Jobless recovery and structural change: a VAR approach

Li-Hsueh Chen and Zhen (Carol) Cui*

Abstract

This study uses Vector Autoregression (VAR) analysis to substantiate the link between jobless recoveries and the fast employment expansion in finance, health, and education sectors. The negative effect of the expansion on aggregate employment is confirmed by the reduced form estimates and the impulse responses for the recursive mode. While the Granger-causality test asserts the predictive power of the expansion over aggregate employment, the variance decomposition indicates that innovations in the expansion explain up to 35% of the error variance of aggregate employment growth.

Keywords: jobless recovery, structural change, sectoral expansion, VAR

JEL classification: E24, E32

* Address: Department of Economics and Statistics, College of Business and Economics, California State University, Los Angeles, Los Angeles, CA 90032; Email: lchen4@calstatela.edu, zcui@calstatela.edu; Phone: (323) 343-5256; Fax: (323) 343-5462.

I. Introduction

Jobless recovery refers to the slow recovery of employment despite the quick rebound of total output after a recession. The US has experienced three jobless recoveries since the 1990s. Some studies relate the occurrence to the structural change in the labor market (Groshen and Potter, 2003; Garin *et al.*, 2013). However, those studies scant the application of rigorous econometric methods. Also, the existing literature in general has mixed results on accounting the contribution of structural change to jobless recoveries. Therefore, this paper adopts an econometric approach to examine and thus to offer some conclusive evidence on the link between structural change and jobless recovery.

We document two structural changes in the post-1990 US labor market. First, finance, health, and education (FHE) sectors have boasted the biggest share of total private employment. Second, the disproportionate concentration of college-educated workers in FHE sectors has widened the education requirement gap for workers across sectors.

Since these changes coincide with the onset of jobless recovery, we hypothesize that the fast expansion of FHE sectors is one of the key factors triggering the jobless recovery. In particular, an individual laid off in another sector during a post-1990 recession is likely to lack the qualification for a job in FHE sectors where new openings are most abundant. This could result in a long period of unemployment from which a jobless recovery ensues.

We then examine our hypothesis using reduced form as well as recursive Vector Autoregressions (VARs). The reduced form estimates suggest that the expansion of FHE sectors has no significant effect on aggregate employment growth before 1990 but a statistically significantly negative effect after 1990. The Granger-causality test supports this finding. The impulse responses for the recursive VAR show that unexpected positive shocks to the growth of

FHE employment share only have a prolonged negative effect on aggregate employment growth after 1990. These shocks account for up to 35% of the forecast error variance of aggregate employment growth after 1990 but only 19% before 1990. Hence, our VAR results substantiate the link between the expansion of FHE sectors and jobless recoveries. They also attest to the notable contribution of structural change to jobless recoveries.

The remainder of the paper is organized as follows. Section II reviews related literature, Section III describes our data, Section IV documents recent jobless recoveries, Section V explains the structural change of the labor market, Section VI discusses the methodology and the empirical results, and Section VII concludes.

II. Related Literature

A number of studies have tried to explain jobless recoveries via structural change. Among them, Groshen and Potter (2003) and Garin *et al.* (2013) are arguably the most prominent. Unfortunately, neither studies has undertaken a rigorous econometric approach.

Groshen and Potter (2003) report the absence of employment recovery after the 2001 recession. They define structural change as the permanent job relocation from one industry to another. Using payroll data from seventy industries, the study compares each industry's job growth rate during the recession with that during the recovery phase. The comparison reveals that job gains after 1990 tend not to occur in the same industries where job losses initially take place. The study infers that structural change leads to the 2001 jobless recovery.[1]

Garin *et al.* (2013) show much delayed recovery in unemployment and total hours worked after the past three recessions. They conjecture that the slow recovery is caused by a reallocation shock that raises productivity of one sector relative to another but leaves aggregate productivity

[1] Aaronson *et al.* (2004) argue against their method and finding.

intact. A two-island model is developed in which a reallocation shock during a recession motivates workers in the relatively less productive island to move to the relatively more productive island. Before those workers join production on the other island, they have to experience a period of unemployment, generating a jobless recovery.

Aside from the above studies, findings on the contribution of structural change to jobless recoveries are inconclusive. For example, Sahin *et al.* (2014) create a mismatch index using the difference between an actual unemployment rate and a counterfactual unemployment rate indicated by a theoretical social planner's problem. The index suggests that mismatch across 2-digit industries explains up to 23% of the rise in unemployment during the Great Recession. DeNicco and Laincz (2014) show that unemployment rates have a structural break in the fourth quarter of 1984. The inclusion of labor force's changing industry composition amplifies the structural break by more than 13%. However, Aaronson *et al.* (2004) construct a measure of sectoral reallocation by decomposing the industry employment share growth rate into three components (i.e., long-term trend, cyclical pattern, and idiosyncratic movement). Their measure indicates a much lower reallocation level in both the 1990 and the 2001 recession compared to previous recessions.

Against this background, the present study adopts an econometric approach to substantiate the link between structural change and jobless recoveries. It also quantifies the contribution of structural change to explaining the jobless recovery, thereby offering a resolution to the ongoing debate.

III. Data Description

Our analysis uses the following macro data series. First, we approximate total output using quarterly real Gross Domestic Product (GDP) in chained 2009 dollars from the Bureau of

Economic Analysis. Second, we approximate aggregate employment using the quarterly averages of monthly total private employment from the Current Employment Statistics (CES) survey published by the Bureau of Labor Statistics (BLS). Last, we obtain each sectoral employment by taking quarterly averages of monthly employment in the corresponding sector from the CES survey. All data series are seasonally adjusted and span from the first quarter of 1948 (1948Q1) to the fourth quarter of 2014 (2014Q4).

Section V also uses the annual person-level data from the 1968–2014 Integrated Public Use Microdata Series – Current Population Survey (IPUMS-CPS). In 1968, the IPUMS-CPS started to report the industry where the respondent worked in the previous year. We adopt the BLS classification and categorize each respondent's industry into one of the following sectors: mining, construction, manufacturing, transportation and utilities, wholesale trade, retail trade, financial activities, health and education, and other services. Following Autor *et al.* (2008), we restrict the sample to full-time employees aged 18 to 64. We define a person who has completed no more than 12 years of schooling as attaining a non-college education (i.e., high school dropouts and high school graduates) and at least 13 years of schooling as attaining a college education (i.e., some college and college plus). All reported statistics are appropriately weighted.

IV. Jobless Recovery

In the literature, jobless recovery refers to the divergent recovery paths of total output and aggregate employment after a recession (Groshen and Potter, 2003; Aaronson *et al.*, 2004; Bachmann, 2012). It is a time where aggregate employment continues to plunge despite a simultaneous improvement in total output after a recession trough date decided by the National Bureau of Economic Research (NBER). We assume this definition and show that jobless recoveries are a new phenomenon in the post-1990 US economy.

Table 1 reports the number of quarters where a positive GDP growth rate is accompanied by a negative employment growth rate after each NBER trough date. We observe at most one such quarter following each pre-1990 recession but at least three after 1990. Table 1 also reports the number of quarters total private employment takes to return to its end-of-recession level after GDP has already done so. Total private employment takes at most two quarters to return to its trough level before 1990 but at least six quarters after 1990. Hence, there is strong evidence indicating the onset of jobless recovery in the post-1990 era.

[insert Table 1 here]

V. Structural Change of the Labor Market

In this section, we note two distinct changes that have occurred in the post-1990 US labor market: the fast expansion of FHE sectors and the widening gap in education requirement for workers across sectors. These two features define the structural change in this paper.

Fig. 1 demonstrates the first feature by showing sectoral share of total private employment over the past six decades. It reveals that manufacturing and FHE sectors have experienced the most dramatic change. While the former sees its share falling from 37% in 1948 to 10% in 2014, the share of the latter has increased from 10% to 25%. Since 1990, FHE sectors have not only been the fastest growing sector but overtaken manufacturing and become the biggest component of total private employment.

[insert Fig. 1 here]

Fig. 2 demonstrates the second feature using the 1968–2014 IPUMS-CPS data. Section III details the sample selection criteria and the classification of industry and college education. For each year, we first obtain the percentage of college workers in every sector. Then the annual standard deviation of those percentages is computed.

[insert Fig. 2 here]

The cross-sector standard deviation, fluctuating around 12.5%, is quite stable prior to 1990. This indicates a relatively constant difference in education requirement for workers across sectors. The series has a clear upward trend after 1990, especially up to 2008. This indicates a widening gap in education requirement for workers across sectors. It is evident that certain sectors over those years have become increasingly harder for unskilled workers to enter. Specifically, college workers consist on average 75% of the FHE sectoral workforce during the past decade. Meanwhile, barely half of the workforce averaged out over all the other sectors attain the same education. Thus, it is more likely for a typical worker laid off in another sector to lack the qualification for a job in FHE sectors after 1990.

In summary, the continuous expansion of FHE sectors has outpaced all others and their employment share has been the biggest ever since 1990. College workers have also become disproportionately concentrated in FHE sectors, indicating a rising barrier to entry for jobs in those sectors. Given that these changes coincide with the onset of jobless recovery, we conjecture that the two are correlated and the changes are a triggering factor. For instance, if an individual loses her job in one sector and lacks the qualification for a job in FHE sectors where new openings are most abundant, structural unemployment will result and linger, causing a jobless recovery.

VI. Methodology and Empirical Results

Reduced form estimates

Motivated by the analysis in Sections IV and V, we are interested in three variables. The first variable is total output denoted as *GDP*. The second variable is aggregate employment denoted as *EMP*. The third variable is the FHE sectoral share of aggregate employment denoted as *FHE*. Section III describes the source and the retrieval of the data.

The main specifications of our reduced form VAR are as follows.

$$DGDP_t = \alpha_0 + \sum_{i=1}^{p} \alpha_i DGDP_{t-i} + \sum_{i=1}^{p} \alpha_{p+i} DFHE_{t-i} + \sum_{i=1}^{p} \alpha_{2p+i} DEMP_{t-i}$$

$$DFHE_t = \beta_0 + \sum_{i=1}^{p} \beta_i DGDP_{t-i} + \sum_{i=1}^{p} \beta_{p+i} DFHE_{t-i} + \sum_{i=1}^{p} \beta_{2p+i} DEMP_{t-i}$$

$$DEMP_t = \gamma_0 + \sum_{i=1}^{p} \gamma_i DGDP_{t-i} + \sum_{i=1}^{p} \gamma_{p+i} DFHE_{t-i} + \sum_{i=1}^{p} \gamma_{2p+i} DEMP_{t-i}$$

Here, $DGDP_t$ is the log difference between *GDP* at quarters *t* and *(t−1)*, $DEMP_t$ is the log difference between *EMP* at quarters *t* and *(t−1)*, $DFHE_t$ is the difference between *FHE* at quarters *t* and *(t−1)*, and *p* denotes the number of lags. Our focus on jobless recovery makes it more appropriate to use differences than levels.

We split our data into two time periods, 1948Q1–1989Q4 and 1990Q1–2014Q4, and apply the reduced form VAR to each of them. Table 2 reports the lag order selection criteria of AIC, SIC, and HQ for up to five lags. The results are inconsistent for the first time period. However, if we include one lag, we reject no serial correlation in residuals at the 1% level. If we include two lags, we fail to do so at the 10% level. The Augmented Dickey–Fuller (ADF) test also rejects unit root at the 1% level for all variables at the lag length of two. Thus, we decide to include two lags (i.e., $p = 2$) in our VAR estimation for the first time period.

For the second time period, Table 2 indicates the selection of one lag. However, the ADF test for variable *DEMP* at this lag length cannot reject unit root at the 5% level with an intercept and at the 10% level with a trend and an intercept. The ADF test is able to do so at the lag length of two. Thus, we decide to include two lags for the second time period as well.

[insert Table 2 here]

Table 3 shows the VAR estimates for the pre-1990 period. Given the limitations of the reduced form VAR, we are mainly interested in the signs and significance levels of the coefficients of $DFHE_{t-1}$ and $DFHE_{t-2}$ in the third regression where $DEMP_t$ is the dependent variable. Both coefficients are positive but statistically insignificant. Thus, the expansion of FHE sectors at best has a weak positive effect on aggregate employment growth before 1990. The Granger-causality test indicates that *DFHE* fails to help predict *DEMP* (the *p*-value is 0.102).

[insert Table 3 here]

Table 4 shows the VAR estimates for the post-1990 period. Contrary to the pre-1990 estimate, the coefficient of $DFHE_{t-1}$ in the third regression is statistically significantly negative. The expansion of FHE sectors in the previous quarter slows down current aggregate employment growth. The coefficient of $DFHE_{t-2}$ is positive but statistically insignificant. It could suggest the following. When the expansion of FHE sectors starts two instead of one quarter earlier, job seekers who lack the necessary skill will have enough time for training and become suitable to work in FHE sectors, thereby encouraging aggregate employment growth. However, this interpretation should be taken with caution as the coefficient is statistically insignificant. The Granger-causality test suggests that *DFHE* helps predict *DEMP* (the *p*-value is 0.099).

[insert Table 4 here]

Figs 3 and 4 compare the actual data with the fitted values. Our reduced form VARs perform well in forecasting all the series except for the post-1990 GDP growth rates. The poor fit is also reflected by the first regression in Table 4 where only the coefficient of $DEMP_{t-1}$ is statistically significant. This could be due to the jobless recovery in which the divergent paths of employment and GDP greatly reduce the predictive power of employment over GDP.

[insert Fig. 3 here]

[insert Fig. 4 here]

Impulse responses

We further examine our hypothesis via the impulse responses for a recursive VAR. It is widely accepted that employment as an economic indicator lags behind GDP. Also, our conjecture identifies the expansion of FHE sectors as a triggering factor of jobless recovery. Thus, we order the three variables as follows: *DGDP*, *DFHE,* and *DEMP*. Other setups are kept the same as the reduced form.

Figs 5 and 6 plot the impulse responses for the pre-1990 and the post-1990 recursive VAR, respectively. The first row shows the effect of an unexpected one-percentage-point drop in GDP growth rate on the three variables. The second row shows the effect of an unexpected one-percentage-point growth in FHE employment share. The third row shows the effect of an unexpected one-percentage-point increase in aggregate employment growth rate. Dashed lines indicate the 95% confidence interval for each impulse response. The effects shown in the first two rows are of our main interest.

[insert Fig. 5 here]

[insert Fig. 6 here]

The impulse responses reveal two findings. First, the first row in Fig. 5 shows a quick and concurrent recovery of GDP and aggregate employment growth rates after a negative shock to *DGDP*. However, the recovery of aggregate employment growth dawdles behind that of GDP growth in Fig. 6, confirming the jobless recovery phenomenon. Second, the second row in Fig. 6 shows a prolonged adverse effect of a positive *DFHE* shock on aggregate employment growth. This effect is short-lived and quickly reversed in Fig. 5. Hence, it corroborates our hypothesis that a faster expansion of FHE sectors impedes the recovery of aggregate employment in the post-1990

US economy. Section V identifies the widening gap in education requirement between FHE and other sectors as one probable transmission channel.

Tables 5 and 6 report the variance decomposition for the pre-1990 and the post-1990 recursive VAR, respectively. We are mainly interested in the variance decomposition of *DEMP* (Panel C in both tables). The results suggest that exogenous shocks to *DFHE* can only explain 12–19% of the forecast error variance of *DEMP* prior to 1990 but 25–35% after 1990. Thus, our finding favors studies such as Sahin *et al.* (2014) and DeNicco and Laincz (2014) in that structural change of the labor market notably contributes to the onset of jobless recovery.

[insert Table 5 here]

[insert Table 6 here]

VII. Conclusion

This paper attributes jobless recoveries to the fast expansion of FHE sectors. We use micro-level data to show that jobs in these sectors have a higher education requirement, potentially creating a barrier to entry for unemployed workers in other sectors. As a result, a long period of structural unemployment could occur and lead to a jobless recovery. We further examine this proposition using both reduced form and recursive VARs. Our findings are in favor of the proposition and can be summarized as follows.

(1) The reduced form estimates only suggest a statistically significantly negative effect of expanding FHE sectors on aggregate employment growth after 1990. The Granger-causality test also reveals that the expansion only helps predict the employment growth after 1990.

(2) The impulse responses show that positive shocks to the change of FHE employment share only have a prolonged negative effect on aggregate employment growth after 1990.

Moreover, the shocks explain 25–35% of the forecast error variance of the employment growth.

Acknowledgements

This work was supported by the College of Business and Economics, California State University, Los Angeles under summer research grant.

References

Aaronson, Daniel, Ellen Rissman, and Daniel Sullivan. 2004. "Can Sectoral Reallocation Explain the Jobless Recovery?" Federal Reserve Bank of Chicago *Economic Perspectives* 2Q: 36–49.

Autor, David, Lawrence Katz, and Melissa Kearney. 2008. "Trends in U.S. Wage Inequality: Revising the Revisionists." *Review of Economics and Statistics* 90(2): 300–323.

Bachmann, Rudiger. 2012. "Understanding the Jobless Recoveries after 1991 and 2001." Available at http://www3.nd.edu/~rbachman/bachmann_jlr_2012.pdf (accessed 4 August 2015).

DeNicco, James, and Christopher Laincz. 2014. "Jobless Recovery: A Time Series Look at the United States." Available at http://www.pages.drexel.edu/~jpd48/Jobless%20Recovery.pdf (accessed 3 August 2015).

Garin, Julio, Michael Pries, and Eric Sims. 2013. "Reallocation and the Changing Nature of Economic Fluctuations." Available at http://www3.nd.edu/~esims1/gps_june27_2013.pdf (accessed 8 August 2015).

Groshen, Erica, and Simon Potter. 2003. "Has Structural Change Contributed to a Jobless Recovery?" Federal Reserve Bank of New York *Current Issues in Economics and Finance* 9(8): 1–7.

King, Miriam, Steven Ruggles, Trent Alexander, Sarah Flood, Katie Genadek, Matthew Schroeder, Brandon Trampe, and Rebecca Vick. 2014. Integrated Public Use Microdata Series: Current Population Survey. [Machine-readable Database]. Minneapolis: University of Minnesota.

Sahin, Aysegul, Joseph Song, Giorgio Topa, and Giovanni Violante. 2014. "Mismatch Unemployment." *American Economic Review* 104(11): 3529–3564.

Table 1. Total private employment recovery timeline

NBER recession	Number of quarters	
	+ GDP growth and – employment growth	Employment back to trough level after GDP recovery
1948Q4 – 1949Q4	0	0
1953Q2 – 1954Q2	1	1
1957Q3 – 1958Q2	0	0
1960Q2 – 1961Q1	0	0
1969Q4 – 1970Q4	0	0
1973Q3 – 1975Q1	1	2
1980Q1 – 1980Q3	0	0
1981Q3 – 1982Q4	0	0
1990Q3 – 1991Q1	4	6
2001Q1 – 2001Q4	3	9
2007Q4 – 2009Q2	3	6

Table 2. VAR lag order selection criteria

	1948Q1–1989Q4			1990Q1–2014Q4		
Lag	AIC	SIC	HQ	AIC	SIC	HQ
0	-29.828	-29.771	-29.805	-31.328	-31.248	-31.296
1	-31.038	-30.809*	-30.945	-34.013*	-33.690*	-33.882*
2	-31.154	-30.753	-30.991*	-33.897	-33.333	-33.669
3	-31.187	-30.615	-30.955	-33.844	-33.038	-33.519
4	-31.194*	-30.450	-30.892	-33.934	-32.886	-33.511
5	-31.134	-30.220	-30.763	-33.848	-32.558	-33.327

Notes: AIC: Akaike information criterion; SIC: Schwarz information criterion; HQ: Hannan-Quinn information criterion; * indicates lag order selected by the criterion.

Table 3. VAR estimates, 1948Q1–1989Q4

	DGDP48	*DFHE48*	*DEMP48*
DFHE48 (-1)	0.160	0.347**	0.831
	(1.031)	(0.156)	(0.588)
DFHE48 (-2)	-0.453	-0.101	0.322
	(1.071)	(0.162)	(0.611)
DEMP48 (-1)	0.818***	-0.081*	0.962***
	(0.285)	(0.043)	(0.162)
DEMP48 (-2)	-0.986***	0.090**	-0.376**
	(0.267)	(0.040)	(0.152)
DGDP48 (-1)	0.011	-0.018	0.099
	(0.117)	(0.018)	(0.066)
DGDP48 (-2)	0.286***	-0.057***	0.185***
	(0.107)	(0.016)	(0.061)
Constant	0.003***	0.001***	-0.001
	(0.001)	(0.000)	(0.001)
N	167	167	167
Adj. R^2	0.2451	0.4718	0.5963
F-statistic	9.872	25.416	41.371
Log Likelihood	673.591	985.605	766.363
AIC	-8.080	-11.862	-9.204
SIC	-7.948	-11.730	-9.073

Notes: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$; SE in parentheses.

Table 4. VAR estimates, 1990Q1–2014Q4

	DGDP90	*DFHE90*	*DEMP90*
DFHE90 (-1)	0.258 (0.807)	0.885*** (0.151)	-0.621** (0.290)
DFHE90 (-2)	0.323 (0.807)	-0.035 (0.151)	0.386 (0.290)
DEMP90 (-1)	0.799* (0.476)	0.004 (0.089)	0.663*** (0.171)
DEMP90 (-2)	-0.244 (0.420)	0.052 (0.079)	0.028 (0.151)
DGDP90 (-1)	0.172 (0.123)	-0.095*** (0.023)	0.184*** (0.044)
DGDP90 (-2)	0.032 (0.128)	-0.003 (0.024)	-0.021 (0.046)
Constant	0.001 (0.001)	0.000* (0.000)	0.000 (0.000)
N	100	100	100
Adj. R^2	0.188	0.822	0.861
F-statistic	4.753	75.55	101.56
Log Likelihood	451.972	616.185	552.352
AIC	-9.081	-12.432	-11.130
SIC	-8.896	-12.248	-10.945

Notes: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$; SE in parentheses.

Table 5. Pre-1990 variance decomposition

(a) Variance decomposition of *DGDP48*

Horizon	Standard error	Variance decomposition (percentage points)		
		DGDP48	*DFHE48*	*DEMP48*
1	0.0042	100	0	0
5	0.0048	90	4	6
10	0.0049	89	4	7
15	0.0049	89	4	7

(b) Variance decomposition of *DFHE48*

Horizon	Standard error	Variance decomposition (percentage points)		
		DGDP48	*DFHE48*	*DEMP48*
1	0.0006	45	55	0
5	0.0009	60	38	2
10	0.0009	60	37	3
15	0.0009	60	37	3

(c) Variance decomposition of *DEMP48*

Horizon	Standard error	Variance decomposition (percentage points)		
		DGDP48	*DFHE48*	*DEMP48*
1	0.0024	55	19	26
5	0.0037	64	12	24
10	0.0038	64	12	24
15	0.0038	64	12	24

Table 6. Post-1990 variance decomposition

(a) Variance decomposition of *DGDP90*

Horizon	Standard error	Variance decomposition (percentage points)		
		DGDP90	*DFHE90*	*DEMP90*
1	0.0025	100	0	0
5	0.0028	94	2	4
10	0.0028	93	2	5
15	0.0029	93	2	5

(b) Variance decomposition of *DFHE90*

Horizon	Standard error	Variance decomposition (percentage points)		
		DGDP90	*DFHE90*	*DEMP90*
1	0.0005	19	81	0
5	0.0011	54	46	0
10	0.0011	56	44	0
15	0.0011	56	44	0

(c) Variance decomposition of *DEMP90*

Horizon	Standard error	Variance decomposition (percentage points)		
		DGDP90	*DFHE90*	*DEMP90*
1	0.0009	29	35	36
5	0.0022	60	27	13
10	0.0024	62	26	12
15	0.0025	63	25	12

Fig. 1. Sectoral employment share of total private employment, 1948Q1–2014Q4

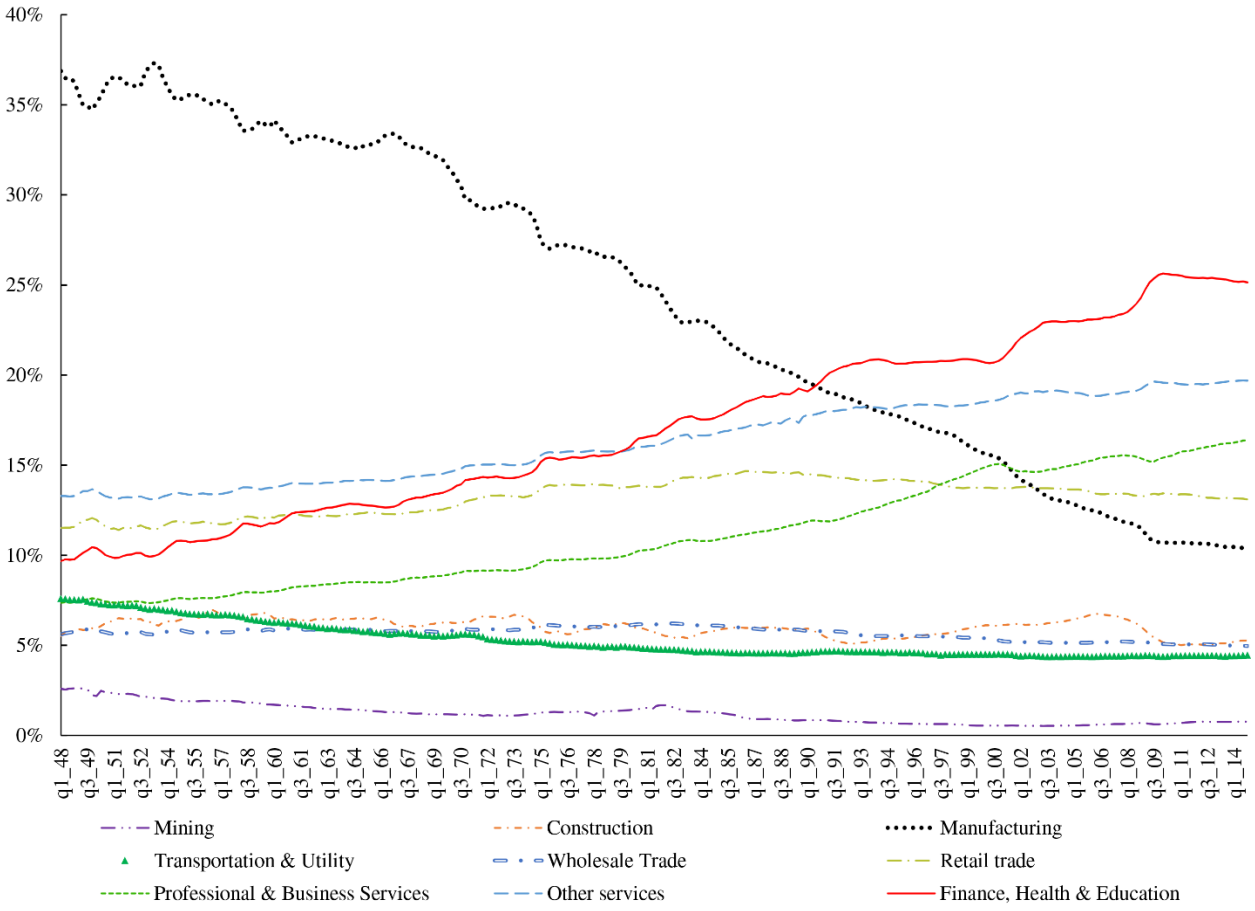


Fig. 2. Cross-sector standard deviation of percentages of college workers, 1967–2013

Fig. 3. Pre-1990 actual data versus fitted values

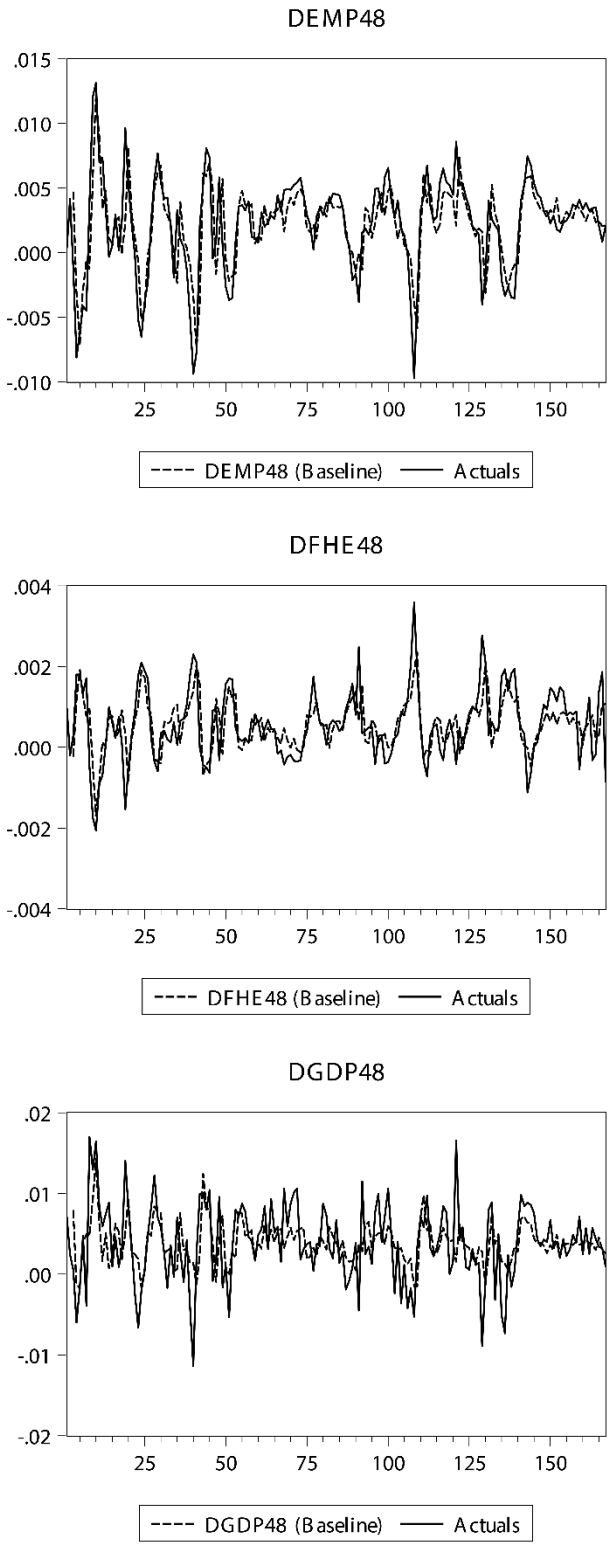
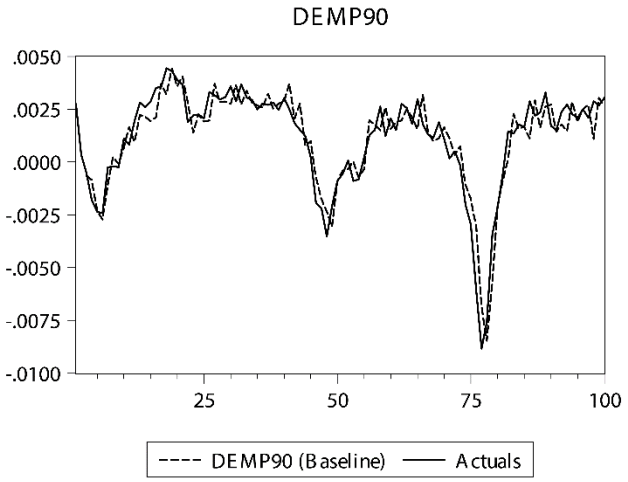
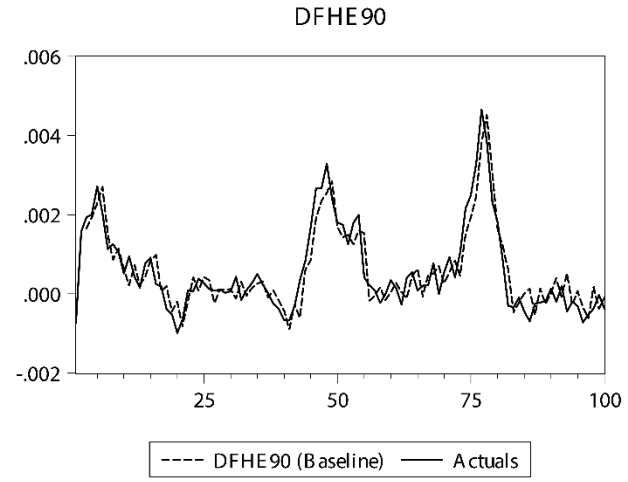


Fig. 4. Post-1990 actual data versus fitted values





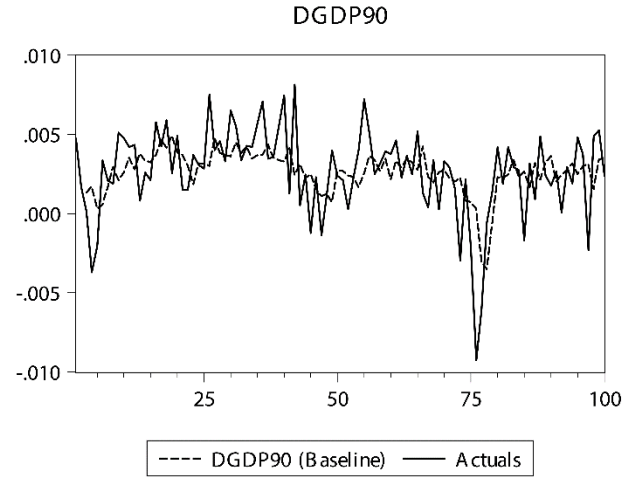


Fig. 5. Pre-1990 impulse responses

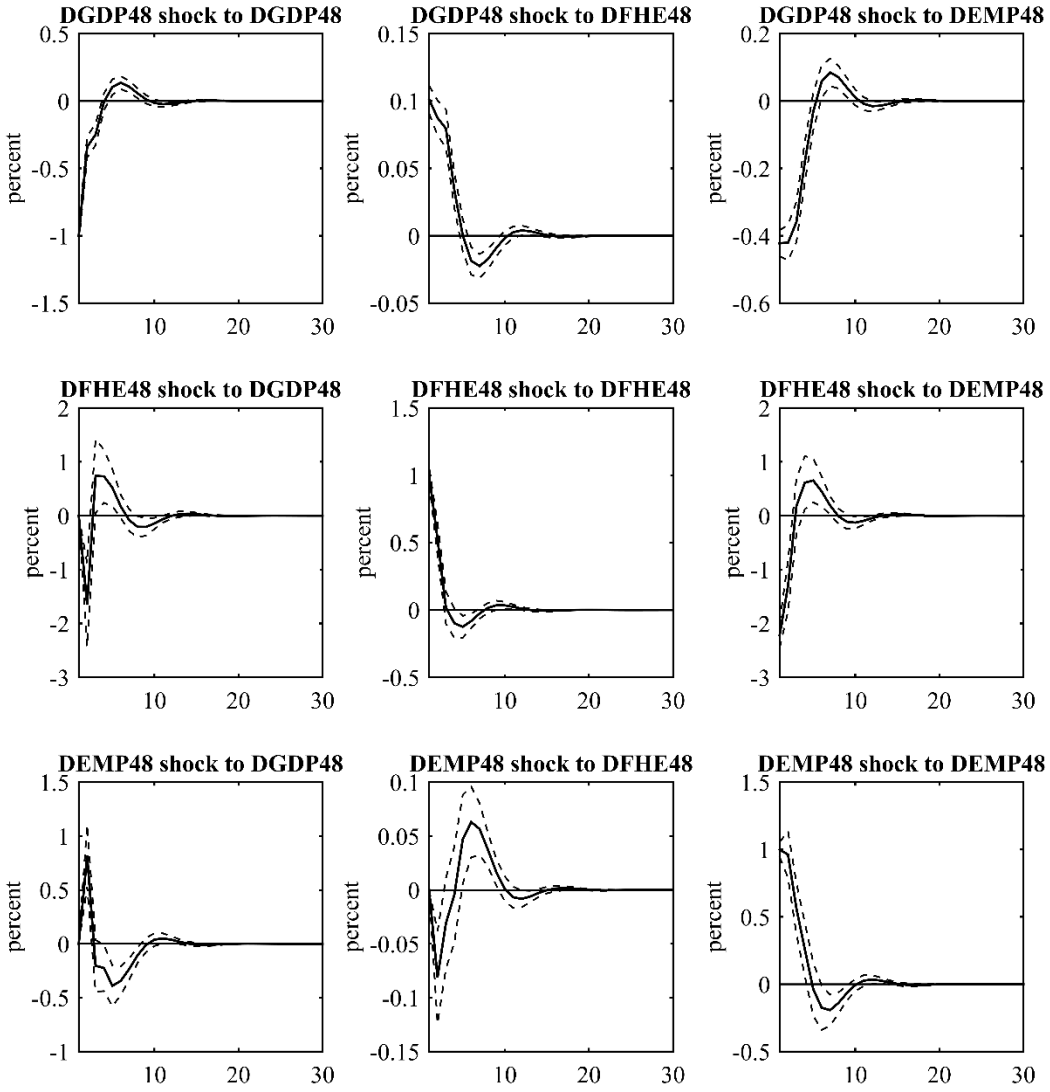


Fig. 6. Post-1990 impulse responses