t = 4.01	t = 22.66	t = 19.96	t = 20.93	t = 17.20
	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00
Extremum	0.45	0.32	0.74	0.72	0.44	0.40	0.42	0.33
95% Fieller CI	(0.44 , 0.47)	(0.29 , 0.34)	(0.66 , 0.84)	(0.65 , 0.81)	(0.44 , 0.45)	(0.39 , 0.41)	(0.41 , 0.44)	(0.32 , 0.34)
II. Change in Employment Shares: 1990-2010								
Job Quality	-0.1371*	-0.0762*	0.0808*	0.0869*	-0.4774*	-0.4198*	-0.1362*	-0.1090*
	(0.0061)	(0.0060)	(0.0144)	(0.0144)	(0.0205)	(0.0202)	(0.0062)	(0.0059)
$(\text{Job Quality})^2$	0.1526*	0.1225*	-0.0531*	-0.0589*	0.5425*	0.5279*	0.1631*	0.1658*
	(0.0060)	(0.0057)	(0.0105)	(0.0105)	(0.0225)	(0.0219)	(0.0067)	(0.0067)
Baseline Covariates	N	Y	N	Y	N	Y	N	Y
Change in Covariates	N	Y	N	Y	N	Y	N	Y
Industry FEs	N	Y	N	Y	N	Y	N	Y
State FEs	N	Y	N	Y	N	Y	N	Y
N	784092	784092	273672	273672	97740	97740	412680	412680
Number of Covariates	3	133	3	118	3	127	3	131
SSE	14421.02	14041.25	3749.17	3725.73	2805.95	2703.10	7654.32	7398.32
Joint Significance	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00
H_0: U-/Inverted U- Test	t = 22.55	t = 12.58	t = 2.98	t = 3.65	t = 23.31	t = 20.76	t = 22.09	t = 18.51
	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00
Extremum	0.45	0.31	0.76	0.74	0.44	0.40	0.42	0.33
95% Fieller CI	(0.44 , 0.46)	(0.29 , 0.34)	(0.68 , 0.88)	(0.67 , 0.83)	(0.44 , 0.44)	(0.39 , 0.41)	(0.41 , 0.43)	(0.32 , 0.34)

Notes: Dependent variable is the change in population or employment share in a particular job and PUMA from 1990-2010, where the shares in 1990 and 2010 are based on non-institutionalized individuals aged 25-64, who are not self-employed, in school, or in the military. Estimation by pooled OLS. FE = fixed effects. SSE = sum of squared errors. For definitions of variables and list of other covariates not reported see Table 1 and text. Regressions are weighted by PUMA population in 1990. Standard errors, clustered at the PUMA level, are in parentheses. ‡ $p < 0.10$, † $p < 0.05$, and * $p < 0.01$.

Appendix

For Online Publication

Table A1. Summary Statistics

Variable	Mean	SD	Min	Max
PUMA-Job Variables				
Δ Population Share	-0.001	0.143	-9.372	5.650
Δ Employment Share	0.000	0.168	-11.507	6.727
Nam-Powers-Boyd Index	0.518	0.183	0.001	0.992
Median Wage Rank	0.446	0.267	0.000	1.000
PUMA Variables				
Age (Mean)	41.694	0.943	38.659	44.733
US Born (%)	0.956	0.056	0.605	0.998
Homeownership Rate	0.737	0.094	0.218	0.936
HS Graduate/GED (%)	0.335	0.075	0.073	0.555
Some College (%)	0.201	0.046	0.091	0.326
Associate's Degree (%)	0.071	0.020	0.022	0.134
Bachelor's Degree (%)	0.138	0.056	0.035	0.346
Master's Degree (%)	0.049	0.025	0.014	0.219
Professional Degree (%)	0.016	0.010	0.003	0.102
Doctoral Degree (%)	0.008	0.007	0.000	0.075
Separated/Divorced (%)	0.137	0.029	0.069	0.249
Widowed (%)	0.027	0.007	0.010	0.056
Never Married %)	0.134	0.062	0.052	0.422
Black (%)	0.091	0.120	0.000	0.795
Hispanic (%)	0.042	0.087	0.000	0.805
American Indian/Alaskan (%)	0.008	0.029	0.000	0.584
Asian/Pacific Islander (%)	0.011	0.030	0.000	0.592
Other Race (%)	0.000	0.001	0.000	0.011
Bilingual Speaker (%)	0.076	0.092	0.009	0.745
Speaks English "Well" (%)	0.017	0.025	0.001	0.214
Speaks english "Not Well" (%)	0.009	0.017	0.000	0.152
HH Size = 2 (%)	0.272	0.031	0.162	0.386
HH Size = 3 (%)	0.214	0.023	0.123	0.282
HH Size = 4 (%)	0.210	0.026	0.084	0.276
HH Size = 5 (%)	0.097	0.017	0.030	0.178
HH Size = 6 (%)	0.034	0.013	0.010	0.115
HH Size = 7 (%)	0.013	0.008	0.002	0.073
HH Size = 8+ (%)	0.007	0.008	0.000	0.073
Own Children = 1 (%)	0.213	0.022	0.128	0.276
Own Children = 2 (%)	0.211	0.027	0.087	0.281
Own Children = 3 (%)	0.088	0.018	0.020	0.154
Own Children = 4 (%)	0.025	0.011	0.006	0.106
Own Children = 5+ (%)	0.010	0.010	0.000	0.127
Own Children Under Age 5 = 1 (%)	0.113	0.013	0.066	0.154
Own Children Under Age 5 = 2 (%)	0.033	0.008	0.014	0.068
Own Children Under Age 5 = 3+ (%)	0.037	0.021	0.008	0.239

Notes: N=784,092. An observation is a PUMA-job combination. Change in population and employment shares are computed for 1990-2010. All other variables are from 1990. 1990 data is from the Decennial Census. 2010 data is from the American Community Survey.

Table A2. Change in Population Shares: 1990-2010

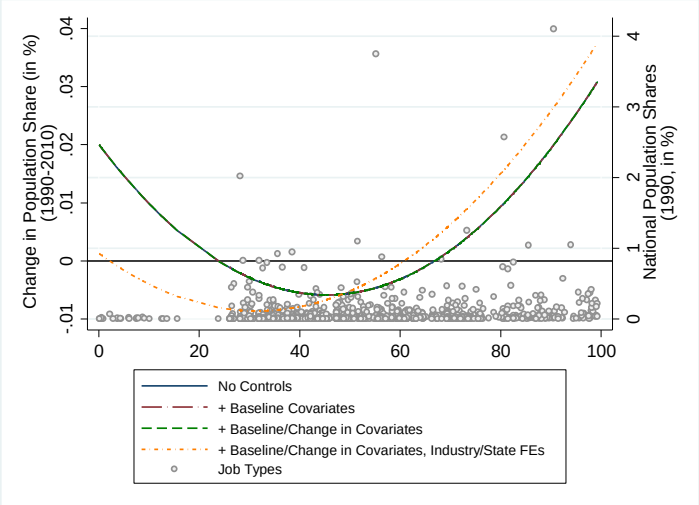
	All Sectors				Tradable Goods Sectors				Tradable Services Sectors				Nontradable Sectors			
Variable	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**	**(13)**	**(14)**	**(15)**	**(16)**
I. Nam-Powers-Boyd Index																
Job Quality	-0.1145*	-0.1145*	-0.1145*	-0.0632*	0.0729*	0.0729*	0.0729*	0.0782*	-0.4097*	-0.4097*	-0.4097*	-0.3572*	-0.1124*	-0.1124*	-0.1124*	-0.0883*
	(0.0054)	(0.0054)	(0.0054)	(0.0053)	(0.0126)	(0.0126)	(0.0126)	(0.0126)	(0.0181)	(0.0181)	(0.0181)	(0.0179)	(0.0054)	(0.0054)	(0.0054)	(0.0051)
$(\text{Job Quality})^2$	0.1264*	0.1264*	0.1264*	0.1005*	-0.0493*	-0.0493*	-0.0493*	-0.0544*	0.4620*	0.4620*	0.4620*	0.4454*	0.1328*	0.1328*	0.1328*	0.1338*
	(0.0053)	(0.0053)	(0.0053)	(0.0051)	(0.0093)	(0.0093)	(0.0093)	(0.0093)	(0.0198)	(0.0198)	(0.0198)	(0.0194)	(0.0059)	(0.0059)	(0.0059)	(0.0059)
Baseline Covariates	N	Y	Y	Y	N	Y	Y	Y	N	Y	Y	Y	N	Y	Y	Y
Change in Covariates	N	N	Y	Y	N	N	Y	Y	N	N	Y	Y	N	N	Y	Y
Industry FEs	N	N	N	Y	N	N	N	Y	N	N	N	Y	N	N	N	Y
State FEs	N	N	N	Y	N	N	N	Y	N	N	N	Y	N	N	N	Y
N	784092	784092	784092	784092	273672	273672	273672	273672	97740	97740	97740	97740	412680	412680	412680	412680
Number of Covariates	3	39	75	133	3	39	75	118	3	39	75	127	3	39	75	131
SSE	10642.18	10641.25	10641.05	10371.97	2808.99	2802.88	2802.00	2789.73	2093.33	2091.05	2089.05	2018.85	5592.08	5589.09	5588.71	5411.22
Joint Significance	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00
H_0: U-/Inverted U- Tes	t = 21.35	t = 21.35	t = 21.35	t = 11.92	t = 3.34	t = 3.34	t = 3.34	t = 4.01	t = 22.66	t = 22.65	t = 22.65	t = 19.96	t = 20.93	t = 20.93	t = 20.93	t = 17.20
	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00
Extremum	0.45	0.45	0.45	0.32	0.74	0.74	0.74	0.72	0.44	0.44	0.44	0.40	0.42	0.42	0.42	0.33
95% Fieller CI	(0.44 , 0.47)	(0.44 , 0.47)	(0.44 , 0.47)	(0.29 , 0.34)	(0.66 , 0.84)	(0.66 , 0.84)	(0.66 , 0.84)	(0.65 , 0.81)	(0.44 , 0.45)	(0.44 , 0.45)	(0.44 , 0.45)	(0.39 , 0.41)	(0.41 , 0.44)	(0.41 , 0.44)	(0.41 , 0.44)	(0.32 , 0.34)
II. Median Wage Rank																
Job Quality	-0.0221*	-0.0221*	-0.0221*	0.0258*	0.1201*	0.1201*	0.1201*	0.1319*	-0.1393*	-0.1393*	-0.1393*	-0.1250*	-0.0107*	-0.0107*	-0.0107*	0.0112*
	(0.0031)	(0.0031)	(0.0031)	(0.0036)	(0.0133)	(0.0133)	(0.0133)	(0.0141)	(0.0079)	(0.0079)	(0.0079)	(0.0102)	(0.0029)	(0.0029)	(0.0029)	(0.0029)
$(\text{Job Quality})^2$	0.0268*	0.0268*	0.0268*	0.003	-0.0952*	-0.0952*	-0.0952*	-0.1055*	0.1969*	0.1969*	0.1969*	0.2292*	0.0138*	0.0138*	0.0138*	0.0149*
	(0.0031)	(0.0031)	(0.0031)	(0.0032)	(0.0098)	(0.0098)	(0.0098)	(0.0103)	(0.0101)	(0.0101)	(0.0101)	(0.0124)	(0.0030)	(0.0030)	(0.0030)	(0.0033)
Baseline Covariates	N	Y	Y	Y	N	Y	Y	Y	N	Y	Y	Y	N	Y	Y	Y
Change in Covariates	N	N	Y	Y	N	N	Y	Y	N	N	Y	Y	N	N	Y	Y
Industry FEs	N	N	N	Y	N	N	N	Y	N	N	N	Y	N	N	N	Y
State FEs	N	N	N	Y	N	N	N	Y	N	N	N	Y	N	N	N	Y
N	784092	784092	784092	784092	273672	273672	273672	273672	97740	97740	97740	97740	412680	412680	412680	412680
Number of Covariates	3	39	75	133	3	39	75	118	3	39	75	127	3	39	75	131
SSE	10683.27	10682.34	10682.14	10408.44	2799.29	2793.18	2792.30	2778.78	2156.10	2153.82	2151.82	2059.23	5613.52	5610.54	5610.15	5437.85
Joint Significance	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00
H_0: U-/Inverted U- Tes	7.21	7.21	7.21		9.05	9.05	9.05	9.38	17.72	17.72	17.71	12.26	3.65	3.65	3.65	
	p = 0.00	p = 0.00	p = 0.00		p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	
Extremum	0.41	0.41	0.41		0.63	0.63	0.63	0.63	0.35	0.35	0.35	0.27	0.39	0.39	0.39	
95% Fieller CI	(0.37 , 0.45)	(0.37 , 0.45)	(0.37 , 0.45)		(0.61 , 0.65)	(0.61 , 0.65)	(0.61 , 0.65)	(0.60 , 0.65)	(0.34 , 0.36)	(0.34 , 0.36)	(0.34 , 0.36)	(0.25 , 0.29)	(0.27 , 0.48)	(0.27 , 0.48)	(0.27 , 0.48)	

Notes: Dependent variable is the change in population share in a particular job and PUMA from 1990-2010, where the shares in 1990 and 2010 are based on non-institutionalized individuals aged 25-64, who are not self-employed, in school, or in the military. Estimation by pooled OLS. FE = fixed effects. SSE = sum of squared errors. For definitions of variables and list of other covariates not reported see Table 1 and text. Regressions are weighted by PUMA population in 1990. Standard errors, clustered at the PUMA level, are in parentheses. ‡ $p < 0.10$, † $p < 0.05$, and * $p < 0.01$.

Table A3. Change in Employment Shares: 1990-2010

	All Sectors				Tradable Goods Sectors				Tradable Services Sectors				Nontradable Sectors			
Variable	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**	**(13)**	**(14)**	**(15)**	**(16)**
I. Nam-Powers-Boyd Index																
Job Quality	-0.1371*	-0.1371*	-0.1371*	-0.0762*	0.0808*	0.0808*	0.0808*	0.0869*	-0.4774*	-0.4774*	-0.4774*	-0.4198*	-0.1362*	-0.1362*	-0.1362*	-0.1090*
	(0.0061)	(0.0061)	(0.0061)	(0.0060)	(0.0144)	(0.0144)	(0.0144)	(0.0144)	(0.0205)	(0.0205)	(0.0205)	(0.0202)	(0.0062)	(0.0062)	(0.0062)	(0.0059)
$(\text{Job Quality})^2$	0.1526*	0.1526*	0.1526*	0.1225*	-0.0531*	-0.0531*	-0.0531*	-0.0589*	0.5425*	0.5425*	0.5425*	0.5279*	0.1631*	0.1631*	0.1631*	0.1658*
	(0.0060)	(0.0060)	(0.0060)	(0.0057)	(0.0105)	(0.0105)	(0.0105)	(0.0105)	(0.0225)	(0.0225)	(0.0225)	(0.0219)	(0.0067)	(0.0067)	(0.0067)	(0.0067)
Baseline Covariates	N	Y	Y	Y	N	Y	Y	Y	N	Y	Y	Y	N	Y	Y	Y
Change in Covariates	N	N	Y	Y	N	N	Y	Y	N	N	Y	Y	N	N	Y	Y
Industry FEs	N	N	N	Y	N	N	N	Y	N	N	N	Y	N	N	N	Y
State FEs	N	N	N	Y	N	N	N	Y	N	N	N	Y	N	N	N	Y
N	784092	784092	784092	784092	273672	273672	273672	273672	97740	97740	97740	97740	412680	412680	412680	412680
Number of Covariates	3	39	75	133	3	39	75	118	3	39	75	127	3	39	75	131
SSE	14421.02	14421.02	14421.02	14041.25	3749.17	3741.56	3740.54	3725.73	2805.95	2802.43	2800.41	2703.10	7654.32	7650.48	7649.80	7398.32
Joint Significance	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00
H_0: U-/Inverted U- Tes	t = 22.55	t = 22.55	t = 22.55	t = 12.58	t = 2.98	t = 2.98	t = 2.98	t = 3.65	t = 23.31	t = 23.30	t = 23.30	t = 20.76	t = 22.09	t = 22.09	t = 22.09	t = 18.51
	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00
Extremum	0.45	0.45	0.45	0.31	0.76	0.76	0.76	0.74	0.44	0.44	0.44	0.40	0.42	0.42	0.42	0.33
95% Fieller CI	(0.44 , 0.46)	(0.44 , 0.46)	(0.44 , 0.46)	(0.29 , 0.34)	(0.68 , 0.88)	(0.68 , 0.88)	(0.68 , 0.88)	(0.67 , 0.83)	(0.44 , 0.44)	(0.44 , 0.44)	(0.44 , 0.44)	(0.39 , 0.41)	(0.41 , 0.43)	(0.41 , 0.43)	(0.41 , 0.43)	(0.32 , 0.34)
II. Median Wage Rank																
Job Quality	-0.0268*	-0.0268*	-0.0268*	0.0301*	0.1372*	0.1372*	0.1372*	0.1505*	-0.1598*	-0.1598*	-0.1598*	-0.1466*	-0.0133*	-0.0133*	-0.0133*	0.0120*
	(0.0035)	(0.0035)	(0.0035)	(0.0043)	(0.0153)	(0.0153)	(0.0153)	(0.0162)	(0.0089)	(0.0089)	(0.0089)	(0.0116)	(0.0034)	(0.0034)	(0.0034)	(0.0034)
$(\text{Job Quality})^2$	0.0332*	0.0332*	0.0332*	0.0053	-0.1081*	-0.1081*	-0.1081*	-0.1197*	0.2293*	0.2293*	0.2293*	0.2711*	0.0188*	0.0188*	0.0188*	0.0210*
	(0.0035)	(0.0035)	(0.0035)	(0.0037)	(0.0113)	(0.0113)	(0.0113)	(0.0118)	(0.0115)	(0.0115)	(0.0115)	(0.0140)	(0.0034)	(0.0034)	(0.0034)	(0.0038)
Baseline Covariates	N	Y	Y	Y	N	Y	Y	Y	N	Y	Y	Y	N	Y	Y	Y
Change in Covariates	N	N	Y	Y	N	N	Y	Y	N	N	Y	Y	N	N	Y	Y
Industry FEs	N	N	N	Y	N	N	N	Y	N	N	N	Y	N	N	N	Y
State FEs	N	N	N	Y	N	N	N	Y	N	N	N	Y	N	N	N	Y
N	784092	784092	784092	784092	273672	273672	273672	273672	97740	97740	97740	97740	412680	412680	412680	412680
Number of Covariates	3	39	75	133	3	39	75	118	3	39	75	127	3	39	75	131
SSE	14482.45	14482.45	14482.45	14096.41	3736.50	3728.89	3727.87	3711.46	2895.12	2891.60	2889.58	2762.66	7687.76	7683.93	7683.24	7439.09
Joint Significance	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00
H_0: U-/Inverted U- Tes	7.56	7.56	7.56		8.96	8.96	8.96	9.28	17.99	17.99	17.99	12.67	3.86	3.86	3.86	
	p = 0.00	p = 0.00	p = 0.00		p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	p = 0.00	
Extremum	0.40	0.40	0.40		0.64	0.64	0.64	0.63	0.35	0.35	0.35	0.27	0.35	0.35	0.35	
95% Fieller CI	(0.36 , 0.44)	(0.36 , 0.44)	(0.36 , 0.44)		(0.61 , 0.66)	(0.61 , 0.66)	(0.61 , 0.66)	(0.60 , 0.65)	(0.34 , 0.36)	(0.34 , 0.36)	(0.34 , 0.36)	(0.25 , 0.29)	(0.25 , 0.43)	(0.25 , 0.43)	(0.25 , 0.43)	

Notes: Dependent variable is the change in population share in a particular job and PUMA from 1990-2010, where the shares in 1990 and 2010 are based on non-institutionalized individuals aged 25-64, who are not self-employed, in school, or in the military. Estimation by pooled OLS. FE = fixed effects. SSE = sum of squared errors. For definitions of variables and list of other covariates not reported see Table 1 and text. Regressions are weighted by PUMA population in 1990. Standard errors, clustered at the PUMA level, are in parentheses. ‡ $p < 0.10$, † $p < 0.05$, and * $p < 0.01$.



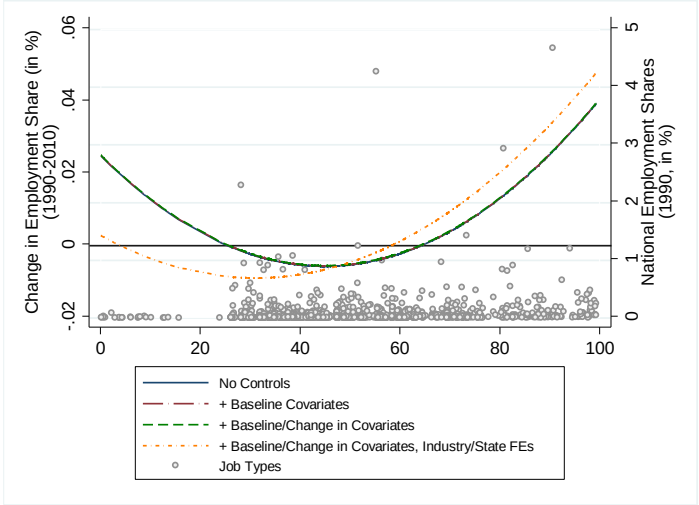
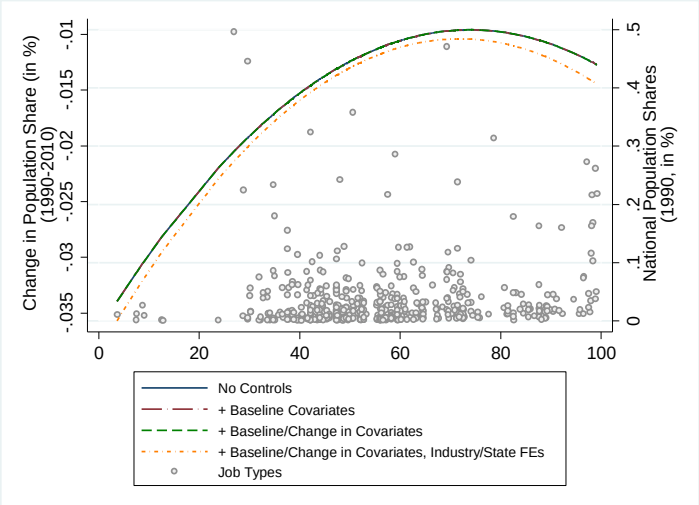


Figure A1. US Job Polarization, 1990-2010: All Sectors.
Note: Y-axis is the change in population (employment) shares in the left (right) panel. X-axis is the Nam-Powers-Boyd measure of job quality in 1990. See text for further details.



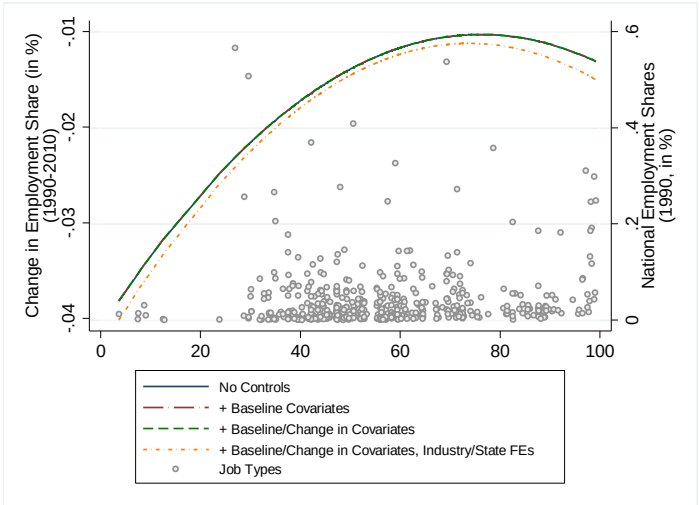


Figure A2. US Job Polarization, 1990-2010: Tradable Goods Sector.
Note: Y-axis is the change in population (employment) shares in the left (right) panel. X-axis is the Nam-Powers-Boyd measure of job quality in 1990. See text for further details.

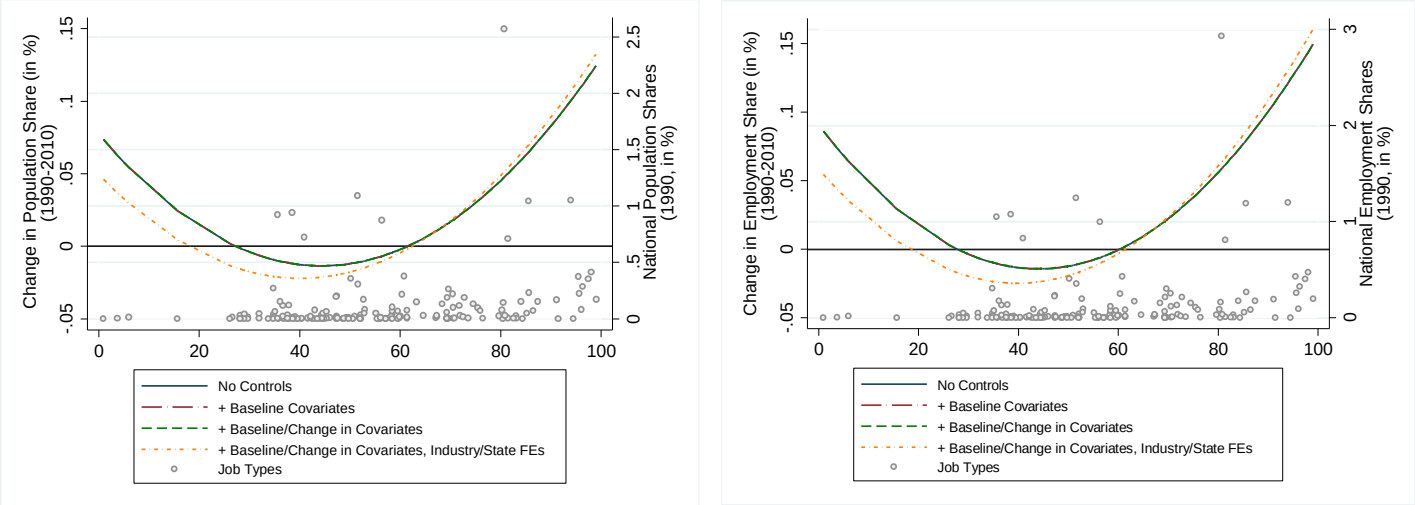


Figure A3. US Job Polarization, 1990-2010: Tradable Services Sector.
Note: Y-axis is the change in population (employment) shares in the left (right) panel. X-axis is the Nam-Powers-Boyd measure of job quality in 1990. See text for further details.

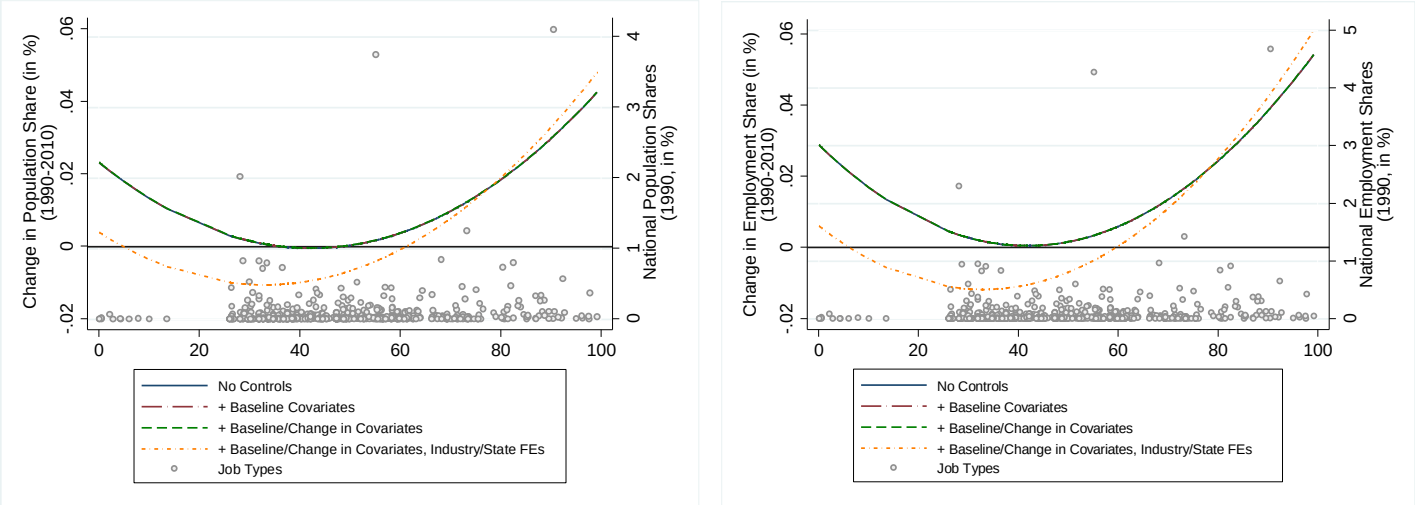


Figure A4. US Job Polarization, 1990-2010: Nontradables Sector.
Note: Y-axis is the change in population (employment) shares in the left (right) panel. X-axis is the Nam-Powers-Boyd measure of job quality in 1990. See text for further details.