The Evolution of Local Labor Markets After Recessions

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Online Appendix

A Data Appendix

A.1 Creating Consistent Geography Definitions over Time

We examine the impacts of recessions for different definitions of local areas: metropolitan areas and commuting zones. Each of these geography definitions changes over time. Moreover, each geography is composed of counties, and these, too, change over time.[58] Metropolitan areas are periodically redefined by the Office of Management and Budget (OMB), and commuting zones are redefined decadally by the Department of Agriculture based on commuting questions in the census (in 1990 and 2000) or American Community Survey (2010). For ease of interpretation, we work with temporally-fixed definitions of metropolitan areas and commuting zones throughout our analyses. Specifically, we use Core-Based Statistical Areas (CBSAs) based on OMB definitions from December 2003, and commuting zones based on the 2000 census.[59] Since both these geographies are composed of counties, it is straightforward to aggregate county-level data using crosswalks released by the Office of Management and Budget (via the Census Bureau) or the Department of Agriculture.

To ensure we work with consistently defined counties, we use the Census Bureau's county change database to recode county and county equivalents in the source data (BEAR, CBP, QCEW, SEER) to consistent definitions.[60] We also restrict our samples of metro areas and commuting zones to the continental United States, excluding Alaska and Hawaii. Finally, we combine the independent cities in Virginia with their surrounding counties.

For analysis using microdata from the decennial census and ACS, counties are generally not observable. Rather, the 1990 census, 2000 census, and ACS identify Public Use Microdata Areas (PUMAs), time-varying areas of at least 100,000 individuals. The 1970 and 1980 censuses instead identify county groups, which are conceptually similar but based on municipal and county units rather than Census tracts. We use population-weighted crosswalks available from the Missouri Census Data Center's Geocorr application to map PUMAs to counties, and we use county group-county crosswalks available from IPUMS to map county groups to CBSAs.[61] As described in the main text, for many of the analyses we first process the microdata and then collapse the relevant measures to our analytic geographies using the crosswalks.

[58] Counties are the most stable, but occasionally change due to state legislative action or boundary disputes.

[59] See https://www.census.gov/geographies/reference-files/time-series/demo/metro-micro/historical-delineation-files.html and https://www.ers.usda.gov/data-products/commuting-zones-and-labor-market-areas/, respectively.

[60] See https://www.census.gov/programs-surveys/geography/technical-documentation/county-changes.html. For counties that change only names or codes, we use the modern versions, and we combine counties that either merge or split.

[61] See https://usa.ipums.org/usa/volii/t1970maps.shtml and https://usa.ipums.org/usa/volii/ctygrp.shtml.

A.2 Imputing Employment in Quarterly Census of Employment and Wages

For some robustness checks, we use the Bureau of Labor Statistics' Quarterly Census of Employment and Wages (QCEW) as an alternative measure to the BEAR data for local area employment. QCEW data are based on unemployment insurance records from each state, are one of the inputs used by BEA to construct its employment data, and constitute the data source used to benchmark the Current Employment Statistics for monthly jobs reports. Data are available starting in 1975 from the BLS website and provide employment and establishment counts, as well as aggregate and average weekly wages, for each county and industry, at annual, quarterly, and (for employment counts) monthly frequencies.[62] However, data suppressions are common, especially earlier in the period. At the county level, data for small or highly concentrated industries (e.g., agriculture and mining) are often suppressed, although very small counties may even have total or total private employment suppressed. When these suppressions occur, *all* data for the county-industry-quarter are suppressed, unlike in County Business Patterns, described below. (For national series, used for constructing the "shifts" in the creation of predicted log employment changes as in Bartik (1991), suppression is not an issue.)

For total and total private (excluding government) employment, we impute missing employment counts at the county level through the following ordered process: 1) If total employment and government employment are reported but private employment is suppressed, we impute private employment as the difference between total and government;[63] 2) If either total *or* private employment is missing in a given quarter, but not for all quarters in the year, we impute the one that is missing based on the average ratio (private share of total) for the year; 3) If either total *or* private employment is missing for an entire year, such that the private share for that year is unavailable, we impute the missing values based on the average share over the rolling window from two years prior to two years after the current year. This process imputes aggregate employment counts for nearly every case from 1978 onward. For the few remaining cases, mostly before 1978, we impute values by running a county-specific regression of the log of the employment measure (either total or total private) on year and quarter dummies from 1978 forward and replacing the missing values (including those from before 1978) with their predicted values from the regression.

A.3 Imputing Employment in County Business Patterns

When constructing the predicted log employment change as in Bartik (1991), we use County Business Patterns (CBP) data to measure local industry employment shares. In the relevant years, CBP data always report establishment counts by county, industry, and establishment size, but frequently suppress employment at the county by industry level. From 1974 forward, the establishment size groups are 1–4, 5–9, 10–19, 20–49, 50–99, 100–249, 250–499, 500–999, 1000–1499, 1500–2499, 2500–4999, and 5000 or more employees.

We impute employment at the county by industry level using establishment counts and nationwide information on employment by establishment size. For establishments with fewer than 1000 employees, we impute employment as the number of establishments times average pre-recession

[62] Aggregate employment for each geography is available from 1975; industry-level measures are available under SIC coding from 1975 through 2000 and NAICS coding from 1990 forward.

[63] We follow this rule for 1978 forward, when local and state government reporting was near universal; prior to this year, many jobs in local and state governments were not in the reporting universe, and available counts, when not suppressed, vastly underestimated government employment. See P.L. 94-566.

employment in the establishment size group, where the average comes from nationwide data across all industries. We use 1999 data to construct these imputation adjustments, but the results are very similar when using other years.

Nationwide CBP data report total employment among establishments with at least 1000 employees, but not by establishment size group. To impute employment for these large establishments, we assume that employment follows a log normal distribution, with mean μ and standard deviation σ, and estimate (μ, σ) using the generalized method of moments (GMM), as in Holmes and Stevens (2002) and Stuart (2022). We estimate (μ, σ) using the following four moments:

$$p_1 = \Phi\left(\frac{\ln(1499) - \mu}{\sigma}\right) - \Phi\left(\frac{\ln(1000) - \mu}{\sigma}\right) \tag{A.1}$$

$$p_2 = \Phi\left(\frac{\ln(2499) - \mu}{\sigma}\right) - \Phi\left(\frac{\ln(1500) - \mu}{\sigma}\right) \tag{A.2}$$

$$p_3 = \Phi\left(\frac{\ln(4999) - \mu}{\sigma}\right) - \Phi\left(\frac{\ln(2500) - \mu}{\sigma}\right) \tag{A.3}$$

$$E[y] = \exp(\mu + \sigma^2/2), \tag{A.4}$$

where p_1 is the share of establishments of at least 1000 employees with 1000–1499 employees, p_2 is the share with 1500–2499 employees, p_3 is the share with 2500–4999 employees, $\Phi(\cdot)$ is the standard normal CDF, and $E[y]$ is average employment among establishments with at least 1000 employees.

We use equations (A.1)–(A.4) to estimate (μ, σ) with GMM, using the identity matrix as the weighting matrix. For years 1978, 1988, 1999, and 2006, the estimates of (μ, σ) are (7.50, 0.67), (7.49, 0.63), (7.50, 0.62), and (7.51, 0.67). We use 1999 parameters throughout for simplicity. Standard facts about the log-normal distribution imply that the imputed means for the four establishment size groups are (1249, 1950, 3373, 6679).[64]

For 1999 and 2006, we can compare the county-industry employment imputations from this procedure (normalized by overall county employment to make industry shares) with those from the Upjohn Institute's WholeData series (Bartik et al., 2019), which provides desuppressed employment counts in the NAICS period. The correlations are very high, in excess of 0.99, suggesting the imputation procedure is quite accurate.

A.4 Local Housing Price Data from the Federal Housing Finance Agency

To measure impacts on local housing prices in supplementary analyses, we draw upon Housing Price Index (HPI) data from the Federal Housing Finance Agency (FHFA; Federal Housing

[64]In particular, if $\ln(y) \sim \mathcal{N}(\mu, \sigma^2)$, then

$$E(y|a < y \leq b) = E(y)\frac{\Phi(\sigma - a_0) - \Phi(\sigma - b_0)}{\Phi(b_0) - \Phi(a_0)}, \quad a_0 \equiv (\ln a - \mu)/\sigma, \quad b_0 \equiv (\ln b - \mu)/\sigma$$

$$E(y|y > a) = E(y)\frac{\Phi(\sigma - a_0)}{\Phi(-a_0)}.$$

Finance Agency (1975–2019)).[65] These data use a repeat-sales methodology to show nominal changes in housing prices while controlling for composition. Developmental data are available for most counties at the annual level, with time series going back to the mid 1970s in many cases (Bogin, Doerner and Larson, 2019). No price data in dollars are provided; rather, each index is normalized to a base period that varies with the temporal avaialbility of each geography. We adjust the current county data to our standardized set of counties as in Appendix A.1. To aggregate into metro areas, we would ideally have the number of eligible units in each county and year. Unfortunately, such unit data are not available to our knowledge. Instead we use annual county population weights, from SEER when it is available and from BEA otherwise. In cases where a constituent county is missing HPI data for a given year, we treat it as ignorable, with the resulting metro area average reflecting the remaining constituent counties. Because this happens rarely for metro areas, especially for larger constituent counties, and HPIs are highly correlated in adjacent areas, any resulting bias should be minimal.

B Results Appendix

B.1 Robustness to Different Measures of Log Employment Changes

Our baseline specification uses the change in log total wage and salary employment from BEAR to measure recession severity. We believe this variable is best because the BEA makes considerable efforts to construct data that are consistent over time, although this is more difficult for the self-employed (whose employment can vary over time in response to tax incentives). The two leading alternatives are private wage and salary employment from BEAR and private wage and salary employment from QCEW.[66] Figure 11 shows that the estimated coefficients for employment, population, the employment-population ratio, and earnings per capita are quite similar when using these other measures to define recession severity. The similarity of the results is not surprising, as the public sector accounts for less than 25 percent of wage and salary employment on average, and BEAR data rely on QCEW data as an input. Still, it is reassuring that our results are not sensitive to this choice.

B.2 Results Using Predicted Log Employment Changes

We estimate equation (1) using OLS. A potential concern with this approach is that employment changes in local areas might stem from factors besides recessions, such as changes in labor supply. A common approach in the literature—much of which examines ten-year employment changes rather than business-cycle peak-to-troughs—is to instead use an instrumental variable that measures log employment changes predicted by a location's baseline industrial structure, following

[65] See `https://www.fhfa.gov/DataTools/Downloads/Pages/House-Price-Index-Datasets.aspx`.

[66] CBP data represent another alternative, although its coverage is not quite as complete as BEAR or QCEW; notably, CBP excludes most public-sector employment, as well as agricultural services, railroads, postal workers, and private households.

Bartik (1991). In our setting, the predicted log employment change for recession r is

$$b_i^r = \sum_j \eta_{i,j}^r (\ln(E_{j,t(r)}) - \ln(E_{j,p(r)})),$$

where $\eta_{i,j}^r$ is the share of employment in local area i in industry j in a base year, and the term in parentheses equals the nationwide log employment change in industry j from business cycle peak to trough. We construct employment shares, $\eta_{i,j}^r$, using CBP data (see Appendix A.3), generally for between 70–90 consistently available industries.[67] We construct the nationwide log employment change, $\ln(E_{j,t(r)}) - \ln(E_{j,p(r)})$, using QCEW data and the same year ranges of peak to trough as we use for the log employment change.[68]

Appendix Table 4 describes the relationship between the actual log employment change and the predicted log employment change. The first column includes no other controls. For every recession besides 1990–1991, the predicted log employment change explains 33–36 percent of the cross-metro variation in the actual log employment change. For 1990–1991, the predicted log employment change explains only 7 percent of the actual variation. Columns 2 and 3 add in division fixed effects and controls for lagged population growth. The coefficients—which are all positive, as expected—are reasonably stable across specifications, especially after 1973–1975 when greater industry-level detail is available. Moreover, the coefficient estimates remain highly statistically significant even with the additional controls.

Appendix Table 5 shows that predicted log employment changes are more highly correlated across time than actual log employment changes. This is not surprising, as the shift-share variable primarily reflects local industry employment shares, which are relatively stable. These high correlations raise the potential concern that the predicted log employment change might not isolate the impact of a recession, which is one reason why this approach is not our preferred one.

Appendix Figure 12 reports results in which we instrument for the actual log employment change in an area with the predicted log employment change, b_i^r. We focus on results that stack the five recessions we study into a single regression to increase precision and focus on central tendencies. The results are quite similar when using the variation in the log employment change that is predicted by the shift-share variable. The short-run impact from the shift-share variable is somewhat smaller (consistent with this variable not capturing some of the idiosyncratic shifts in labor demand that are reflected in the actual log employment change), but the estimates are nearly identical 9–12 years after the recession.[69] We conclude that our finding of a persistent post-

[67]For shares, we average the years 1972–1973, 1978–1979, 1988–1989, 1998–1999, and 2006–2007. The exact number of industries used depends on how many industries are consistently defined in the CBP data during each recession period. For the 1980–1982 and 1990–1991 recessions, we use 71 and 70 SIC industries, respectively. For the 2001 and 2007–2009 recessions, we use 83 and 87 industries, respectively. For the 1973–1975 recession, detailed industries are not available from CBP (or any other source at the county level to our knowledge), and we use the 10 industries provided.

[68]QCEW data have the advantage of being available at a quarterly frequency, which we could (but do not) use in constructing the predicted log employment change; our results are not sensitive to this choice. Because detailed county-by-industry employment counts in the QCEW are commonly suppressed, with less information with which to make imputations, we use the CBP to construct the pre-recession employment share.

[69]To explore whether the shift-share results are influenced by boom-bust dynamics in extractive industries, we estimated instrumental variable regressions that exclude metro areas with the top 5 or 10 percent highest shares of employment in the mining, quarrying, and oil and gas extraction industry. These estimates point to slightly larger declines in the employment-population ratio, but the results are fairly similar.

recession decline in local economic activity is not driven entirely by the idiosyncratic sources of variation included in our measure.[70]

B.3 The Post-Recession Evolution of Economic Activity in Commuting Zones

Our main approach defines local labor markets as metropolitan areas. Another reasonable approach is to use commuting zones, which span the entire (continental) United States, including rural areas. Appendix Figure 15 shows that results are very similar when using commuting zones (specifically, the 2000 definition).

B.4 Additional Results for the Comparison to VAR Models

Figure 7 shows that the BK VAR, estimated using state-level data from 1976–1990, implies complete recovery of the employment-population ratio within a decade of a decrease in local employment. This appendix describes results which show that differences in the sample, time period, and level of geography do not explain why we find a persistent decrease in the employment-population ratio while the prior literature estimating BK VARs finds evidence of complete recovery.

First, we use state-level data to show that the results of the BK VAR are similar when estimated on different years. The results are in Appendix Figure 22. Panel A presents estimates for the original BK years, 1976–1990. In Panel B, we use the same window length (15 years), shifted towards the end of the sample period. The BK sample begins four years before the start of the 1980–1982 recession, and we choose a later sample at a comparable point in the business cycle by selecting years 2003–2017 (i.e., 2003 is four years before the start of the 2007–2009 recession). The results are extremely similar, which indicates that the BK results are not driven by a focus on a specific time period. In Panel C, we use data from 1976–2019 to examine whether additional years of data change the results.[71] The results based on an extended number of years show recovery of the unemployment rate, participation rate, and employment-population ratio that is slower but still complete.[72] This pattern is consistent with the additional years of data reducing the finite sample bias that we document in Section 6.

Second, we show that the results of the BK VAR are similar when estimated using metro areas instead of states as the unit of geography. In particular, we estimate a version of the BK VAR where the dependent variable in the first equation is the change in log employment and the dependent variable in the second equation is the log employment-population ratio. We focus on this two-equation VAR because reliable measures of the number of individuals that are unemployed or in the labor force are not available for metro areas throughout our time period. Otherwise, we use the same lag structure as in the BK VAR.

We generate a comparison between the state and metro area results in several steps because the official LAUS data used by BK are not available for metro areas from 1976–1990. Panel A of Appendix Figure 23 reports results after replacing the Current Employment Statistics establishment-

[70] A limitation of these instrumental variable results is that they display considerably more variability across recessions, as shown for the log employment-population ratio in Appendix Figure 13.

[71] We begin in 1976 because LAUS data are not available before then. We use data up through 2019 in our analysis of recessions.

[72] Dao, Furceri and Loungani (2017) compare results from a version of the BK model estimated on data from 1976–1990 vs. 1976–2013, and they also find that recovery of these variables is slower but ultimately complete when using an extended number of years to estimate the vector autoregression.

level employment estimates used by BK with the analogous employment measure available in BEA data. The results are similar to those shown in Panel A of Figure 7, which demonstrates that changing the source of employment data does not change the conclusions of the model. In Panel B of Appendix Figure 23, we use estimates of the population ages 15 and above from the Census Bureau/SEER in place of BK's approach, which estimates population as the sum of establishment-level employment and survey measures of the number of individuals who are unemployed or not in the labor force. These estimates are similar, and they also imply complete recovery of the employment-population ratio within 7 years. Finally, Panel C uses the same underlying data as Panel B, but for metro areas. Estimates of the BK VAR on metro area data imply complete recovery of the employment-population ratio within 7–8 years. Our event study regressions, which use the same data as Panel C, find clear evidence of a persistent decline in the employment-population ratio. We conclude that the difference between our results and those in BK is not driven by the unit of geography.

Third, we show that event study results are comparable when using metro areas or states as the unit of geography. Appendix Figure 24 reports results from a stacked event study regression where the dependent variable is the log employment-population ratio. The state-level results reveal a persistent decrease in the employment-population ratio, although there is a bit more recovery for states and much less precision in the estimates. Nonetheless, the event study estimates point to much longer-lasting declines in the employment-population ratio than is implied by the BK VAR.

B.5 Back of Envelope Calculations on the Role for Productivity-Enhancing Reallocation

This appendix reports the results of simple calculations that assess whether recessions are likely to increase aggregate earnings per worker by reallocating employment to more productive areas. We refer to these calculations in the conclusion.

The change in aggregate earnings per worker due to recession-induced cross-area reallocation is

$$Y^C_{t+k} - Y_t = \sum_i (\theta^C_{i,t+k} - \theta_{i,t}) Y_{i,t}, \tag{A.5}$$

where Y_t is aggregate earnings per worker in pre-recession year t, and Y^C_{t+k} is the counterfactual level of earnings per worker in year $t + k$ reflecting recession-induced employment reallocation across local labor markets. These aggregate earnings per worker terms are defined as:

$$Y_t \coloneqq \sum_i \theta_{i,t} Y_{i,t} \tag{A.6}$$

$$Y^C_{t+k} \coloneqq \sum_i \theta^C_{i,t+k} Y_{i,t}, \tag{A.7}$$

where $Y_{i,t}$ is earnings per worker in metro i in year t, $\theta_{i,t} \equiv E_{i,t}/E_t$ is the employment share of metro i in year t, and $\theta^C_{i,t+k}$ is the counterfactual employment share in year $t + k$. We construct this counterfactual employment share as

$$\theta^C_{i,t+k} = \frac{E_{i,t} \times \exp(s_i \hat{\delta}_{t+k})}{\sum_j E_{j,t} \times \exp(s_j \hat{\delta}_{t+k})}. \tag{A.8}$$

The numerator of this expression is the pre-recession employment level multiplied by the percent change in employment predicted by recession severity from equation (1). Using only the employment change that is explained by recession severity ensures that we do not attribute secular changes (absorbed by our controls) to the recession.

Column 1 of Appendix Table 10 reports the unweighted standard deviation (SD) of the difference between the counterfactual employment share and the observed pre-recession employment share, $(\theta^C_{i,t+k} - \theta_{i,t})$. We construct this counterfactual 7–9 years after the business cycle trough, using the estimates in Panel A of Appendix Table 6. We set t as the recession start year. Column 2 reports the unweighted SD of the relative employment share difference, $(\theta^C_{i,t+k} - \theta_{i,t})/\theta_{i,t}$. There is a fair amount of reallocation, with the standard deviation ranging from 3.5 to 7.8 percent of baseline employment. Column 3 reports the nationwide average of mean annual earnings per worker in the recession start year, expressed in constant 2019 dollars. Column 4 reports the change in aggregate earnings per worker, $Y^C_{t+k} - Y_t$. In three out of five recessions, cross-area reallocation lowers earnings per worker. However, the aggregate changes are extremely small, ranging from a reduction of \$224 (1990–1991) to an increase of \$23 (1980–1982). This is underscored in column 5, which divides column 4 by column 3 and then multiplies by 100 to express percent changes. The largest change is only 0.3 percent of recession start year earnings per worker.

To shed further light on these results, Appendix Figure 26 displays the cross-metro correlations between the employment share change $(\theta^C_{i,t+k} - \theta_{i,t})$ and earnings per worker in the recession start year $(Y_{i,t})$. The marker symbols are proportional to the start year employment share. High-earning metropolitan areas regularly lose and gain employment. On average, there is no net shift towards higher or lower earning metropolitan areas, as seen in Table 10.

In sum, these calculations suggest that recessions do not meaningfully reallocate employment towards more productive metropolitan areas.

Appendix Table 1: Characteristics of Metropolitan Areas with More versus Less Severe Recessions, with p-values

	Recession									
	1973–75		1980–82		1990–91		2001		2007–09	
Pre-recession characteristic	Less Severe	More Severe	Less Severe	More Severe	Less Severe	More Severe	Less Severe	More Severe	Less Severe	More Severe
Manufacturing emp. share	0.141	0.254	0.140	0.236	0.131	0.179	0.096	0.163	0.082	0.110
p-value	*0.000*		*0.000*		*0.000*		*0.000*		*0.000*	
Mining emp. share	0.013	0.004	0.013	0.005	0.013	0.005	0.008	0.003	0.008	0.002
p-value	*0.000*		*0.002*		*0.000*		*0.004*		*0.000*	
Construction emp. share	0.052	0.051	0.058	0.051	0.055	0.053	0.059	0.056	0.060	0.067
p-value	*0.552*		*0.000*		*0.271*		*0.026*		*0.001*	
Finance, insurance, real estate emp. share	0.062	0.059	0.073	0.063	0.068	0.065	0.066	0.064	0.073	0.079
p-value	*0.308*		*0.000*		*0.133*		*0.381*		*0.008*	
Population (1000s)	333.1	595.4	552.9	430.6	329.8	768.2	531.6	732.4	618.7	744.7
p-value	*0.044*		*0.348*		*0.002*		*0.194*		*0.441*	
Log population growth	0.090	0.066	0.247	0.108	0.137	0.078	0.162	0.096	0.091	0.117
p-value	*0.002*		*0.000*		*0.000*		*0.000*		*0.012*	
Employment-population ratio	0.518	0.537	0.534	0.547	0.546	0.579	0.591	0.632	0.612	0.585
p-value	*0.008*		*0.063*		*0.000*		*0.000*		*0.002*	
Real earnings per capita (1000s)	19.7	21.0	21.5	23.2	23.5	26.4	28.3	32.7	34.1	33.5
p-value	*0.005*		*0.001*		*0.000*		*0.000*		*0.470*	
Share with BA degree or more	0.120	0.096	0.172	0.142	0.195	0.183	0.229	0.220	0.260	0.240
p-value	*0.000*		*0.000*		*0.065*		*0.203*		*0.012*	
Nonwhite share	0.145	0.133	0.209	0.122	0.189	0.188	0.257	0.203	0.274	0.277
p-value	*0.348*		*0.000*		*0.930*		*0.002*		*0.906*	
Foreign-born share	0.029	0.027	0.048	0.028	0.045	0.043	0.081	0.048	0.068	0.081
p-value	*0.565*		*0.000*		*0.728*		*0.000*		*0.071*	

Notes: See notes to Table 3 for variable definitions and data sources. This table also reports p-values from regression-based t-statistics (accounting for heteroskedasticity) of the difference in a given variable between areas experiencing a more vs. less severe recession.

Appendix Table 2: Metropolitan Area Correlates with Change in Log Employment During Recessions

	DV: Log employment change during indicated recession(s)					
	All	1973–75	1980–82	1990–91	2001	2007–09
	(1)	(2)	(3)	(4)	(5)	(6)
Coefficients for selected pre-recession covariates						
Industry employment shares						
Manufacturing share	−0.298	−0.399	−0.230	−0.276	−0.305	−0.400
	(0.057)	(0.136)	(0.105)	(0.092)	(0.086)	(0.128)
Mining share	0.116	0.136	0.231	0.009	0.113	0.024
	(0.023)	(0.043)	(0.061)	(0.056)	(0.041)	(0.033)
Construction share	−0.021	0.064	−0.002	0.057	−0.041	−0.141
	(0.027)	(0.056)	(0.045)	(0.053)	(0.051)	(0.060)
Finance, insurance, real estate share	−0.052	−0.167	−0.026	−0.061	0.115	−0.196
	(0.038)	(0.056)	(0.053)	(0.057)	(0.063)	(0.082)
Labor market and demographic characteristics						
Log population	0.001	−0.042	0.144	−0.129	−0.018	−0.050
	(0.032)	(0.051)	(0.045)	(0.058)	(0.072)	(0.069)
Employment-population ratio	0.067	−0.101	0.236	−0.116	0.083	−0.004
	(0.053)	(0.089)	(0.075)	(0.102)	(0.112)	(0.162)
Log real earnings per capita	−0.217	0.047	−0.351	−0.114	−0.318	0.064
	(0.064)	(0.111)	(0.091)	(0.123)	(0.150)	(0.171)
Share with BA degree or more	0.108	0.121	0.151	0.114	−0.199	−0.004
	(0.032)	(0.043)	(0.053)	(0.080)	(0.100)	(0.132)
Nonwhite Share	−0.002	0.001	0.090	0.009	−0.162	−0.014
	(0.036)	(0.068)	(0.060)	(0.066)	(0.073)	(0.086)
Foreign-born Share	−0.016	−0.034	0.071	−0.130	0.137	−0.220
	(0.034)	(0.059)	(0.056)	(0.073)	(0.088)	(0.082)
R-squared	0.519	0.610	0.687	0.624	0.579	0.561

Notes: Table reports results of regressing the key independent variable of the main analysis, the log employment change from business cycle peak to trough, on several metro-level characteristics measured prior to the beginning of each recession. Industry shares, log population, the employment-population ratio, and log real earnings per capita are measured two years prior to pre-recession start (1971, 1977, 1987, 1998, and 2005), while education, race, and foreign-born shares are measured as of the previous decadal census or ACS (1970, 1980, 1990, 2000, and 2005-2007). Besides covariates shown, each recession includes remaining industry shares (agriculture, wholesale trade, retail trade, and transportation & utilities), the share of individuals with a high school degree or some college, Census division fixed effects, and age-group-specific log population changes in the period prior to recession start. All covariates and outcomes are studentized for comparability. Estimates in column 1 come from stacking all recessions into a single regression and interacting division fixed effects and pre-recession population change variables with an indicator for each recession to mirror our main analysis. There are 358 metropolitan areas in the sample. Standard errors are clustered by metropolitan area in column 1 and robust to heteroskedasticity in columns 2–6.

Source: Authors' calculations using BEAR, SEER, decennial census, and ACS data.

Appendix Table 3: Metropolitan Area Correlates with Change in Bartik Shift-Share Instrument During Recessions

	DV: Predicted log employment change during indicated recession(s)					
	All (1)	1973–75 (2)	1980–82 (3)	1990–91 (4)	2001 (5)	2007–09 (6)
Coefficients for selected pre-recession covariates						
Industry employment shares						
Manufacturing share	−0.892	−1.013	−1.077	−1.034	−0.960	−1.007
	(0.046)	(0.063)	(0.095)	(0.106)	(0.077)	(0.067)
Mining share	0.037	0.238	0.082	−0.174	−0.009	−0.095
	(0.018)	(0.025)	(0.054)	(0.049)	(0.020)	(0.035)
Construction share	−0.063	−0.121	−0.062	−0.139	0.081	−0.199
	(0.025)	(0.025)	(0.045)	(0.066)	(0.037)	(0.052)
Finance, insurance, real estate share	−0.034	0.007	−0.030	−0.038	0.024	−0.245
	(0.024)	(0.031)	(0.041)	(0.039)	(0.039)	(0.056)
Labor market and demographic characteristics						
Log population	−0.034	0.045	0.017	−0.054	−0.115	−0.257
	(0.027)	(0.046)	(0.045)	(0.044)	(0.042)	(0.057)
Employment-population ratio	−0.027	0.095	0.098	−0.198	−0.147	−0.279
	(0.044)	(0.089)	(0.072)	(0.086)	(0.079)	(0.091)
Log real earnings per capita	0.057	0.022	0.085	0.246	0.199	0.241
	(0.053)	(0.104)	(0.096)	(0.097)	(0.085)	(0.108)
Share with BA degree or more	0.059	0.022	0.089	0.065	−0.144	0.097
	(0.028)	(0.023)	(0.045)	(0.072)	(0.089)	(0.107)
Nonwhite Share	−0.010	−0.115	0.004	−0.057	−0.004	0.062
	(0.029)	(0.041)	(0.050)	(0.062)	(0.056)	(0.070)
Foreign-born Share	0.050	0.096	0.067	−0.058	−0.056	−0.089
	(0.028)	(0.028)	(0.044)	(0.054)	(0.052)	(0.058)
R-squared	0.758	0.910	0.788	0.782	0.828	0.766

Notes: Table reports results of regressing the Bartik shift-share instrument on several metro-level characteristics measured prior to the beginning of each recession. Appendix B.2 describes the construction of the shift-share predicted log employment change variable. See notes to Table 2.
Source: Authors' calculations using BEAR, SEER, decennial census, and ACS data.

Appendix Table 4: Cross-Sectional Relationship between Metropolitan Area Log Employment Change and Predicted Log Employment Change

	Dependent variable: Log employment change during recession		
	(1)	(2)	(3)
Panel A: All Recessions			
Predicted log employment change	1.833	1.506	1.414
	(0.104)	(0.092)	(0.098)
R-squared	0.420	0.584	0.643
Panel B: 1973–1975 Recession			
Predicted log employment change	1.869	1.258	1.195
	(0.177)	(0.199)	(0.209)
R-squared	0.355	0.466	0.498
Panel C: 1980–1982 Recession			
Predicted log employment change	1.965	1.778	1.547
	(0.162)	(0.141)	(0.156)
R-squared	0.362	0.593	0.667
Panel D: 1990–1991 Recession			
Predicted log employment change	1.394	0.777	1.090
	(0.234)	(0.228)	(0.231)
R-squared	0.067	0.428	0.493
Panel E: 2001 Recession			
Predicted log employment change	1.533	1.270	1.273
	(0.116)	(0.135)	(0.139)
R-squared	0.346	0.410	0.540
Panel F: 2007–2009 Recession			
Predicted log employment change	1.799	1.537	1.608
	(0.174)	(0.193)	(0.205)
R-squared	0.332	0.456	0.515
Division fixed effects		x	x
Pre-recession population growth			x

Notes: Table reports estimates of regressing the log employment change during recessions against the predicted log employment change during recessions (Bartik, 1991). In Panel A, we interact division fixed effects and age-group-specific pre-recession population growth with indicators for each recession. There are 358 metropolitan areas in the sample. Standard errors in parentheses are clustered by metropolitan area in Panel A and robust to heteroskedasticity in Panel B.
Source: Authors' calculations using BEAR, CBP, QCEW, and SEER data.

Appendix Table 5: Correlation of Metropolitan Area Predicted Log Employment Changes

	Predicted Change in Log Employment During Recession Years				
	1973–75	1979–82	1989–91	2000–02	2007–09
Panel A: Unadjusted					
1973–75	1.000				
1979–82	0.813	1.000			
1990–91	0.722	0.724	1.000		
2001	0.721	0.696	0.809	1.000	
2007–09	0.473	0.525	0.724	0.667	1.000
Panel B: Adjusted for Census division					
1973–75	1.000				
1979–82	0.758	1.000			
1990–91	0.667	0.662	1.000		
2001	0.661	0.629	0.811	1.000	
2007–09	0.496	0.498	0.737	0.686	1.000
Panel C: Adjusted for Census division and pre-recession population growth					
1973–75	1.000				
1979–82	0.740	1.000			
1990–91	0.595	0.577	1.000		
2001	0.556	0.535	0.716	1.000	
2007–09	0.434	0.453	0.673	0.611	1.000

Notes: Table reports correlations of predicted log employment changes (Bartik, 1991) across recessions for 358 metropolitan areas. Panel B reports correlations after partialling out Census division fixed effects, and Panel C partials out Census division fixed effects and pre-recession population growth.
Source: Authors' calculations using BEAR, CBP, and QCEW data.

Appendix Table 6: Summary of Changes in Metropolitan Area Economic Activity, 7–9 Years After Business Cycle Trough, by Recession

	Recession				
	1973–75	1980–82	1990–91	2001	2007–09
Panel A: Dependent Variable: Log Employment					
Coefficient on log emp. decrease	−1.227	−0.935	−1.640	−1.529	−0.780
	(0.185)	(0.137)	(0.151)	(0.130)	(0.130)
Implied change after 1 SD log emp. decrease	−0.069	−0.074	−0.074	−0.053	−0.030
Panel B: Dependent Variable: Log Population Age 15+					
Coefficient on log emp. decrease	−0.642	−0.595	−0.634	−0.537	−0.378
	(0.118)	(0.078)	(0.127)	(0.100)	(0.068)
Implied change after 1 SD log emp. decrease	−0.036	−0.047	−0.029	−0.018	−0.015
Panel C: Dependent Variable: Log Employment-Population Ratio					
Coefficient on log emp. decrease	−0.585	−0.340	−1.006	−0.992	−0.402
	(0.099)	(0.110)	(0.120)	(0.131)	(0.104)
Implied change after 1 SD log emp. decrease	−0.033	−0.027	−0.046	−0.034	−0.016
Panel D: Dependent Variable: Log Earnings per Capita					
Coefficient on log emp. decrease	−0.760	−0.776	−1.060	−1.626	−0.764
	(0.114)	(0.167)	(0.148)	(0.225)	(0.177)
Implied change after 1 SD log emp. decrease	−0.042	−0.061	−0.048	−0.056	−0.030
Panel E: Dependent Variable: Log Earnings per Worker					
Coefficient on log emp. decrease	−0.176	−0.437	−0.054	−0.634	−0.363
	(0.068)	(0.073)	(0.105)	(0.137)	(0.108)
Implied change after 1 SD log emp. decrease	−0.010	−0.035	−0.002	−0.022	−0.014
SD of log employment change	0.056	0.079	0.045	0.034	0.039

Notes: Table reports estimates of equation (1), separately for each recession. The dependent variable is indicated in the panel title and constructed as the change relative to two years before the nationwide recession start. The key independent variable is the change in log wage and salary employment during the recession from BEAR data. We pool estimates for years 7–9 after business cycle trough. All regressions control for division-year fixed effects and interactions between pre-recession population growth and year indicators. There are 358 metropolitan areas in the sample. Standard errors are clustered by metropolitan area.

Source: Authors' calculations using BEAR and SEER data.

Appendix Table 7: Post-Recession Changes in Metropolitan Area Wage Earnings from the Census/ACS, by Recession

	Recession				
	1973–75	1980–82	1990–91	2001	2007–09
Panel A: Log Annual Earnings, Without Composition Adjustment					
Average log earnings	−0.345	−0.405	−0.219	−0.628	−0.467
	(0.116)	(0.093)	(0.121)	(0.099)	(0.125)
10th percentile, log earnings	−0.725	−0.521	−0.650	−1.201	−0.398
	(0.220)	(0.167)	(0.264)	(0.232)	(0.268)
50th percentile, log earnings	−0.274	−0.389	−0.093	−0.438	−0.580
	(0.124)	(0.097)	(0.110)	(0.096)	(0.126)
90th percentile, log earnings	−0.067	−0.255	−0.070	−0.404	−0.409
	(0.098)	(0.069)	(0.086)	(0.092)	(0.144)
Panel B: Weekly and Hourly Earnings					
Average log weekly earnings	−0.295	−0.395	−0.132	−0.488	−0.428
	(0.101)	(0.077)	(0.090)	(0.083)	(0.110)
Average log hourly earnings	−0.251	−0.355	−0.159	−0.376	−0.375
	(0.090)	(0.069)	(0.078)	(0.079)	(0.096)
Panel C: Log Annual Earnings, With Composition Adjustment					
Average log earnings	−0.312	−0.302	−0.200	−0.704	−0.379
	(0.100)	(0.079)	(0.102)	(0.082)	(0.118)
10th percentile, log earnings	−0.650	−0.278	−0.613	−1.335	−0.299
	(0.205)	(0.157)	(0.210)	(0.223)	(0.272)
50th percentile, log earnings	−0.270	−0.298	−0.132	−0.541	−0.376
	(0.085)	(0.074)	(0.088)	(0.067)	(0.100)
90th percentile, log earnings	−0.211	−0.245	−0.116	−0.508	−0.373
	(0.090)	(0.062)	(0.063)	(0.076)	(0.136)

Notes: Table reports estimates of separate regressions for each recession. The dependent variable is indicated in the row titles and constructed as the change between pre-recession and post-recession years (1970 to 1980, 1980 to 1990, 1990 to 2000, 2000 to 2005–2007, and 2005–2007 to 2015–2017). The key independent variable is the change in log wage and salary employment during the recession from BEAR data. The underlying sample is limited to individuals age 25–54 and then collapsed to 358 metropolitan areas. All regressions control for division-year fixed effects and pre-recession population growth. The dependent variables in Panel C are constructed using residuals from regressing log earnings on indicators for education, indicators for age, an indicator for sex, and indicators for race/ethnicity (white/black/Hispanic/other), plus interactions between the education indicators and a quartic in age. Standard errors are robust to heteroskedasticity.
Source: Authors' calculations using BEAR, decennial census, and ACS data.

Appendix Table 8: Changes in Metropolitan Area Economic Activity as Measured 7–9 Years After Business Cycle Trough and Using Census/ACS Years

Dependent variable	Coefficient on log employment decrease (1)	Implied change from 1 SD decrease in log employment (2)
Panel A: Effects on outcomes 7–9 years after trough (baseline approach)		
Log employment	−1.141	−0.066
	(0.072)	
Log population age 15+	−0.577	−0.033
	(0.049)	
Log employment-population ratio	−0.564	−0.033
	(0.056)	
Log earnings per capita	−0.893	−0.052
	(0.078)	
Log earnings per worker	−0.329	−0.019
	(0.039)	
Panel B: Effects on outcomes measured in same years as census/ACS outcomes (robustness check)		
Log employment	−1.010	−0.059
	(0.066)	
Log population age 15+	−0.508	−0.029
	(0.042)	
Log employment-population ratio	−0.501	−0.029
	(0.052)	
Log earnings per capita	−0.823	−0.048
	(0.070)	
Log earnings per worker	−0.322	−0.019
	(0.032)	

Notes: Table reports estimates of equation (1). Column 1 reports the point estimate and standard error, and column 2 contains the point estimate multiplied by the standard deviation of the log employment change during a recession (0.058). The dependent variable is indicated in the row. In Panel A, the dependent variable is constructed as the change relative to two years before the nationwide business cycle peak, and we report the pooled coefficient for years 7–9 after the business cycle trough. In Panel B, the dependent variable is constructed as the change between pre-recession and post-recession years that can be used in our analysis of census/ACS data (1969 to 1979, 1979 to 1989, 1989 to 1999, 1999 to 2004–2006, and 2004–2006 to 2014–2016). The key independent variable is the change in log wage and salary employment during the recession from BEAR data. All regressions control for division-year fixed effects and interactions between pre-recession population growth and year indicators. There are 358 metropolitan areas in the sample. Standard errors are clustered by metropolitan area.
Source: Authors' calculations using BEAR, SEER, decennial census, and ACS data.

Appendix Table 9: Bias in Vector Autoregression Parameters

	Parameter			
	$\tilde{\alpha}_{11}$	$\tilde{\alpha}_{12}$	$\tilde{\alpha}_{21}$	$\tilde{\alpha}_{22}$
Truth	0.000	0.000	0.750	1.000
Time series obs. (T)	Average estimate			
15	−0.038	−0.101	0.702	0.855
25	−0.022	−0.060	0.725	0.918
50	−0.010	−0.030	0.742	0.960
100	−0.004	−0.015	0.750	0.980
500	−0.001	−0.003	0.757	0.996
5000	0.000	0.000	0.763	1.000

Notes: Table displays true values and average estimates of parameters in equations (7)–(8) for the indicated number of time series observations (T). We simulate data following equations (12)–(14). We set $e_{i,0} \sim \mathcal{N}(13.88, 1.03^2)$, $p_{i,0} \sim \mathcal{N}(14.43, 1.05^2)$, $\varepsilon_{i,e,t} \sim \mathcal{N}(0, 0.015^2)$, $\varepsilon_{i,p,t} \sim \mathcal{N}(0, 0.015^2)$, $\phi = 0.75$, and $N = 50$. Results are based on 499 Monte Carlo simulations.

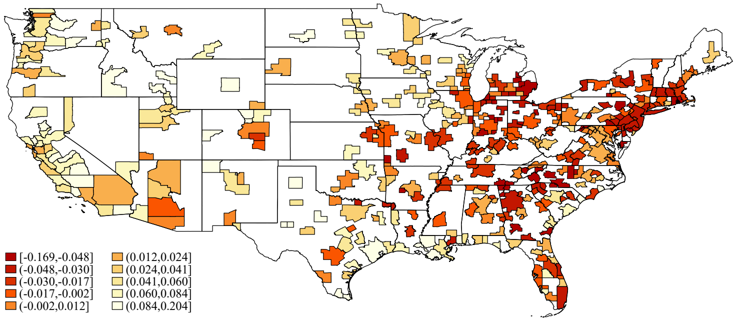
Appendix Table 10: Changes in Earnings per Worker due to Recession-Induced Reallocation

Recession	SD, emp. share change (1)	SD, rel. emp. share change (2)	Mean earnings per worker, peak year (3)	Change in mean earnings per worker (4)	Percent change in mean earnings per worker (× 100) (5)
1973–1975	0.00038	0.073	56,131	−12	−0.021
1980–1982	0.00035	0.078	56,425	23	0.041
1990–1991	0.00050	0.072	65,394	−225	−0.344
2001	0.00020	0.049	79,945	−71	−0.089
2007–2009	0.00017	0.035	88,751	3	0.003

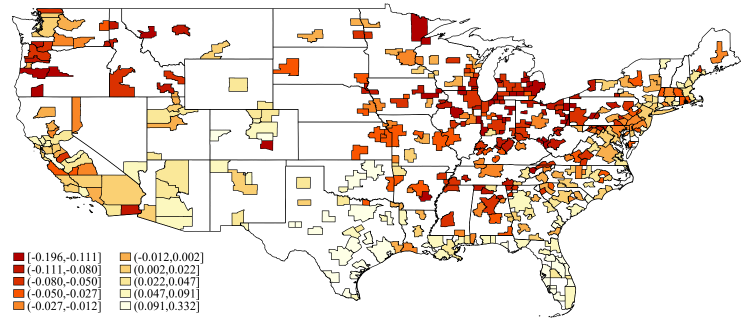
Notes: Column 1 reports the unweighted standard deviation of the difference between the counterfactual employment share (reflecting recession-induced employment reallocation) and the observed pre-recession employment share, $(\theta^C_{i,t+k} - \theta_{i,t})$. We construct this counterfactual 7–9 years after the business cycle trough, using the estimates in Panel A of Table 6. Column 2 reports the unweighted SD of the relative employment share change, $(\theta^C_{i,t+k} - \theta_{i,t})/\theta_{i,t}$. Column 3 reports the mean earnings per worker in the pre-recession business cycle peak year. Column 4 reports the change in aggregate earnings per worker, $Y^C_{t+k} - Y_t = \sum_i (\theta^C_{i,t+k} - \theta_{i,t}) Y_{i,t}$. Column 5 divides column 4 by column 3 and then multiplies by 100 to express percent changes.
Source: Authors' calculations using BEAR, decennial census, and ACS data.

Appendix Figure 1: Log Employment Changes During Recessions in Metropolitan Areas

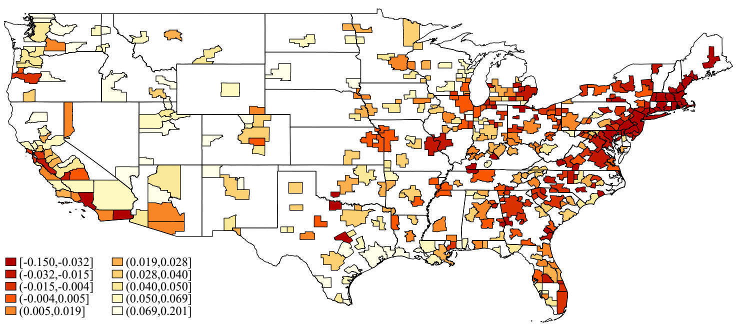
(a) 1973–1975 Recession



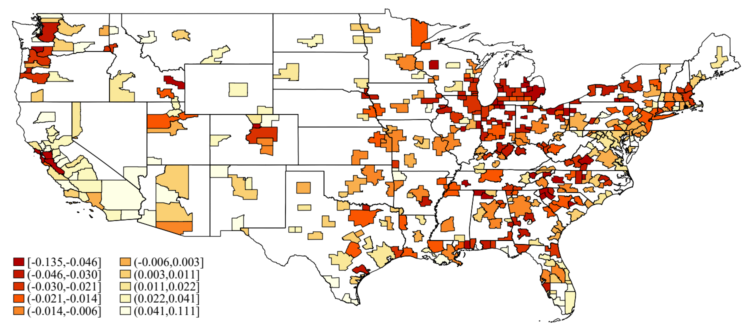
(b) 1980–1982 Recession



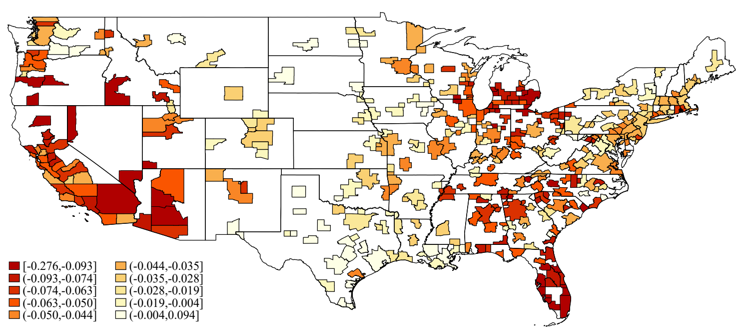
(c) 1990–1991 Recession



(d) 2001 Recession



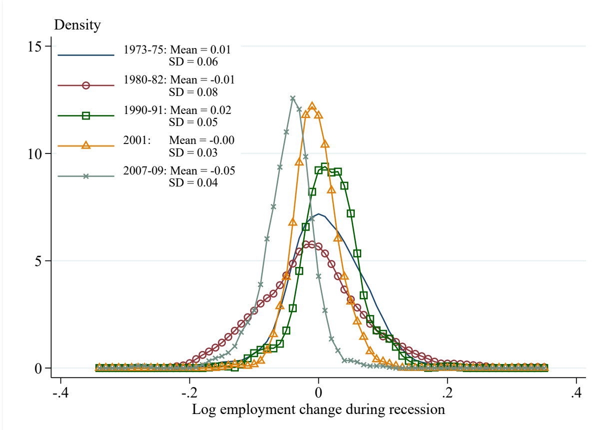
(e) 2007–2009 Recession



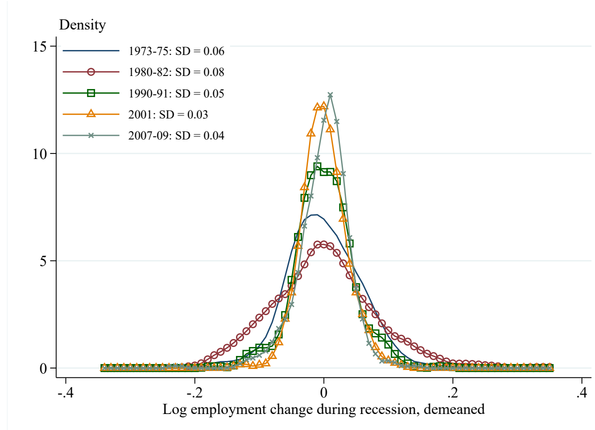
Notes: Each map shows the change in log employment from nationwide business cycle peak to trough for 358 metropolitan areas as described in the text. Each color group represents a decile of the recession-specific log employment change, with darker colors indicating larger employment losses.
Source: Authors' calculations from BEAR.

Appendix Figure 2: Density of Log Employment Changes and Predicted Log Employment Changes During Recessions Across Metropolitan Areas

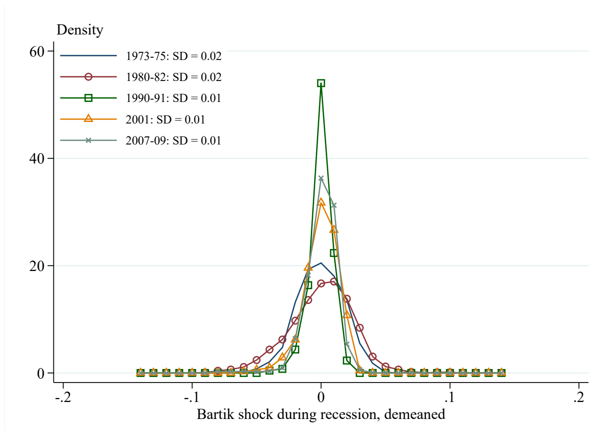
(a) Log Employment Change



(b) Log Employment Change, Demeaned

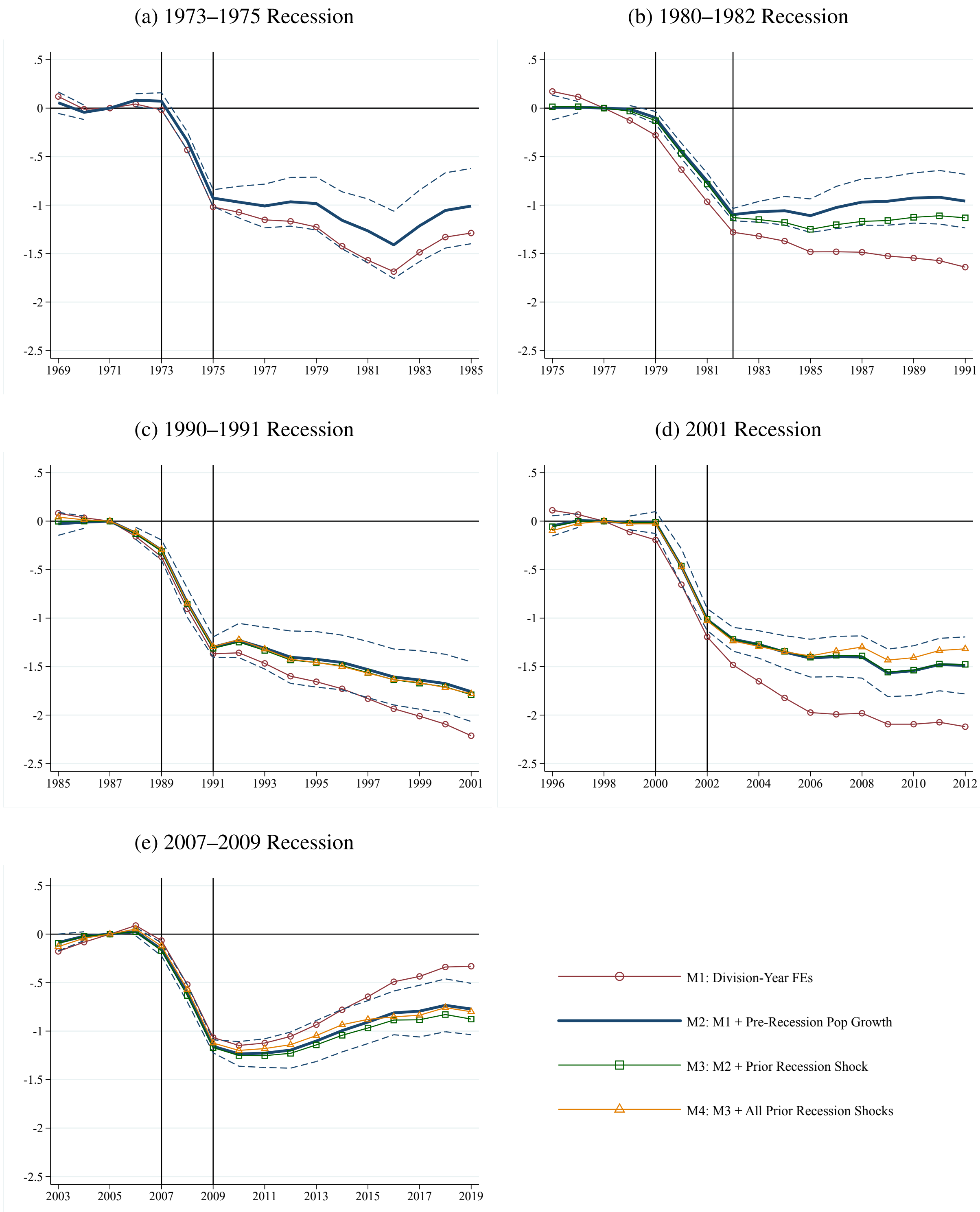


(c) Predicted Log Employment Change, Demeaned



Notes: Figure shows estimated kernel densities of the log wage and salary employment change (Panels A and B) and predicted log employment change based on pre-recession industrial structure (as in Bartik (1991); Panel C) across metros for each of the five recessions between 1973–1975 and 2007–2009. In Panels B and C, log employment changes are demeaned for each recession using the unweighted average across metros. There are 358 metropolitan areas in the sample.
Source: Authors' calculations from BEAR, CBP, and QCEW data.

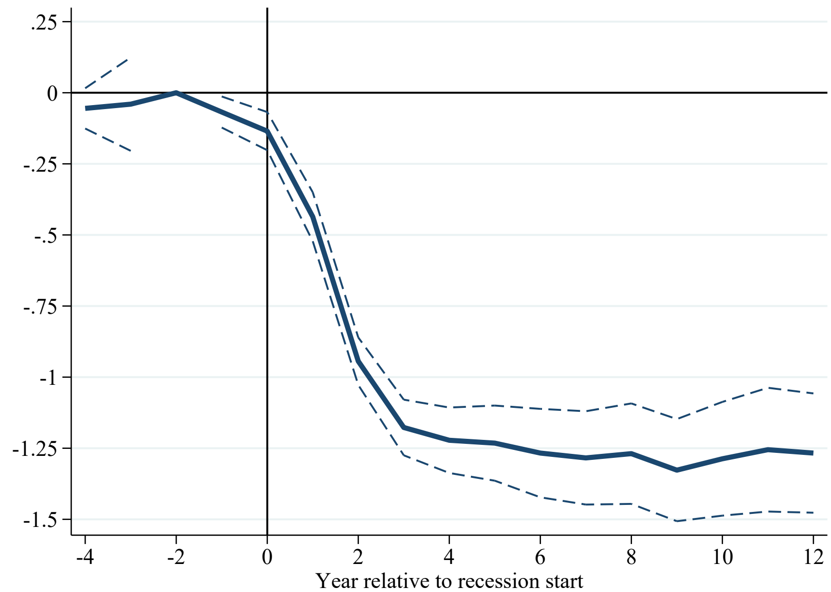
Appendix Figure 3: The Evolution of Metropolitan Area Log Employment, by Recession



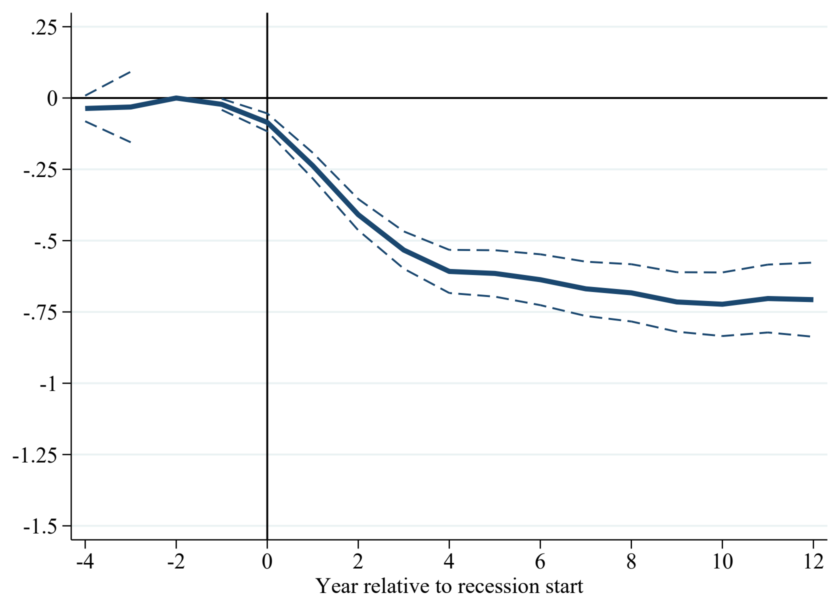
Notes: Figure reports estimates of equation (1), separately for each recession. The dependent variable is log wage and salary employment from BEAR data, and the key independent variable is the change in log wage and salary employment during the recession from BEAR data. Specifications are indicated by the legend. There are 358 metropolitan areas in the sample. Standard errors are clustered by metropolitan area.
Source: Authors' calculations using BEAR and SEER data.

Appendix Figure 4: The Evolution of Metropolitan Area Log Employment and Establishments from County Business Patterns, by Recession

(a) Log Employment



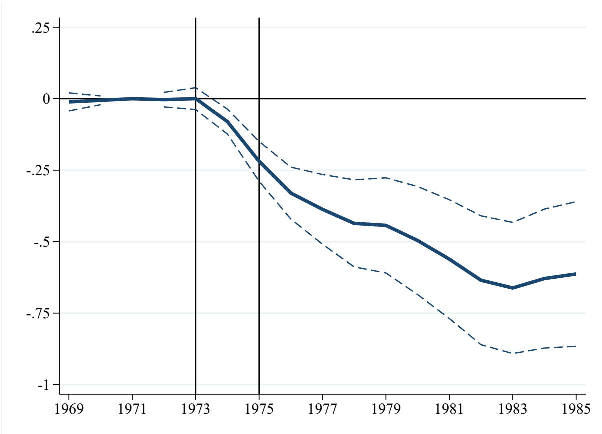
(b) Log Establishments



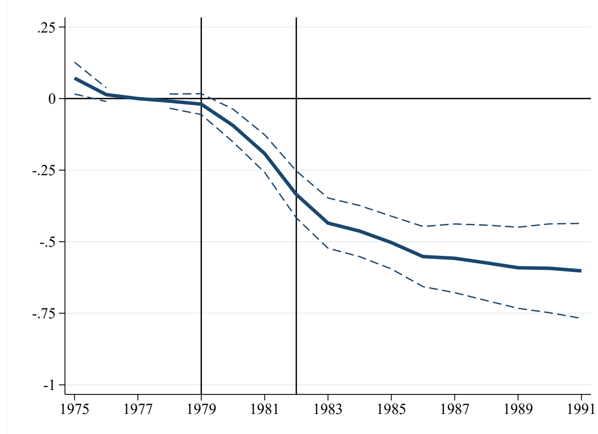
Notes: Figure reports estimates of equation (1). The dependent variable in Panel A is log employment, and the dependent variable in Panel B is the log number of establishments. Both come from CBP data. See notes to Figure 3. Source: Authors' calculations using CBP, BEAR, and SEER data.

Appendix Figure 5: The Evolution of Metropolitan Area Log Population, by Recession

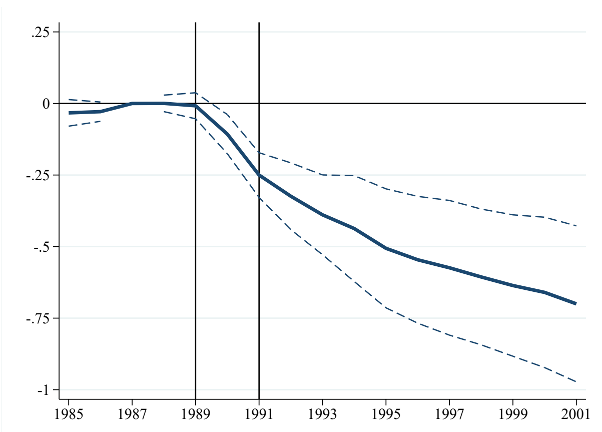
(a) 1973–1975 Recession



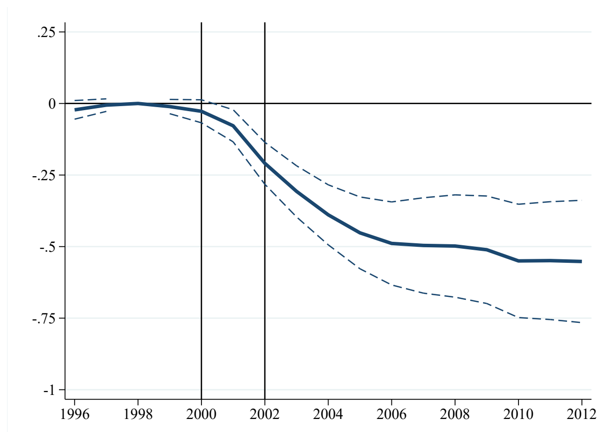
(b) 1980–1982 Recession



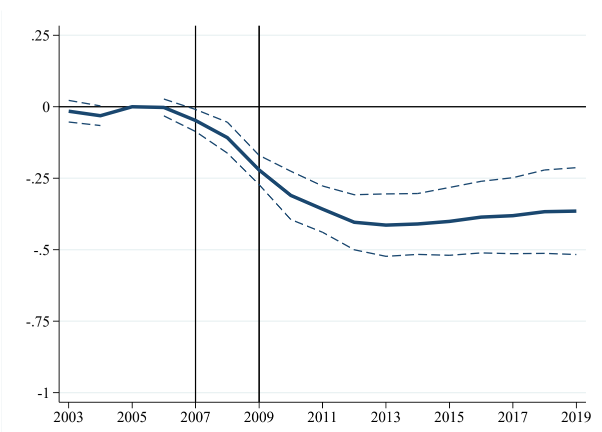
(c) 1990–1991 Recession



(d) 2001 Recession



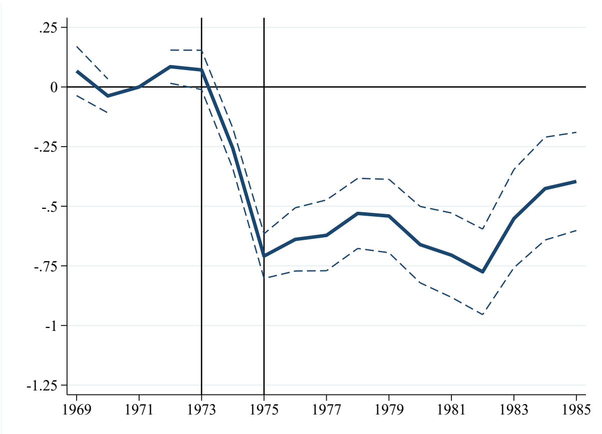
(e) 2007–2009 Recession



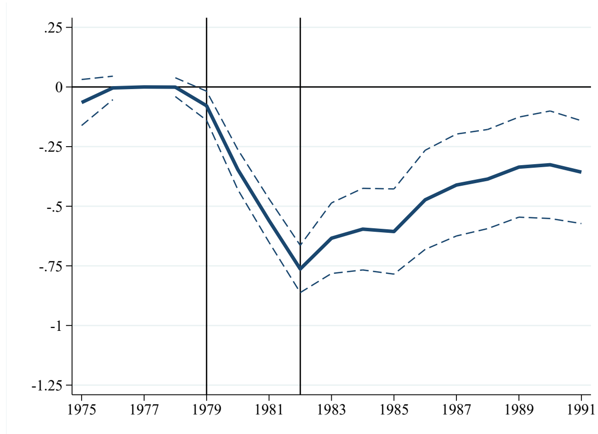
Notes: Figure reports estimates of equation (1), separately for each recession. The dependent variable is log population age 15 and above. See notes to Figure 3.
Source: Authors' calculations using BEAR and SEER data.

Appendix Figure 6: The Evolution of the Metropolitan Area Log Employment-Population Ratio, by Recession

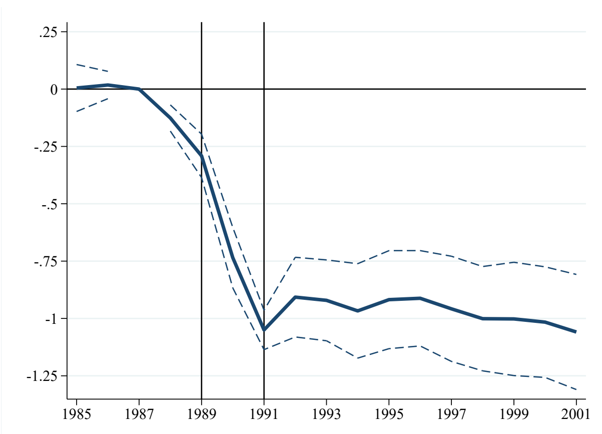
(a) 1973–1975 Recession



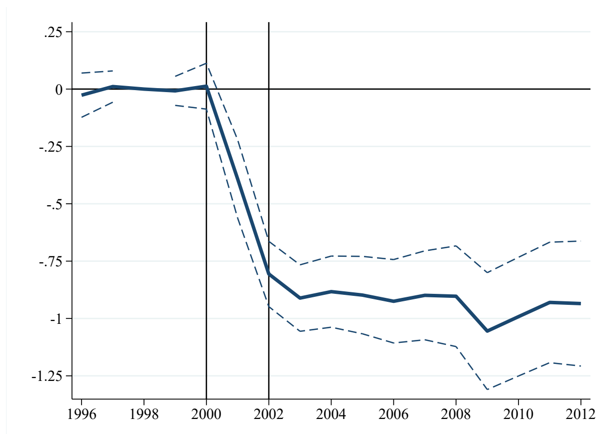
(b) 1980–1982 Recession



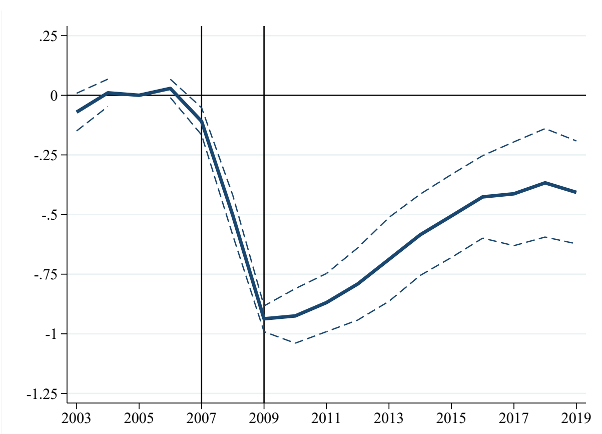
(c) 1990–1991 Recession



(d) 2001 Recession



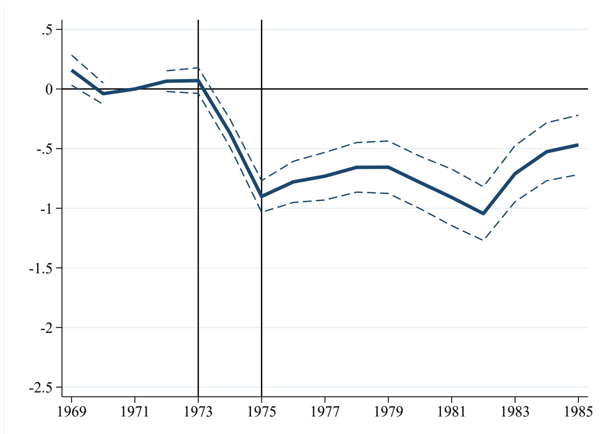
(e) 2007–2009 Recession



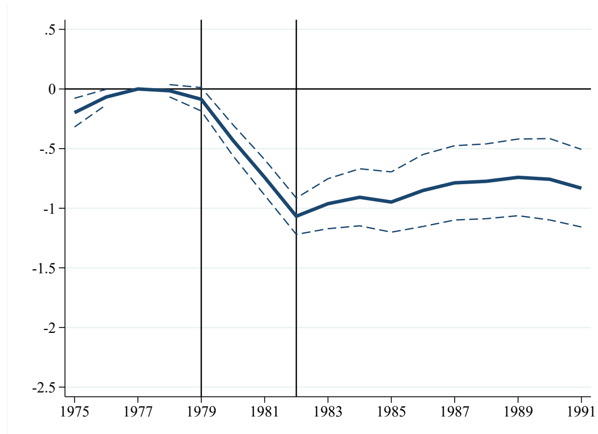
Notes: Figure reports estimates of equation (1), separately for each recession. The dependent variable is the log ratio of wage and salary employment to population age 15 and above. See notes to Figure 3.
Source: Authors' calculations using BEAR and SEER data.

Appendix Figure 7: The Evolution of Metropolitan Area Log Real Earnings per Capita, by Recession

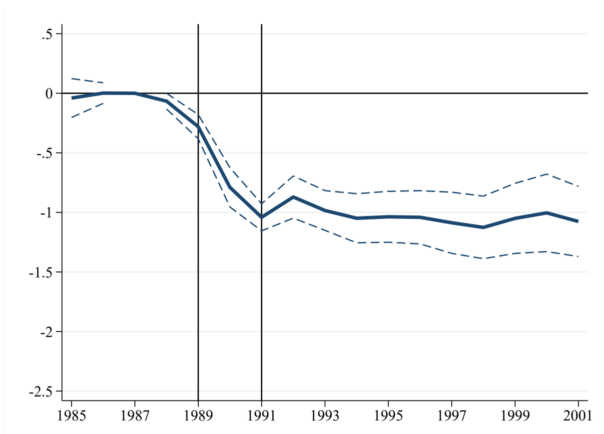
(a) 1973–1975 Recession



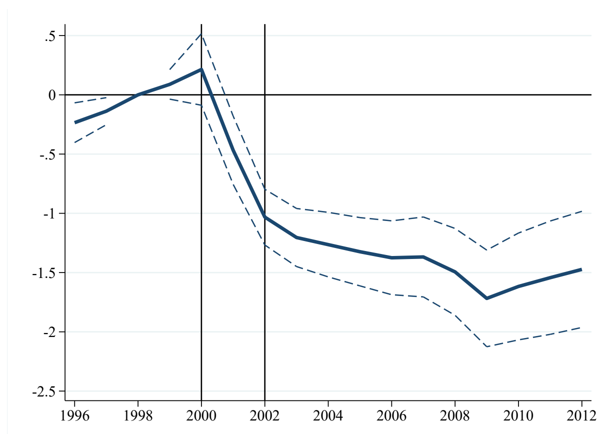
(b) 1980–1982 Recession



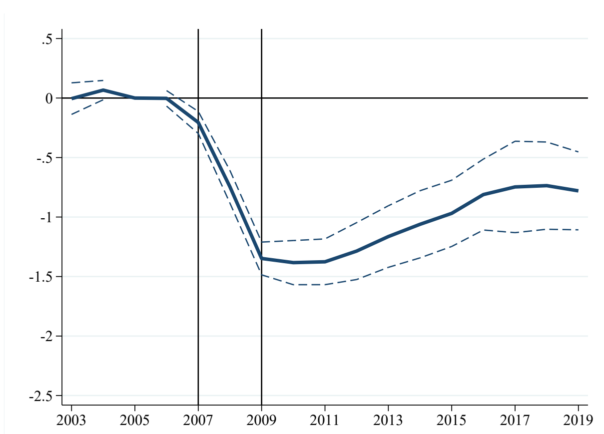
(c) 1990–1991 Recession



(d) 2001 Recession

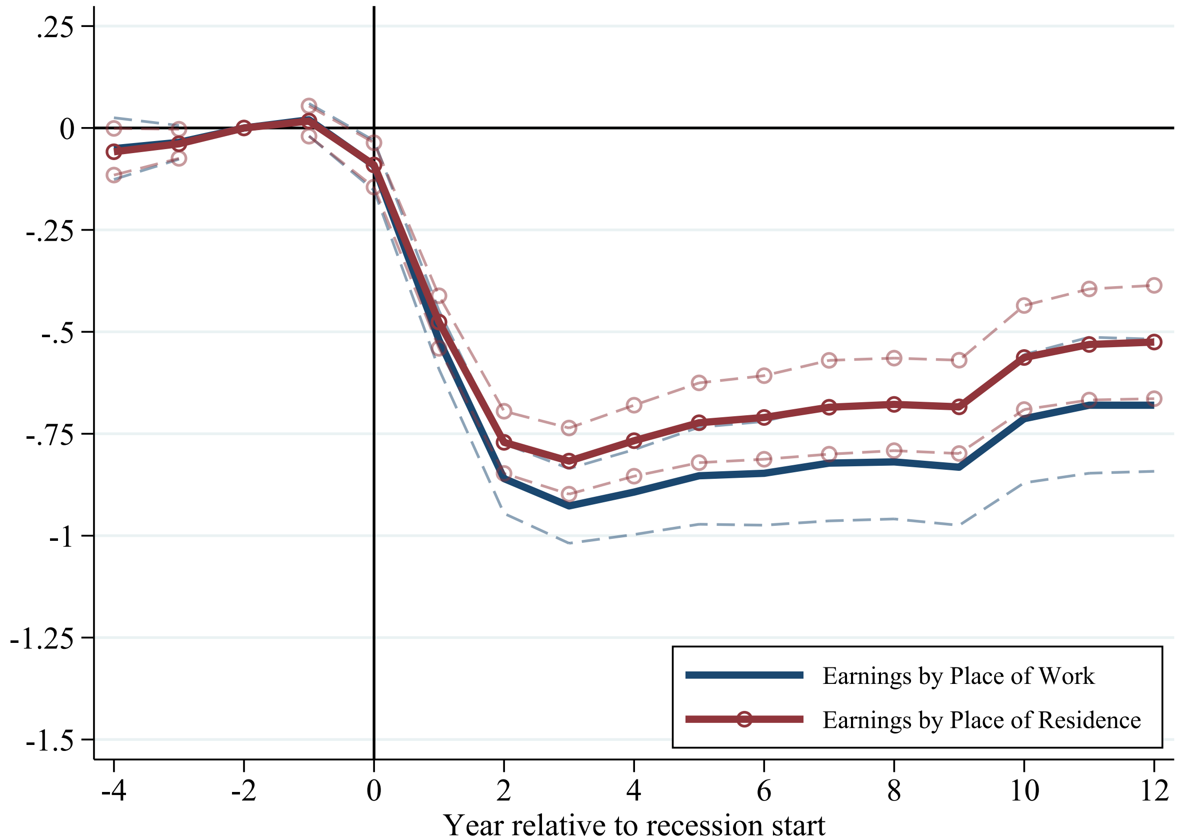


(e) 2007–2009 Recession



Notes: Figure reports estimates of equation (1), separately for each recession. The dependent variable is log real earnings per capita (age 15+). See notes to Figure 3.
Source: Authors' calculations using BEAR and SEER data.

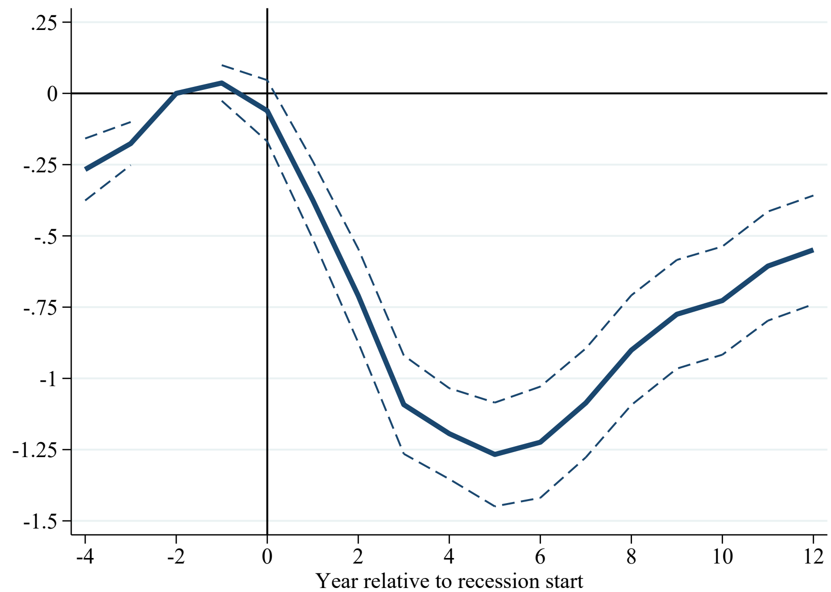
Appendix Figure 8: The Evolution of Metropolitan Area Log Real Earnings Per Capita, Robustness to Different Earnings Measures



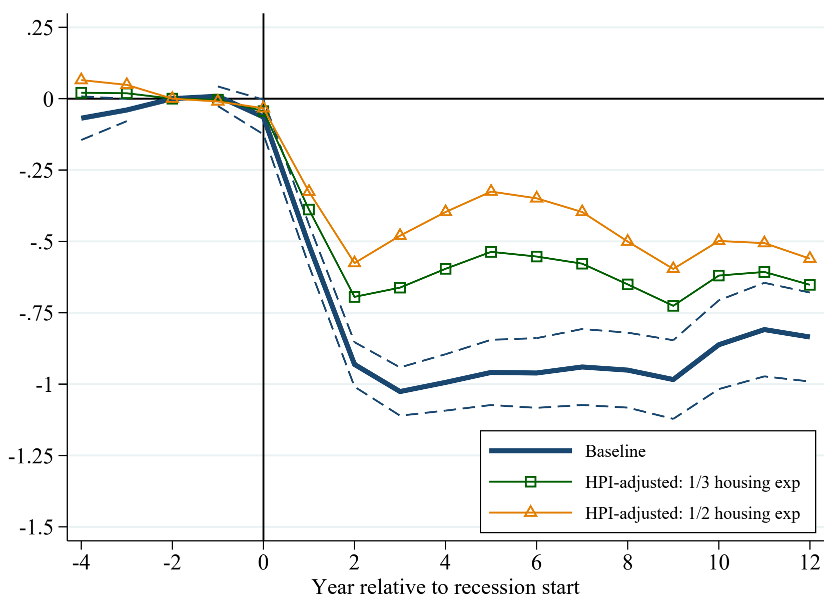
Notes: Figure reports estimates of equation (1). The dependent variables are log real earnings per capita (age 15+), either by place of work or place of residence, as indicated in the legend. The denominator of population is the same, but the numerator is different. Because proprietors' income cannot be separated from earnings by place of residence, both earnings measures include proprietors' income; this is distinct from the earnings measure in Panel C of Figure 4, which excludes proprietors' income. There are 358 metropolitan areas in the sample.
Source: Authors' calculations using BEAR and SEER data.

Appendix Figure 9: The Evolution of Metropolitan Area Log Housing Prices and Price-Adjusted Log Earnings per Capita After Recessions

(a) Log Housing Price Index



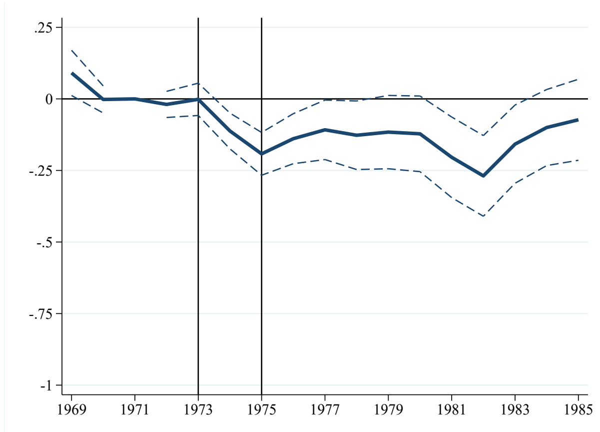
(b) Log Earnings per Capita, Without and With Price Adjustments



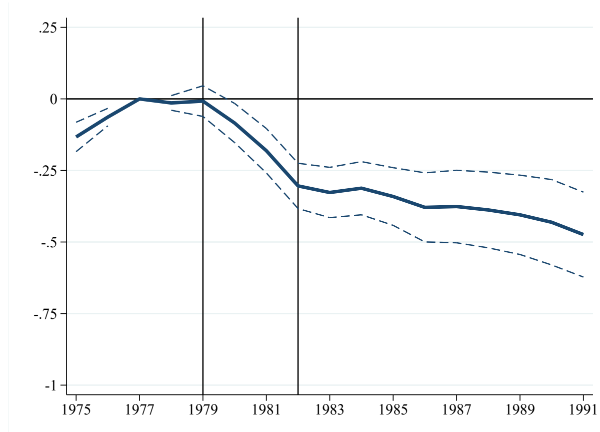
Notes: Figure reports estimates of equation (1). The dependent variable in panel A is the log of the Federal Housing Finance Agency Housing Price Index. Panel C repeats the baseline estimates of log earnings per capita as in Panel C of Figure 4 alongside estimates adjusted for the price changes from panel A under two scenarios: housing representing one-third of expenditures and housing representing one-half of expenditures.
Source: Authors' calculations using FHFA, BEAR, and SEER data.

Appendix Figure 10: The Evolution of Metropolitan Area Log Real Earnings per Worker, by Recession

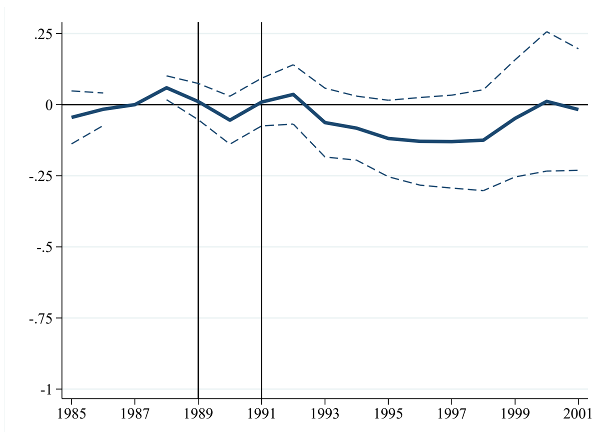
(a) 1973–1975 Recession



(b) 1980–1982 Recession

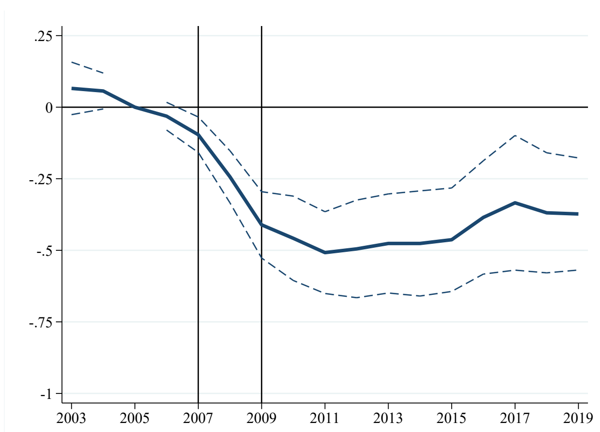


(c) 1990–1991 Recession



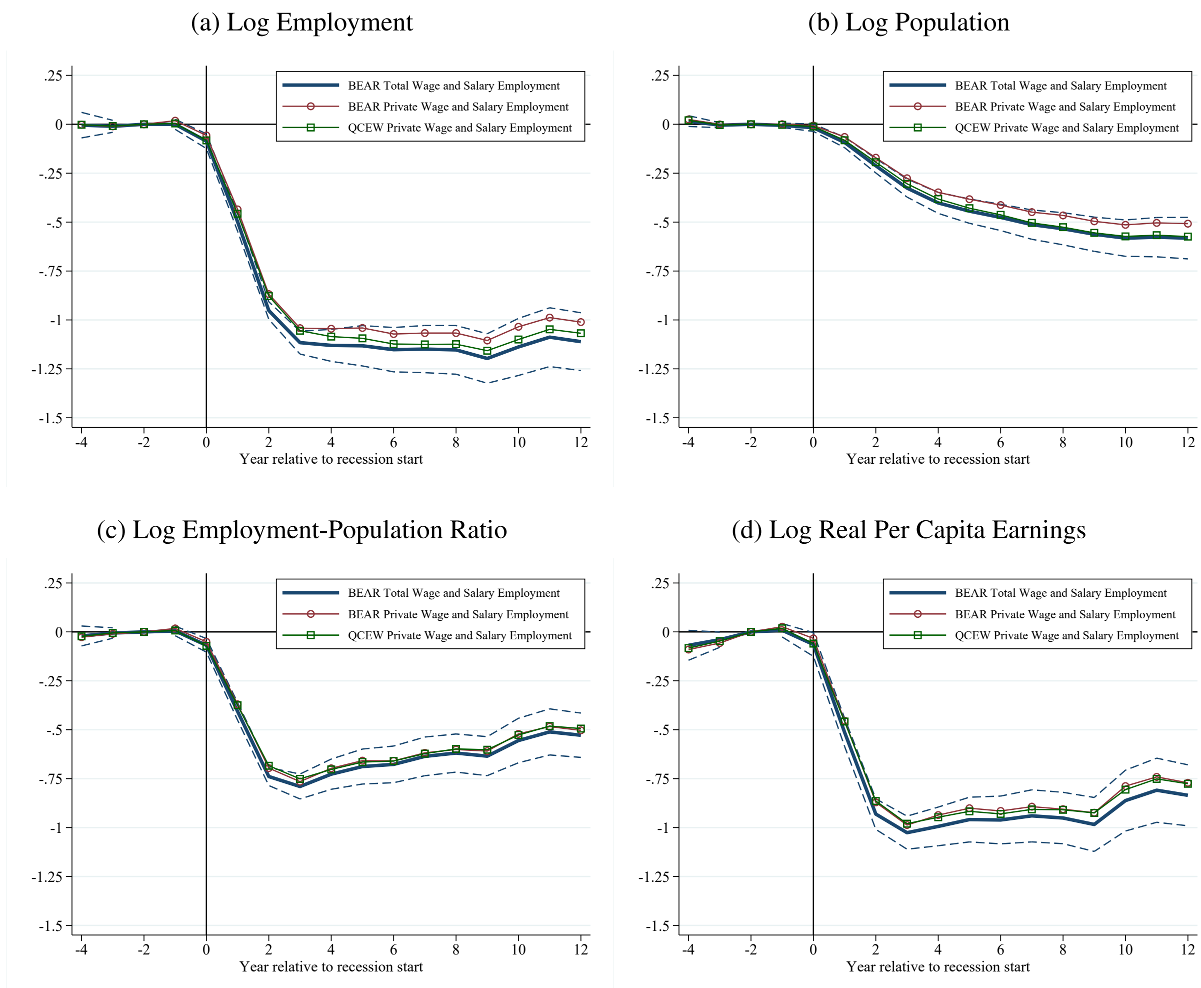
(d) 2001 Recession

(e) 2007–2009 Recession



Notes: Figure reports estimates of equation (1), separately for each recession. The dependent variable is log real earnings per wage and salary worker. See notes to Figure 3.
Source: Authors' calculations using BEAR and SEER data.

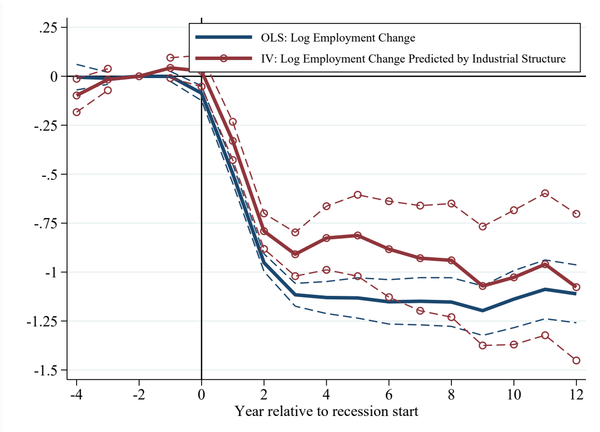
Appendix Figure 11: The Evolution of Metropolitan Area Labor Market Outcomes After Recessions, Robustness to Different Log Employment Change Measures



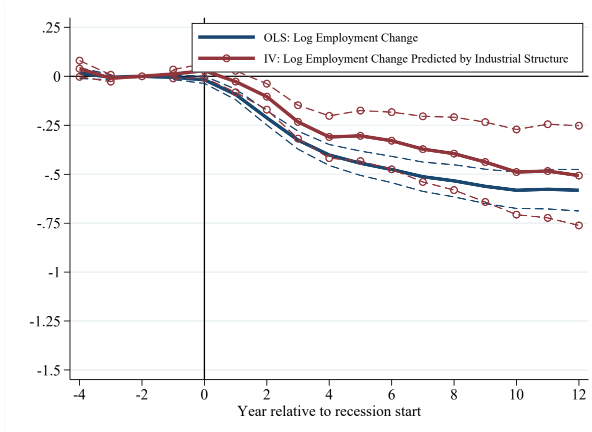
Notes: Figure reports estimates of equation (1). The dependent variable is log wage and salary employment in Panel A, log population age 15 and above in Panel B, the log ratio of wage and salary employment to population age 15 and above in Panel C, and log real earnings per capita (age 15+) in Panel D. The key independent variable is indicated in the legend. For independent variables besides BEA total wage/salary employment, we normalize the coefficients by multiplying point estimates by the ratio of the standard deviation of the independent variable to the standard deviation of the BEA wage/salary log employment change. The QCEW log employment change is not available for the 1973–1975 recession, and we use the BEA total wage/salary log employment change as the key explanatory variable for this recession to ensure that all estimates are based on all recessions. There are 358 metropolitan areas in the sample. Standard errors are clustered by metropolitan area. See notes to Figure 4.
Source: Authors' calculations using BEAR, QCEW, and SEER data.

Appendix Figure 12: The Evolution of Metropolitan Area Labor Market Outcomes After Recessions, Robustness to Using Instrumental Variable Based on Pre-Existing Industrial Structure

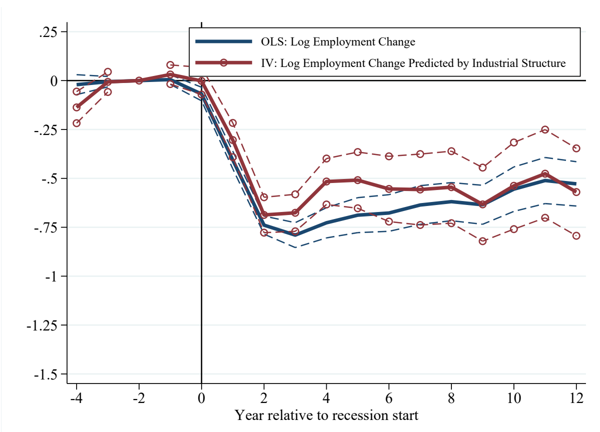
(a) Log Employment



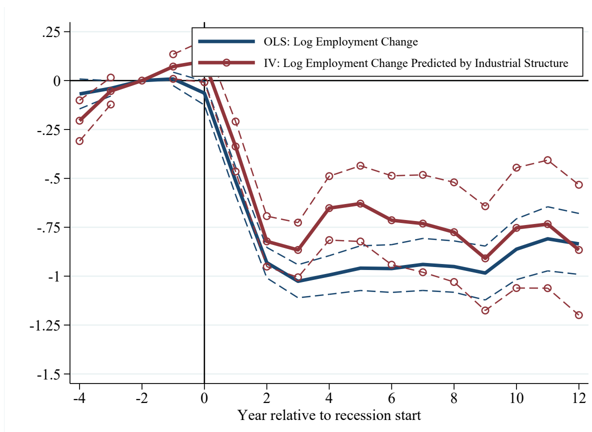
(b) Log Population



(c) Log Employment-Population Ratio



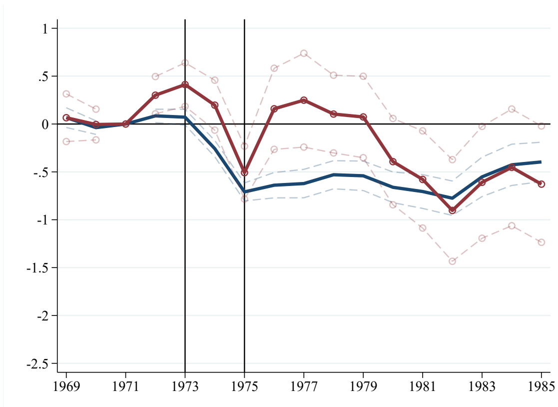
(d) Log Real Per Capita Earnings



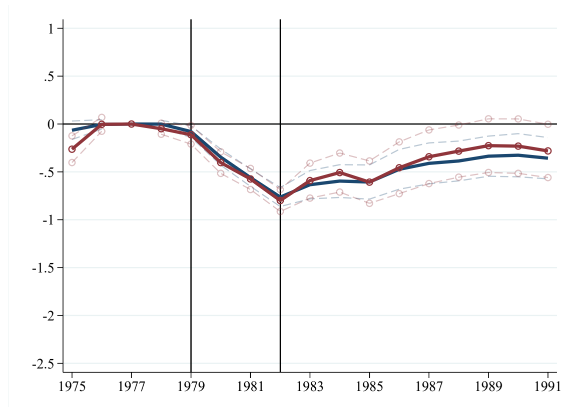
Notes: Figure reports estimates of equation (1). The dependent variable is log wage and salary employment in Panel A, log population age 15 and above in Panel B, the log ratio of wage and salary employment to population age 15 and above in Panel C, and log real earnings per capita (age 15+) in Panel D. The key independent variable is the change in log wage and salary employment during the recession from BEAR data. The estimates in red circles are based on using the log employment change during the recession predicted by pre-existing industrial employment shares and nationwide log employment changes during the recession (Bartik, 1991) as an instrumental variable. There are 358 metropolitan areas in the sample. Standard errors are clustered by metropolitan area. See notes to Figure 4.
Source: Authors' calculations using BEAR and SEER data.

Appendix Figure 13: The Evolution of the Metropolitan Area Log Employment-Population Ratio After Recessions, Robustness to Using Instrumental Variable Based on Pre-Existing Industrial Structure, by Recession

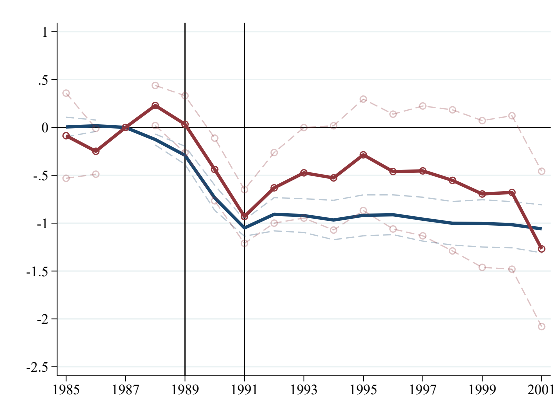
(a) 1973–1975 Recession



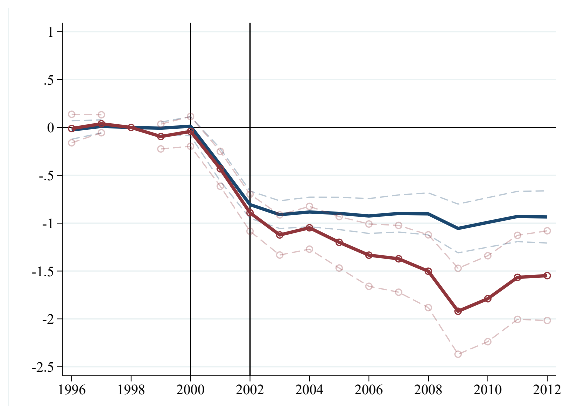
(b) 1980–1982 Recession



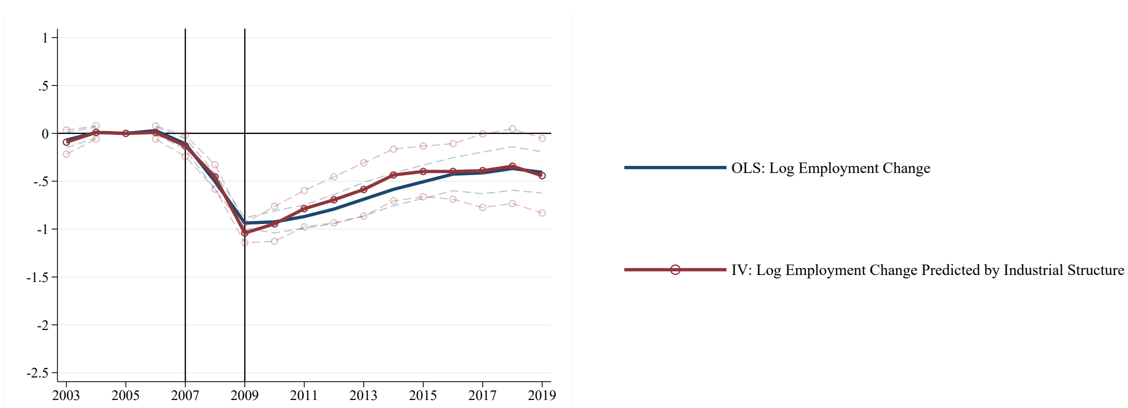
(c) 1990–1991 Recession



(d) 2001 Recession



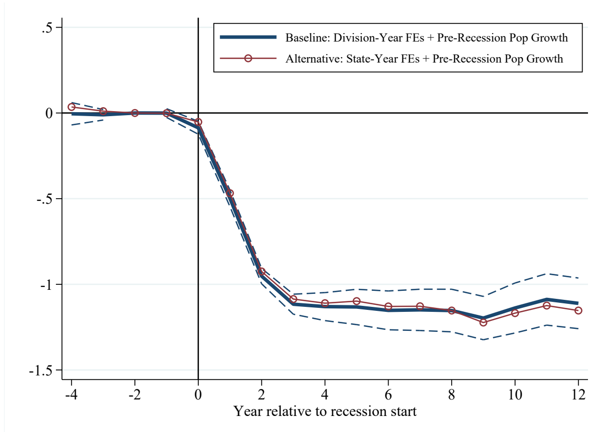
(e) 2007–2009 Recession



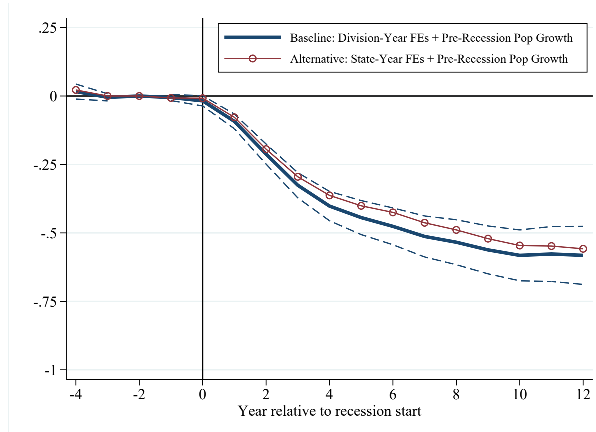
Notes: Figure reports estimates of equation (1), separately for each recession. The dependent variable is log wage and salary employment in Panel A, log population age 15 and above in Panel B, the log ratio of wage and salary employment to population age 15 and above in Panel C, and log real earnings per capita (age 15+) in Panel D. The key independent variable is the change in log wage and salary employment during the recession from BEAR data. The estimates in red circles are based on using the log employment change during the recession predicted by pre-existing industrial employment shares and nationwide log employment changes during the recession (Bartik, 1991) as an instrumental variable. There are 358 metropolitan areas in the sample. Standard errors are clustered by metropolitan area. See notes to Figure 4.
Source: Authors' calculations using BEAR and SEER data.

Appendix Figure 14: The Evolution of Metropolitan Area Labor Market Outcomes After Recessions, Robustness to Controlling for State-Year Fixed Effects

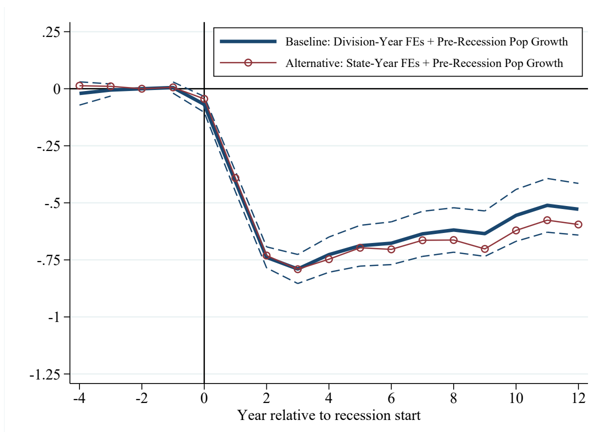
(a) Log Employment



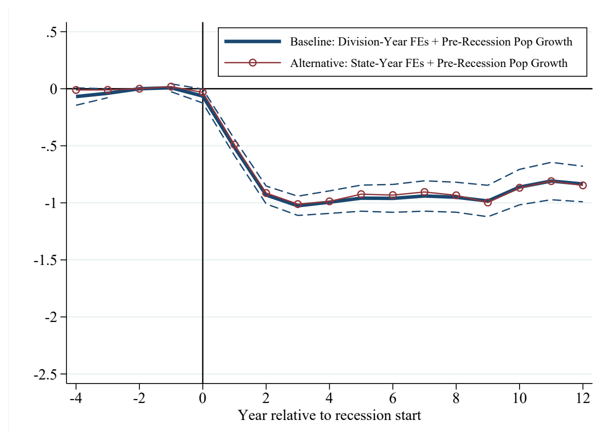
(b) Log Population



(c) Log Employment-Population Ratio

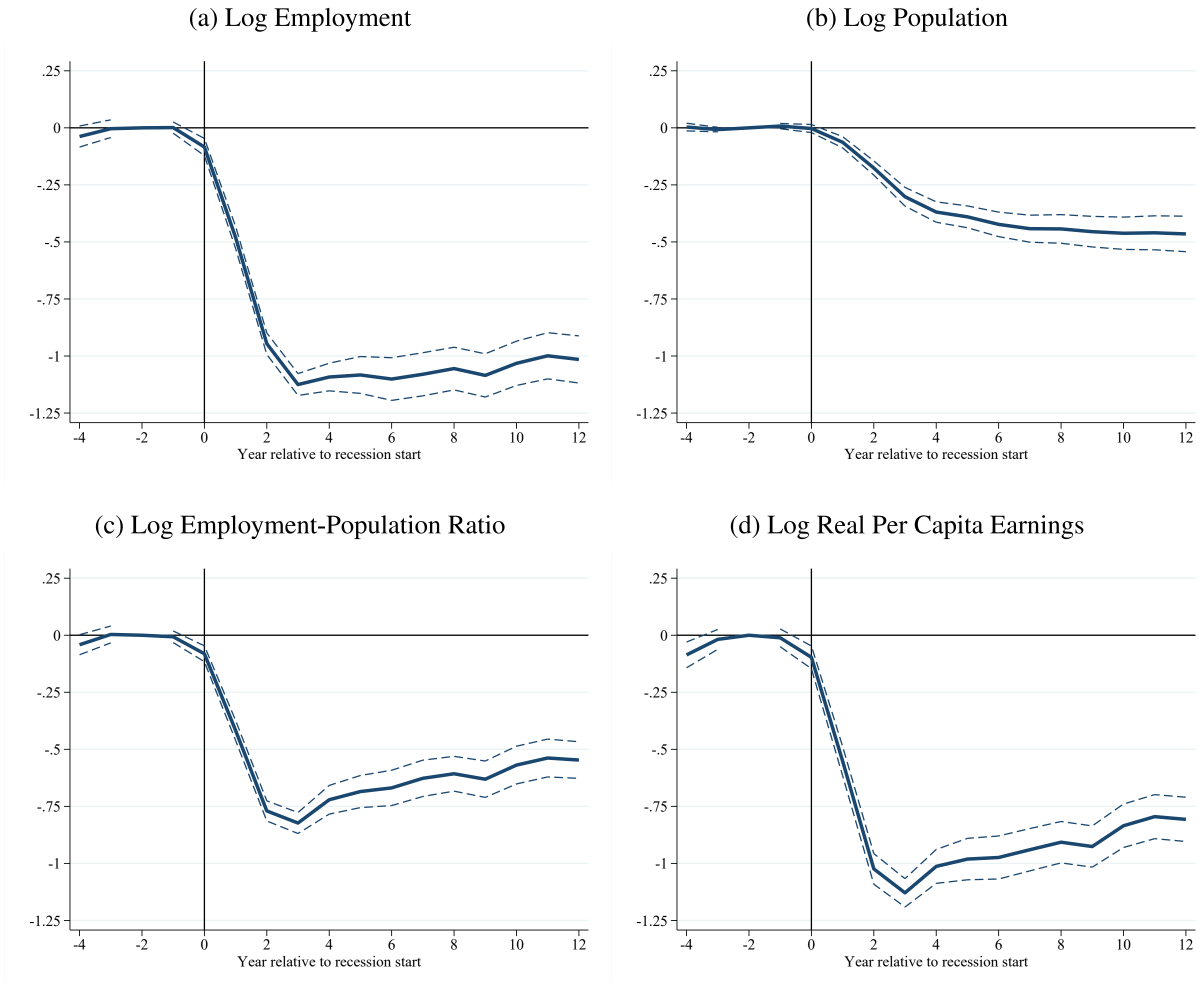


(d) Log Real Per Capita Earnings



Notes: Figure reports estimates of equation (1). The dependent variable is log wage and salary employment in Panel A, log population age 15 and above in Panel B, the log ratio of wage and salary employment to population age 15 and above in Panel C, and log real earnings per capita (age 15+) in Panel D. The key independent variable is the change in log wage and salary employment during the recession from BEAR data. The estimates in the blue, solid line come from our baseline specification, which includes division-by-year fixed effects and controls for pre-recession population growth. The estimates in the red line (circle markers) come from a specification that replaces the division-year fixed effects with state-year fixed effects to control for changes over time in policies and other confounding factors at the state-level. For metro areas that lie in multiple states, we use the state holding the largest share of each metro's population in the year 2000.
Source: Authors' calculations using BEAR and SEER data.

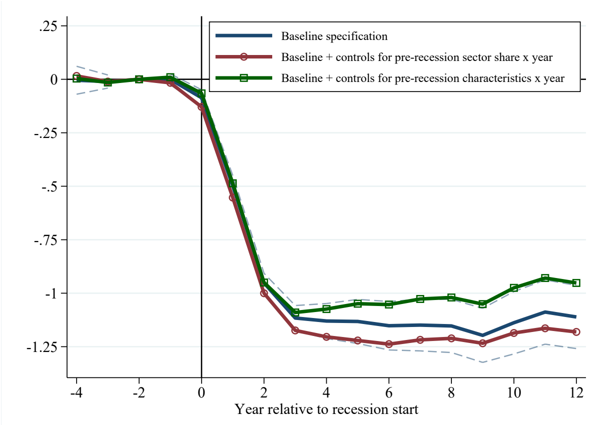
Appendix Figure 15: The Evolution of Commuting Zone Labor Market Outcomes After Recessions



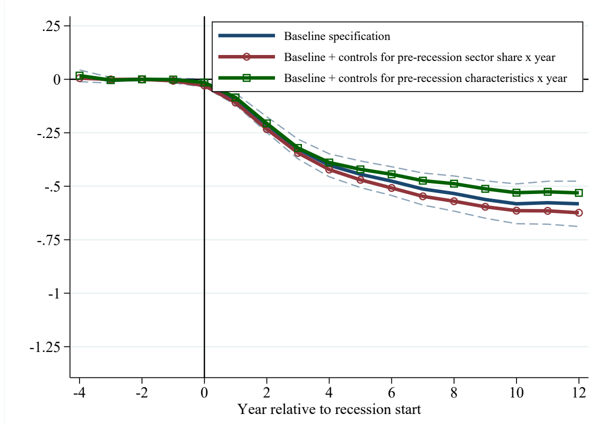
Notes: Figure reports estimates of equation (1). The dependent variable is log wage and salary employment in Panel A, log population age 15 and above in Panel B, the log ratio of wage and salary employment to population age 15 and above in Panel C, and log real earnings per capita (age 15+) in Panel D. There are 691 commuting zones in the sample. Standard errors are clustered by commuting zone. See notes to Figure 4.
Source: Authors' calculations using BEAR and SEER data.

Appendix Figure 16: The Evolution of Metropolitan Area Labor Market Outcomes After Recessions, Robustness to Controlling for Pre-Recession Sector Employment Shares and Labor Market and Demographic Characteristics

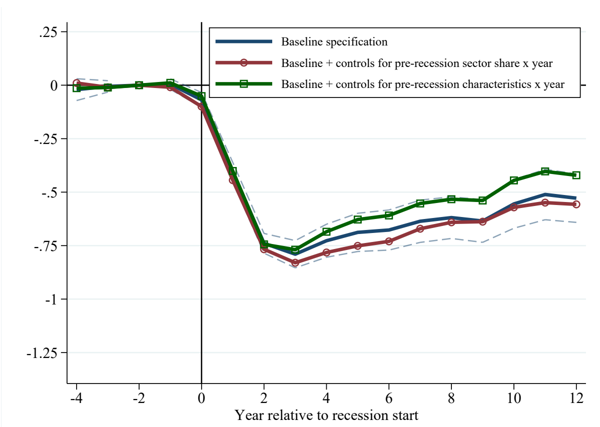
(a) Log Employment



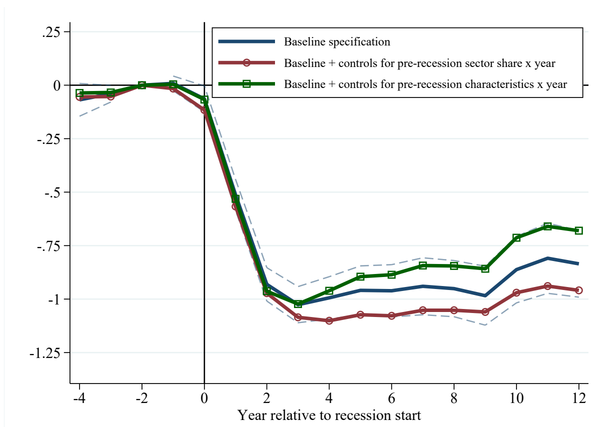
(b) Log Population



(c) Log Employment-Population Ratio



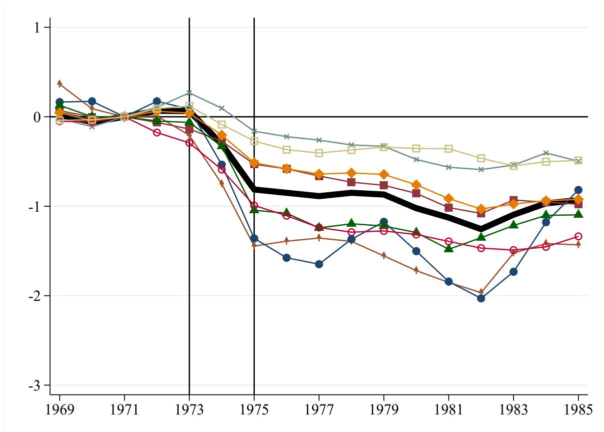
(d) Log Real Per Capita Earnings



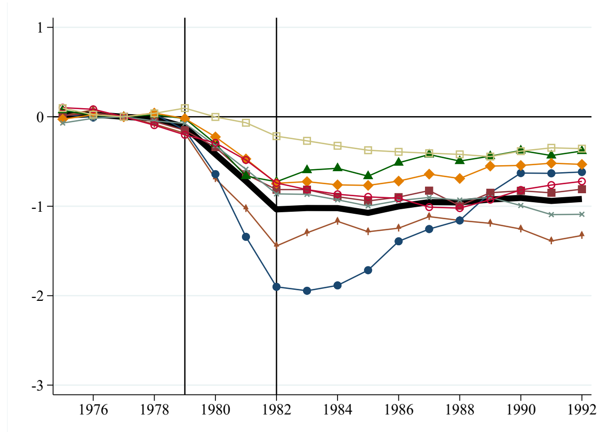
Notes: Figure reports estimates of equation (1). The dependent variable is log wage and salary employment in Panel A, log population age 15 and above in Panel B, the log ratio of wage and salary employment to population age 15 and above in Panel C, and log real earnings per capita (age 15+) in Panel D. The key independent variable is the change in log wage and salary employment during the recession from BEAR data. The estimates in the blue, solid line come from our baseline specification, which includes division-by-year fixed effects and controls for pre-recession population growth. The estimates in the red line (circle markers) come from a specification that also includes interactions between year fixed effects and the pre-recession share of employment in ten sectors: agriculture, construction, finance, government, manufacturing, mining, retail trade, services, utilities, and wholesale trade. The estimates in the green line (square markers) come from a specification that also includes interactions between year fixed effects and several pre-recession labor market and demographic characteristics: log population, the log employment-population ratio, log real earnings per capita, the share of individuals with a high school degree or some college, the share of individuals with a BA degree or more, the share of individuals that are nonwhite, and the share of individuals that are foreign-born. There are 358 metropolitan areas in the sample. Standard errors are clustered by metropolitan area. See notes to Figure 4.
Source: Authors' calculations using BEAR and SEER data.

Appendix Figure 17: The Evolution of Metropolitan Area Log Employment by Sector and Recession

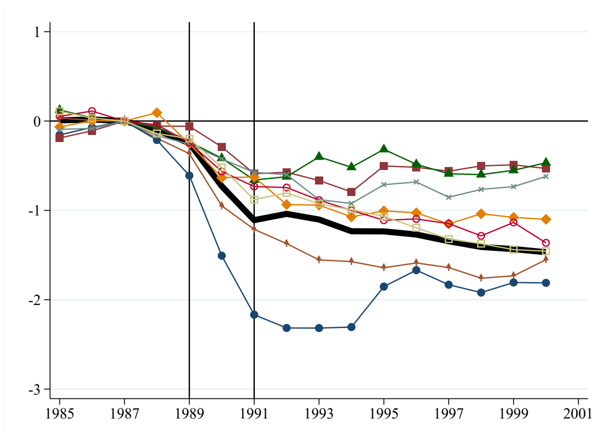
(a) 1973–1975 Recession



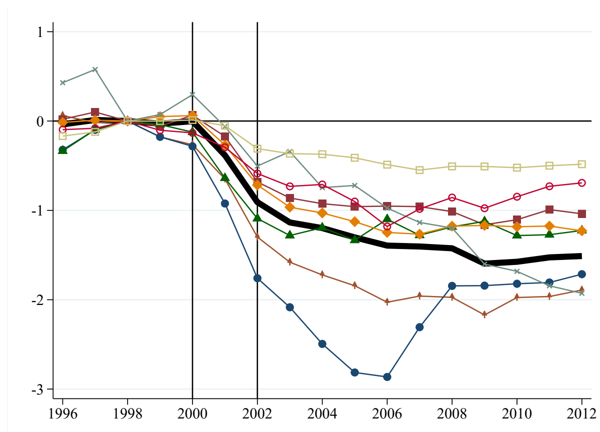
(b) 1980–1982 Recession



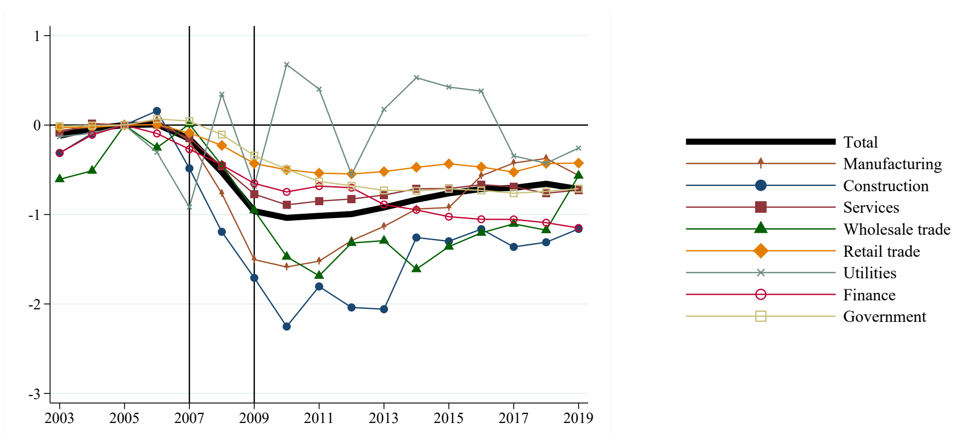
(c) 1990–1991 Recession



(d) 2001 Recession



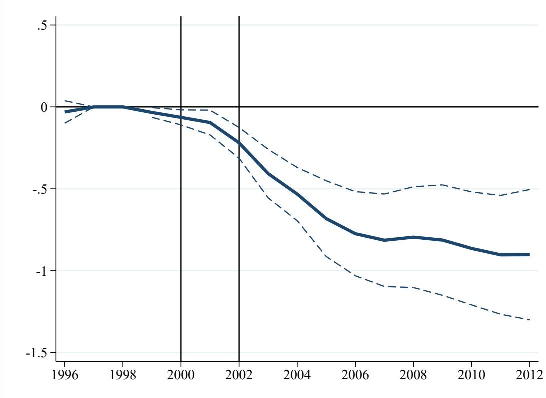
(e) 2007–2009 Recession



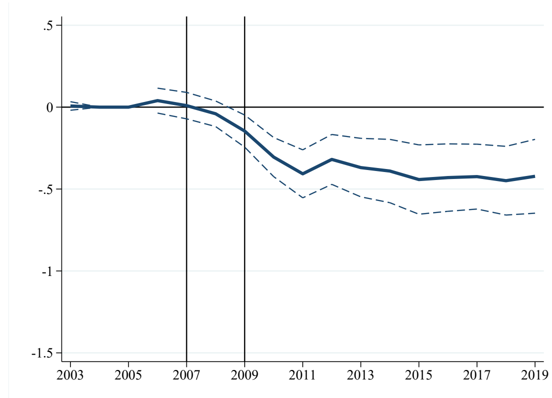
Notes: Figure reports estimates of equation (1), separately for each recession. The dependent variable is log employment from the indicated sector. We use BEAR data for the 1973–75, 1980–82, 1990–91, and 2007–09 recessions. We use QCEW data for the 2001 recession (due to SIC-NAICS industry seaming issues), except for government, which comes from BEAR. See notes to Figure 3. Source: Authors' calculations using BEAR, SEER, and QCEW data.

Appendix Figure 18: The Evolution of Metropolitan Area In-Migration and Out-Migration, by Recession

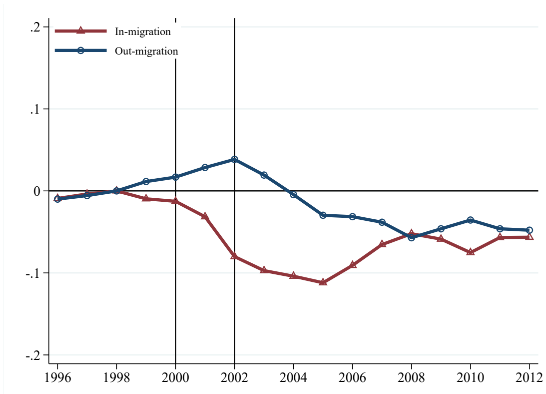
(a) 2001, DV: Population



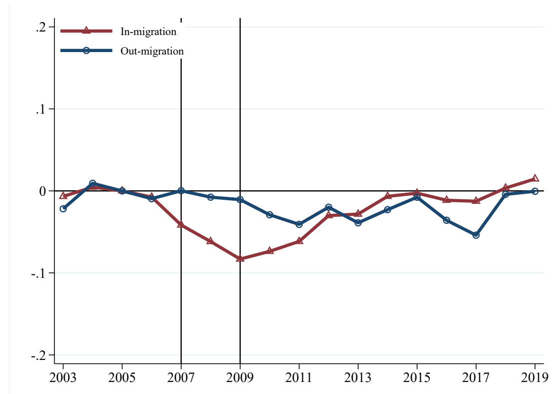
(b) 2007–2009, DV: Population



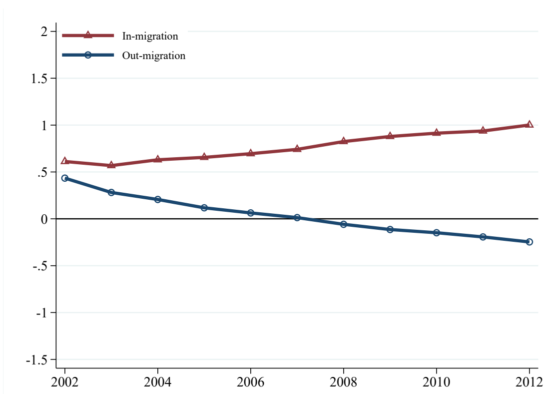
(c) 2001, DV: In-Migration and Out-Migration



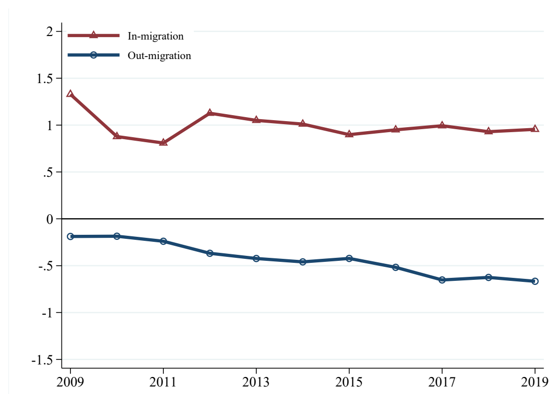
(d) 2007–09, DV: In-Migration and Out-Migration



(e) 2001, Share of Total Change Due to In-Migration and Out-Migration



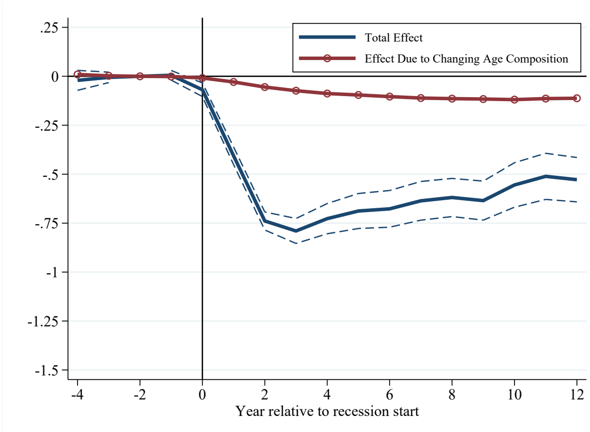
(f) 2007–09, Share of Total Change Due to In-Migration and Out-Migration



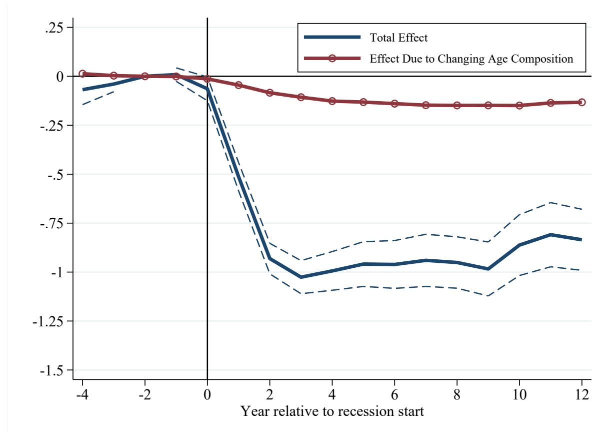
Notes: Figure reports estimates of a variant of equation (1) in which the dependent variable is the outcome in year t and we control for interactions between year fixed effects and in-migration, out-migration, and net birth rates in year $p(r) - 2$. This approach facilitates an exact decomposition using the regression coefficients (including net births, which we don't show for brevity). In Panel A, the dependent variable is the number of exemptions in year t divided by the same variable in year $p(r) - 2$. In Panel B, the dependent variables are in-migration and out-migration relative to the number of exemptions in year $p(r) - 2$. In Panel C, we divide cumulative sums of the coefficients from Panel B by the coefficients in Panel A; we multiply the out-migration coefficient by -1 so that a positive number indicates that a given population component contributes to the post-recession population decline. Regressions also include specification 2 controls described in the notes to Figure 3. Source: Authors' calculations using CBP, BEAR, and SOI data.

Appendix Figure 19: The Role of Age Distribution Shifts on the Evolution of the Log Employment-Population Ratio and Earnings per Capita After Recessions

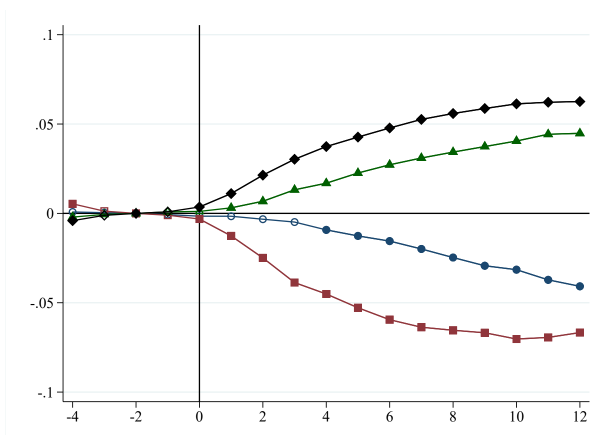
(a) Log Employment-Population Ratio



(b) Log Earnings per Capita



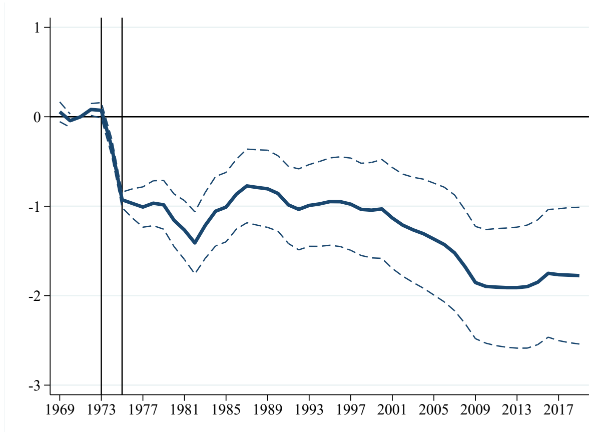
(c) Share of Population in Each Age Group



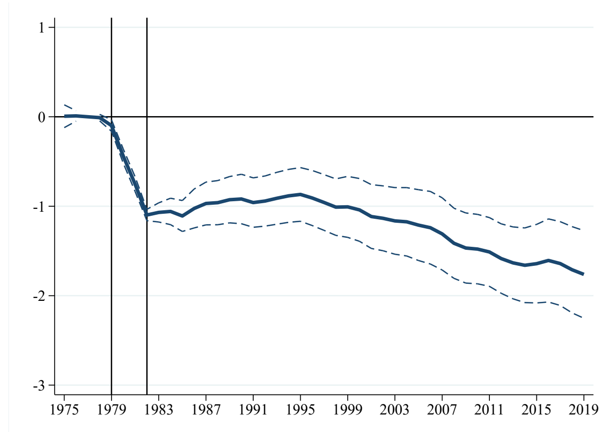
Notes: Panels A and B repeat the baseline estimates of equation (1) for the log employment-population ratio and log earnings per capita as in Panels B and C of Figure 4 but also show the predicted change in these outcomes due to post-recession changes in the age structure. The dependent variables in Panel C are the shares of the population of various ages as indicated in the legend. The estimates in Panel C are based on a variant of equation (1) in which the dependent variable in year t is a given age share and we control for interactions between year fixed effects and all-but-one age share in year $p(r) - 2$. This approach facilitates an exact decomposition using the regression coefficients. To estimate predicted changes in the first two panels, we combine the estimates from Panel C with estimates of the cross-sectional, pre-recession relationship between the log employment-population ratio or log earnings per capita and these age shares.
Source: Authors' calculations using BEAR and SEER data.

Appendix Figure 20: The Evolution of Metropolitan Area Log Employment After Recessions, Longer Horizon

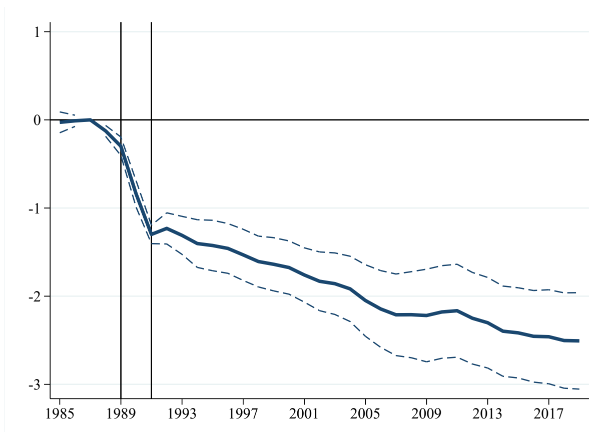
(a) 1973–1975 Recession



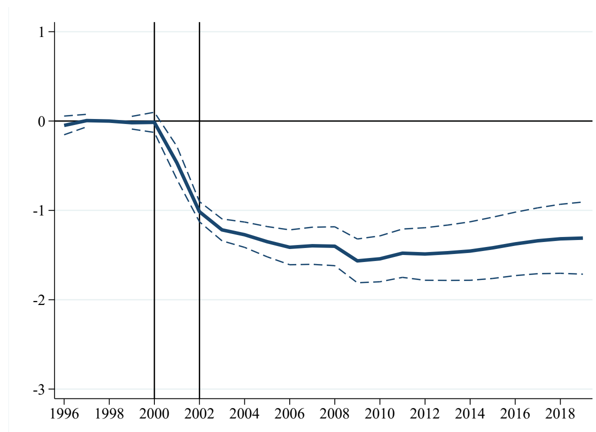
(b) 1980–1982 Recession



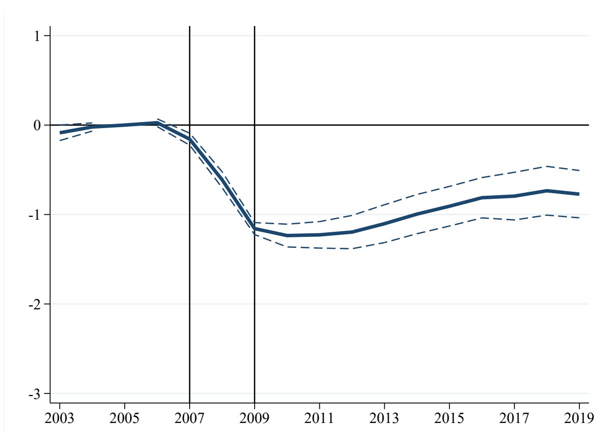
(c) 1990–1991 Recession



(d) 2001 Recession



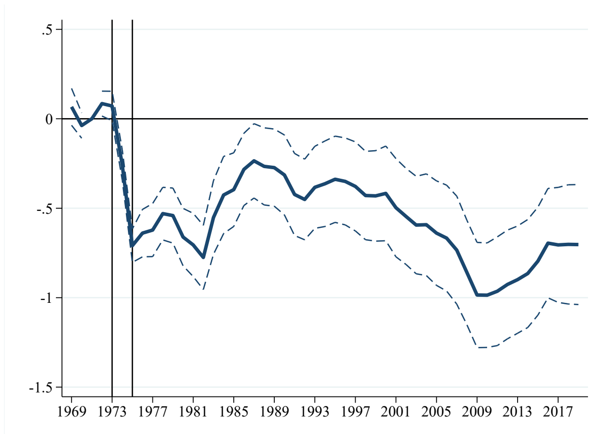
(e) 2007–2009 Recession



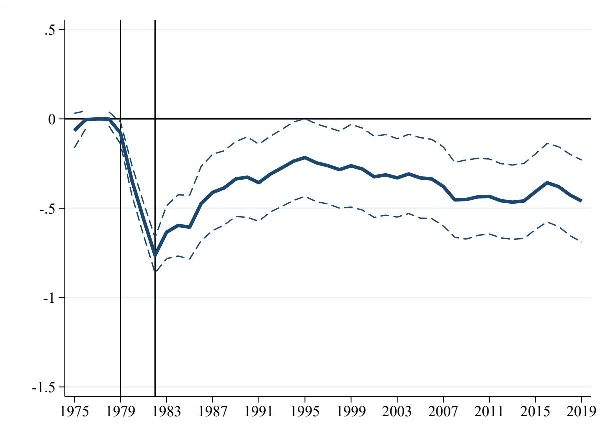
Notes: Figure reports estimates of equation (1), separately for each recession. The dependent variable is log wage and salary employment from BEAR data. See notes to Figure 3, which reports estimates over a shorter time horizon.
Source: Authors' calculations using BEAR and SEER data.

Appendix Figure 21: The Evolution of the Metropolitan Area Log Employment-Population Ratio After Recessions, Longer Horizon

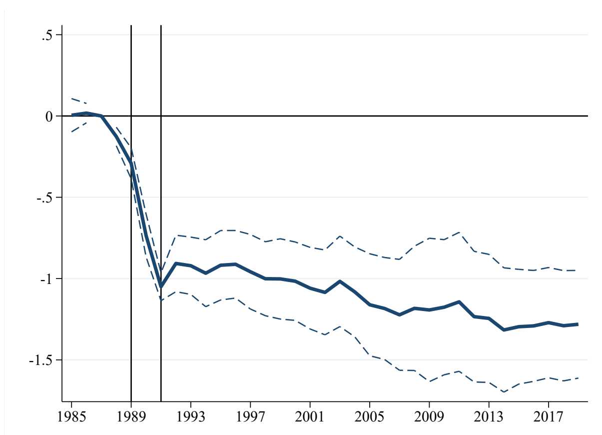
(a) 1973–1975 Recession



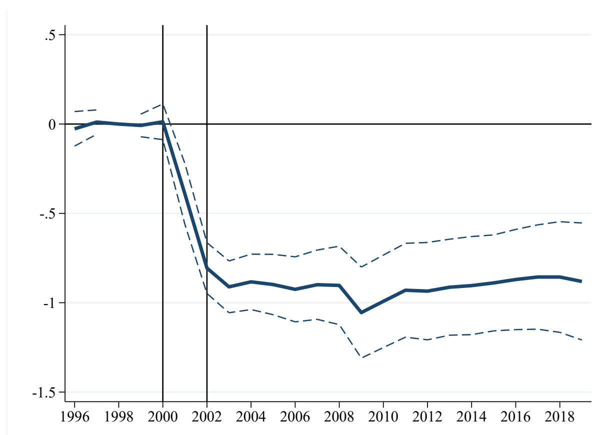
(b) 1980–1982 Recession



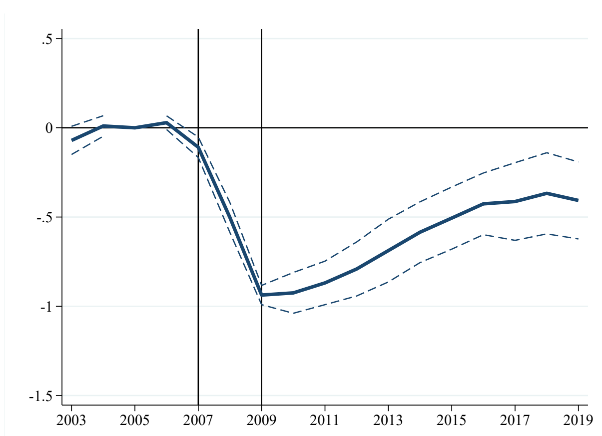
(c) 1990–1991 Recession



(d) 2001 Recession



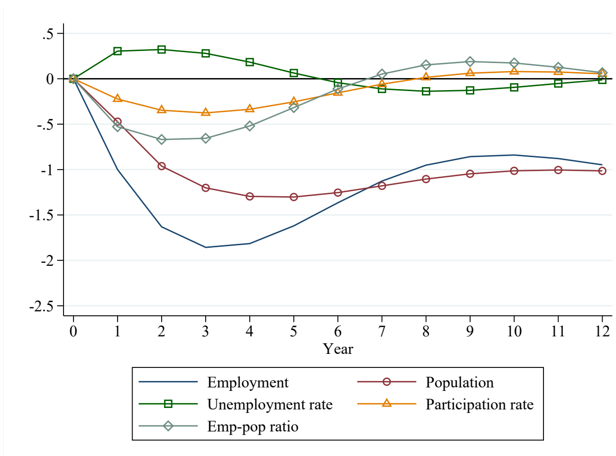
(e) 2007–2009 Recession



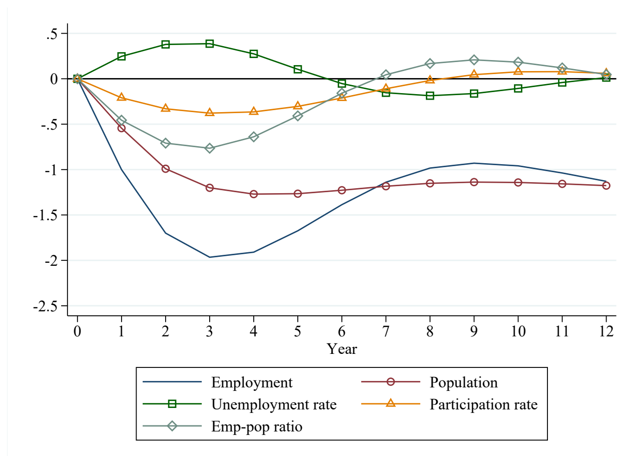
Notes: Figure reports estimates of equation (1), separately for each recession. The dependent variable is the log ratio of wage and salary employment to population age 15 and above. See notes to Figure 6, which reports estimates over a shorter time horizon.
Source: Authors' calculations using BEAR and SEER data.

Appendix Figure 22: Comparison of Vector Autoregression Impulse Response Functions Estimated for Different Time Periods

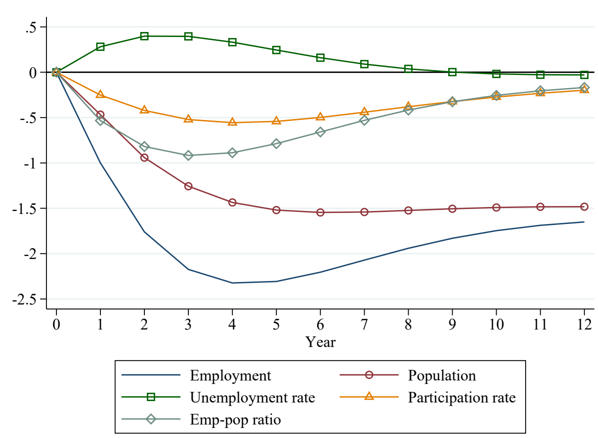
(a) Original BK Years: 1976–1990



(b) Same Number of Years, Different Period: 2003–2017



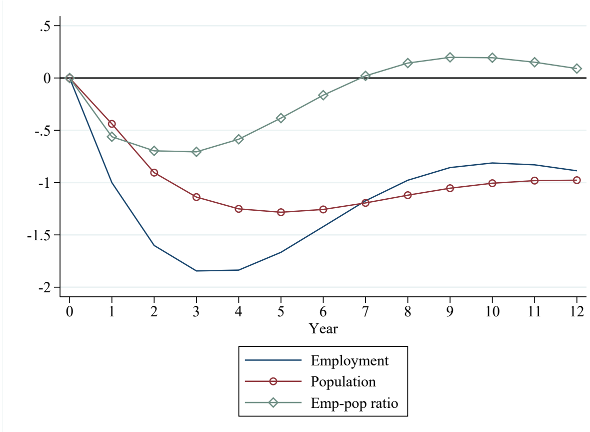
(c) Additional Number of Years: 1976–2019



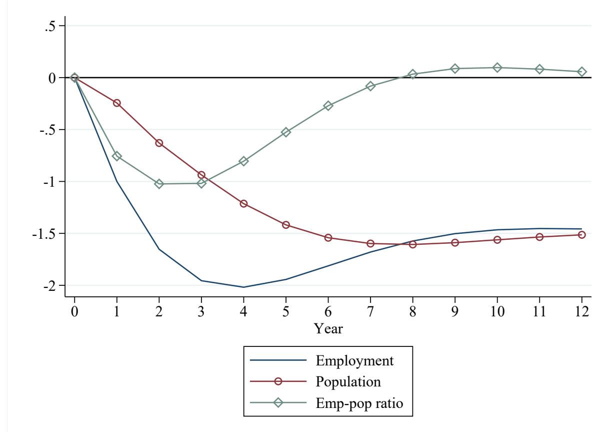
Notes: Figure shows impulse response functions of indicated variables with respect to a negative log employment shock. We construct impulse response functions for the BK VAR using estimates of equations (4)–(6). Sample contains 50 states and Washington, D.C. Panel A estimates the VAR using data from 1976–1990 as in Blanchard and Katz (1992). Panel B uses data from 2003–2017, which represents the same number of years and a similar point in the business cycle. Panel C uses data from years 1976–2019.
Source: Authors' calculations using CES and LAUS data.

Appendix Figure 23: Comparison of VAR Results for State and Metro Areas

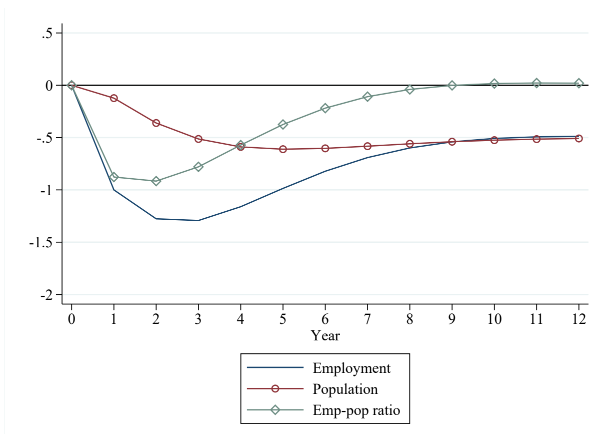
(a) State-Level Data, 1976–1990, BEA Employment and LAUS Implied Population



(b) State-Level Data, 1976–1990, BEA Employment and Census Population

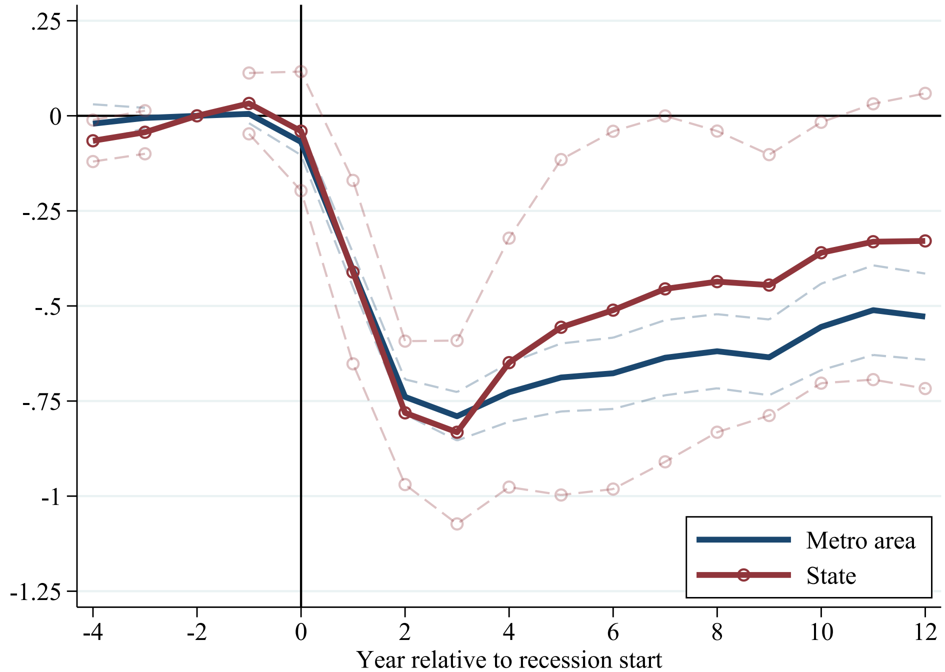


(c) Metro-Level Data, 1976–1990, BEA Employment and Census Population



Notes: Figure shows impulse response functions of indicated variables with respect to a negative log employment shock. We construct impulse response functions using estimates of a two-equation VAR where the dependent variable in the first equation is the change in log employment and the dependent variable in the second equation is the log employment-population ratio. Otherwise, we use the same lag structure as in the BK VAR. Panel A reports results after replacing the Current Employment Statistics establishment-level employment estimates used by BK with the analogous employment measure available in BEA data. Panel B reports results after using estimates of the population ages 15 and above from SEER in place of BK's approach, which estimates population as the sum of establishment-level employment and survey measures of the number of individuals who are unemployed or not in the labor force. Panel C uses the same underlying data as Panel B, but for metro areas.
Source: Authors' calculations using BEAR, CES, LAUS, and SEER data.

Appendix Figure 24: Comparison of Event Study Estimates for the Log Employment-Population Ratio for Metro Areas and States

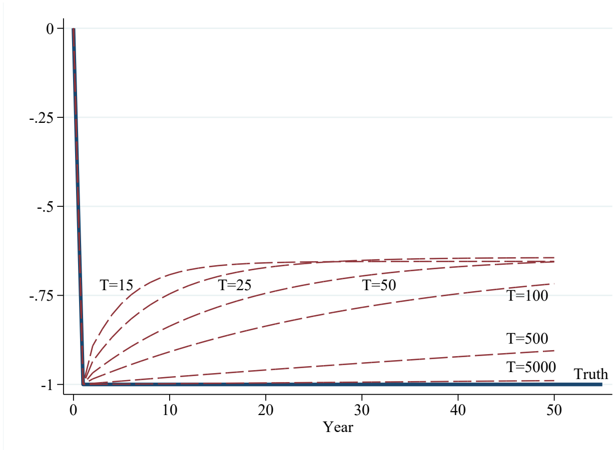


Notes: Figure reports estimates of equation (1). The dependent variable is the log ratio of wage and salary employment to population age 15 and above, and the key independent variable is the change in log wage and salary employment during the recession from BEAR data. The estimates in the solid blue line are for metro areas, and the estimates in the red line with circle markers are for states. The metro specification includes division-year fixed effects, and the state specification includes region-year fixed effects. Both estimates control for the pre-recession change in population. Standard errors are clustered by metro area or state.

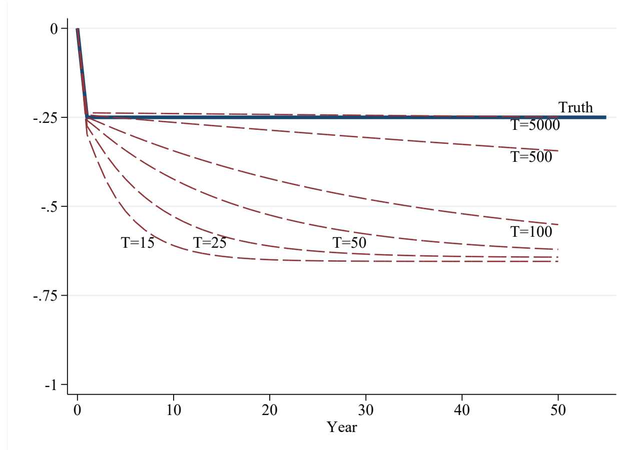
Source: Authors' calculations using BEAR and SEER data.

Appendix Figure 25: Finite Sample Bias from Vector Autoregression Impulse Response Functions for All Outcomes

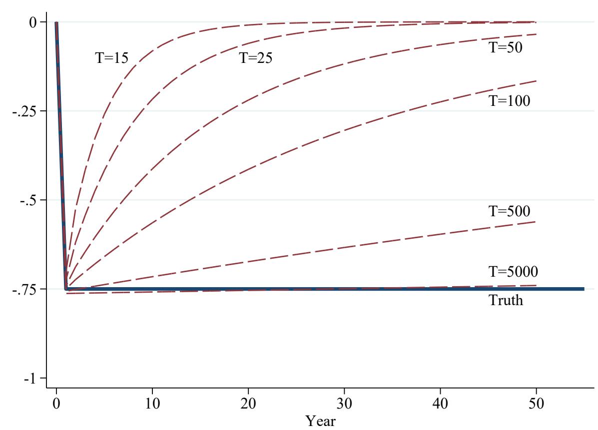
(a) Log employment



(b) Log population



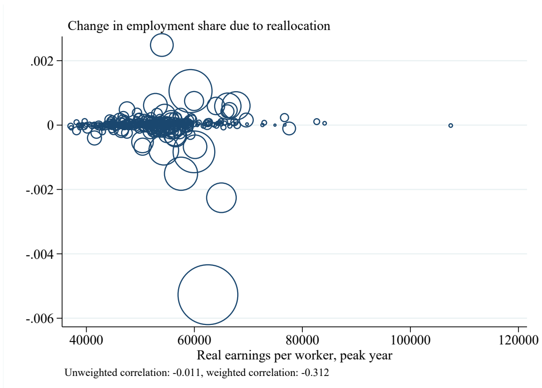
(c) Log employment-population ratio



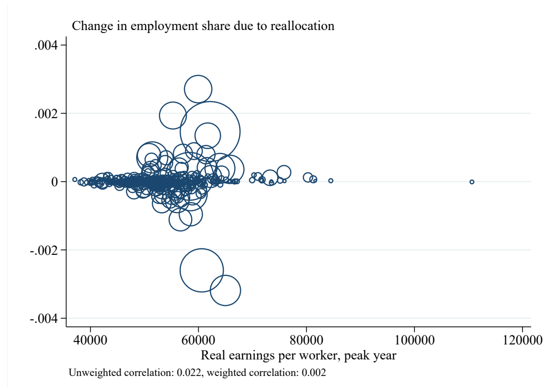
Notes: Figure displays average estimates of impulse response functions of the indicated variable with respect to a negative log employment shock based on estimates of equations (7)–(8). We simulate data following equations (12)–(14). We set $e_{i,0} \sim \mathcal{N}(13.88, 1.03^2)$, $p_{i,0} \sim \mathcal{N}(14.43, 1.05^2)$, $\varepsilon_{i,e,t} \sim \mathcal{N}(0, 0.015^2)$, $\varepsilon_{i,p,t} \sim \mathcal{N}(0, 0.015^2)$, $\phi = -0.75$, and $N = 50$. Results are based on 499 Monte Carlo simulations.

Appendix Figure 26: Correlation between Reallocation-Induced Change in Employment Share and Peak Year Earnings per Worker

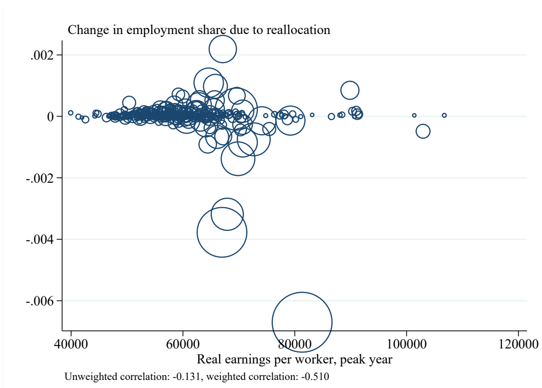
(a) 1973–1975 Recession



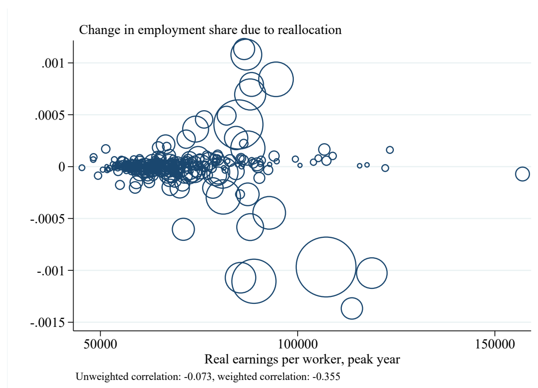
(b) 1980–1982 Recession



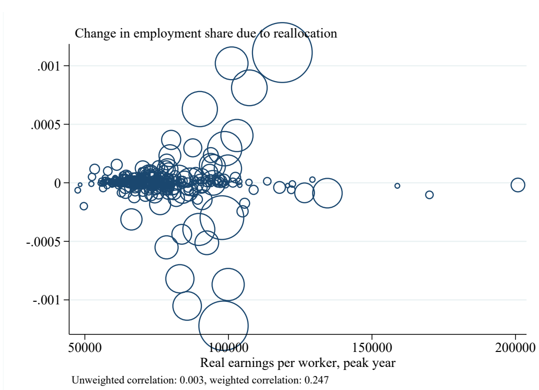
(c) 1990–1991 Recession



(d) 2001 Recession



(e) 2007–2009 Recession



Notes: Change in metro employment share is the employment share under the counterfactual minus the employment share in the business cycle peak year. Marker size is proportional to peak year employment share. Unweighted and peak-year-employment-share weighted correlations are reported. See notes to Appendix Table 10.
Source: Authors' calculations using BEAR and SEER data.