THE FEDERAL RESERVE BANK
OF CHICAGO

ESSAYS ON ISSUES
2019 NUMBER 421
https://doi.org/10.21033/cfl-2019-421

# Chicago Fed Letter

## Explaining variation in real wage growth over the recent expansion

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In August 2019 the unemployment rate was roughly 1 percentage point below the Congressional Budget Office's (CBO) estimate of its long-run or natural rate, nearly matching the unemployment rate gap that developed during the historically tight labor market of the late 1990s. Nevertheless, real wage growth remains well below its pace of the late 1990s and even that of the milder 2000s expansion.

Some underperformance in real wage growth might be expected, given the economy has experienced subdued productivity growth in the past decade. However, some economists have argued recently that more nuanced measures of labor market performance are consistent with more slack (i.e., labor and capital that are idle) in the economy, and therefore slower real wage growth, than the unemployment rate gap would predict.[1]

In this *Chicago Fed Letter*, we additionally show that the impact of slack on real wage growth has changed significantly across groups of workers over time. In particular, we use data from prior to the 2008 financial crisis to estimate the association between real wage growth and the unemployment rate gap separately by gender-age-education groups. We then predict how aggregate real wage growth and the trend unemployment rate would have evolved if pre-2008 cyclical relationships had remained steady after 2008 and how specific demographic groups contributed to these patterns.

Since 2008 real wage growth for workers with at most a high school diploma has been only 0.25 percentage points per year less than for college graduates.

We find that aggregate real wage growth would have been up to 1 percentage point higher since 2011 if the cyclicality of real wage growth had remained similar to pre-2008 patterns. Current real wage growth is just over 0.5 percentage points below its predicted pre-2008 pace. Much of this shortfall arises from college-educated workers, especially college-educated workers in their fifties and sixties where there has been virtually *no* cyclical wage improvement during this expansion. By contrast, high school graduates and dropouts, and especially men in those education groups, have done relatively well over this expansion.[2]

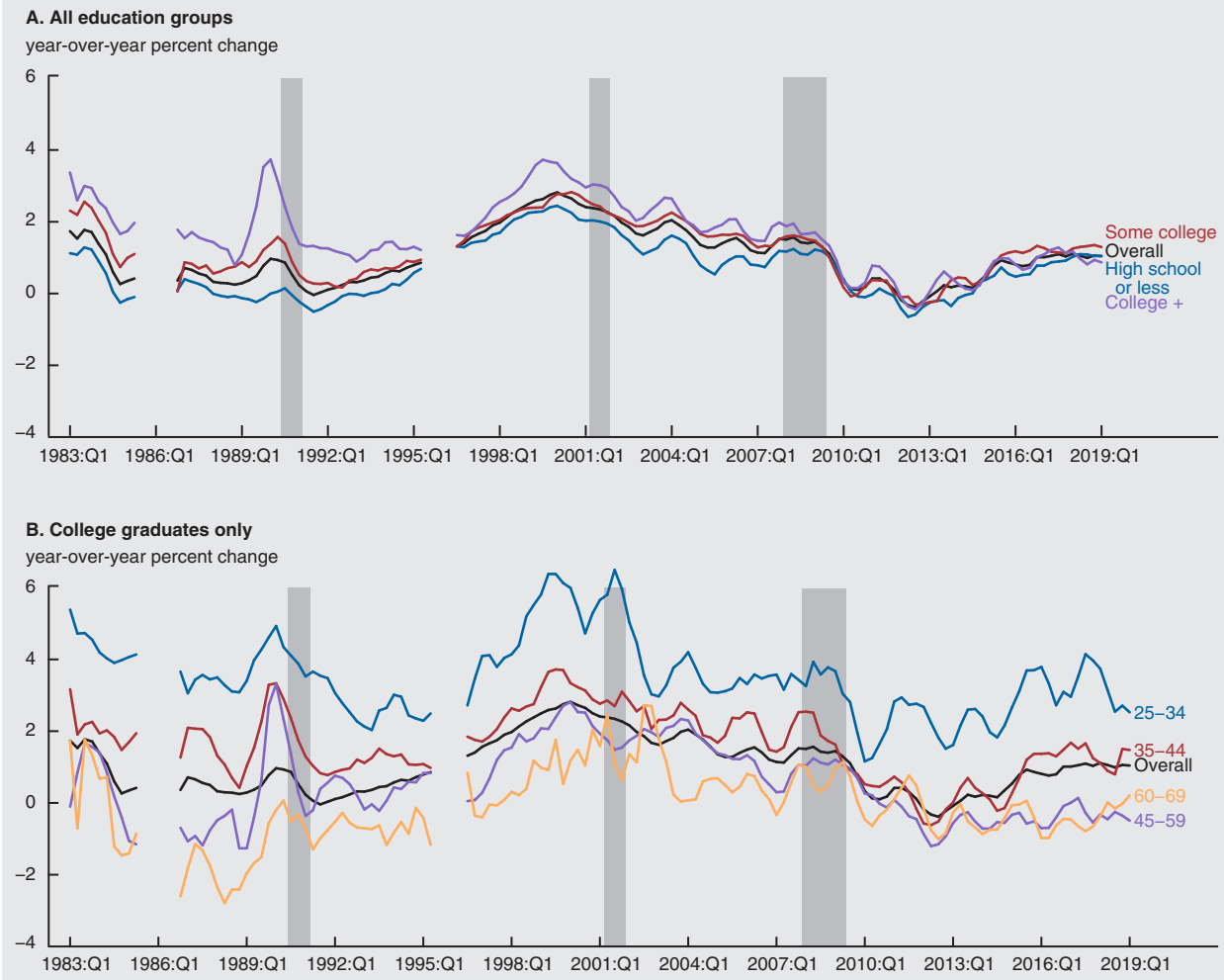
Finally, the trend unemployment rate that would be consistent with our statistical model needs to be quite low to explain recent real wage growth along with a historically low unemployment rate. Indeed, our implied trend unemployment rate has fluctuated between 2.5% and 3% since 2014. We also report estimates of the trend unemployment rate for selected age-education groups in order to quantify the tightness of specific labor markets.

## Changes in the cyclicality of real wage growth

We begin by illustrating a key example of the changing association between real wage growth and labor market slack across groups of workers. Figure 1, panel A, plots the median of year-over-year real hourly wage growth by education level from the U.S. Bureau of Labor Statistics' *Current Population Survey* (CPS).[3] From the early 1980s through the mid-2000s, additional education was associated with higher real wage growth. College graduates (purple line) typically earned an additional 2% per year, whereas individuals with some college experience but not a degree (red line) earned about 1.5% more per year and those with at most a high school diploma (blue line) took home an additional 0.75% per year. This gradient, where more education was associated with higher real wage growth, rarely deviated much regardless of whether the economy was in expansion or recession (gray bars denote recessions in the figures).

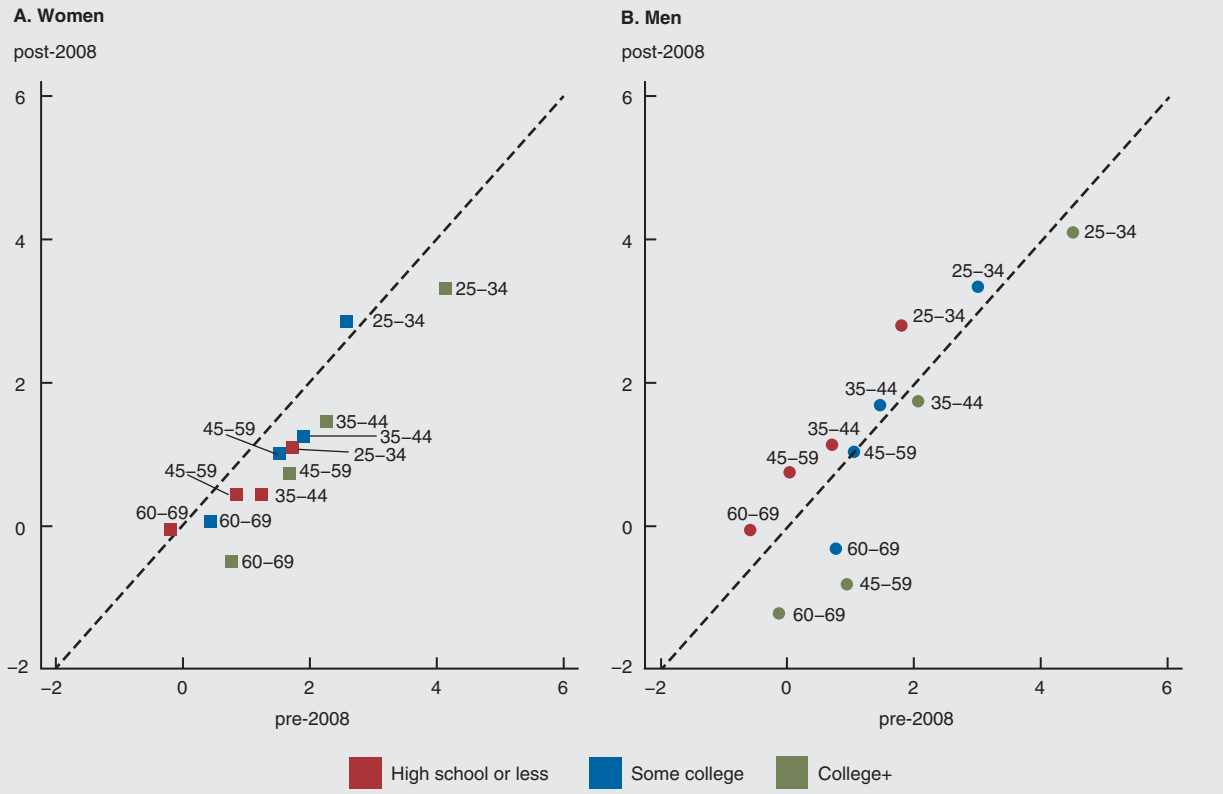
However, since 2008 the education gradient has more or less disappeared. On average, real wage growth among high school dropouts and graduates has been only 0.25 percentage points per year less than for college graduates, roughly a fifth the size of the average differential between the two groups in the 25 years prior to the financial crisis. Additionally, there have been significant changes in the cyclicality of real wage growth within education groups (figure 1, panel B). For example, relative to the past, the wages of younger college graduates (blue and red lines) have recovered faster than those of older college graduates (purple and yellow lines) during this expansion.

**1. Median real wage growth**




Note: The dark gray bars indicate periods of recession as identified by the National Bureau of Economic Research.
Source: Authors' calculations based on data from the U.S. Bureau of Labor Statistics, *Current Population Survey*.

## 2. Predicted real wage growth by education, pre-2008 versus post-2008




SOURCE: Authors' calculations based on data from the U.S. Bureau of Labor Statistics, *Current Population Survey*.

To generalize these and other patterns, we use data from the CPS for the years 1983 to 2017 to estimate demographic-specific median regressions of the form:

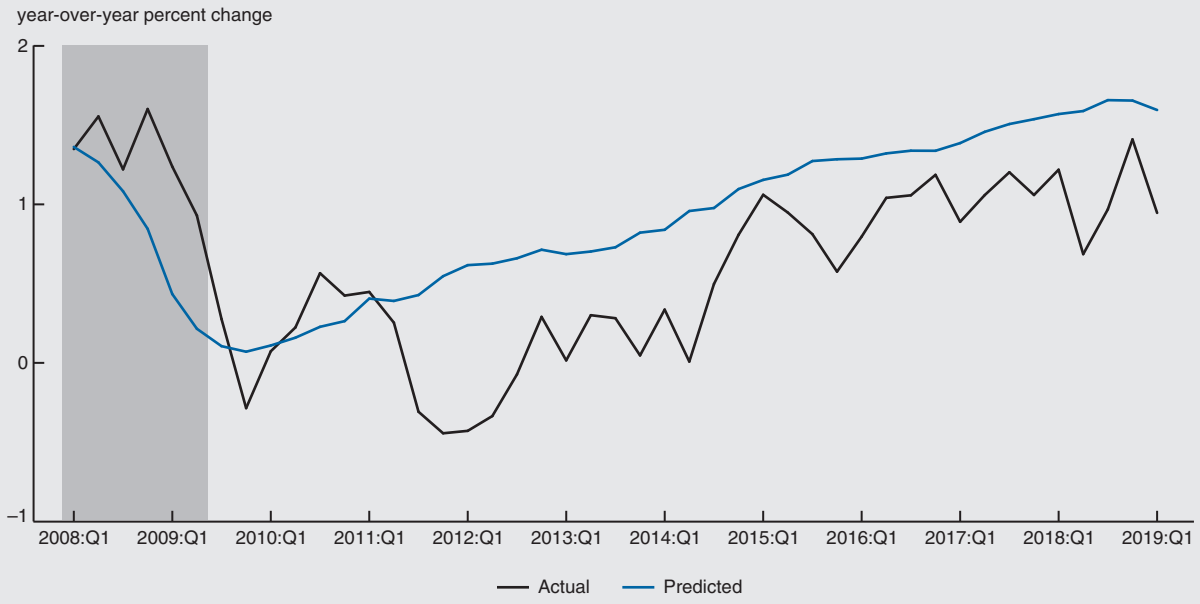
$$1) \quad w_{it} = \alpha + \beta_1 \left(u_t - u_t^*\right) + \beta_2 \times post08_t + \beta_3 \left(u_t - u_t^*\right) \times post08_t + \delta X_{it} + \varepsilon_{it},$$

where $w_{it}$ is year-over-year real wage growth of individual $i$ in month $t$, $u_t$ and $u_t^*$ are the *national* unemployment rate and the Chicago Fed estimate of its long-run or natural rate,[4] $post08_t$ is a dummy that takes a value of 1 if $t$ is after 2007 and zero otherwise, and $X_{it}$ is a set of industry, occupation, and census division controls. The term $\left(u_t - u_t^*\right) \times post08_t$ explicitly allows for the relationship between wage growth and the unemployment rate gap to differ before and after 2008. We estimate the model separately for 24 demographic groups, binned by four age groups (25–34, 35–44, 45–59, and 60–69), three education groups (high school diploma or less, some college, and college graduate), and gender.[5]

As an illustration of the estimation results, panels A and B of figure 2 show scatter plots of predicted 2018 real wage growth using two sets of coefficients from equation 1: those based on pre-2008 (plotted on the horizontal axis) and post-2008 (vertical axis) relationships. Estimates for women are reported in panel A and for men in panel B. In both panels, each dot/square represents one of the 12 age-education groups. For example, the green square in the upper right corner of figure 2, panel A, represents real wage predictions for women aged 25 to 34 years with a college degree. For that group, our pre-2008-based estimates predict 2018 real wage growth of 4.1%. By comparison, the post-2008-based estimates predict 2018 real wage growth of 3.3%.

If the pre-2008 and post-2008 parameters are the same prior to and post-financial crisis (i.e., $\beta_2$ and $\beta_3$ are both zero), the dots will fall along the 45-degree line. However, the dots tend to fall below

**3. Predicted aggregate real wage growth using pre-2008 model**




NOTE: The dark gray bar indicates a period of recession as identified by the National Bureau of Economic Research.
SOURCE: Authors' calculations based on data from the U.S. Bureau of Labor Statistics, *Current Population Survey*.

the 45-degree line, implying that the pre-2008 wage regressions project 2018 real wages to be higher than what ultimately materialized when using post-2008 data. That is, real wage growth has come in low during this expansion, relative to historic relationships between labor market conditions and real wage growth. That pattern holds for women in nearly every age-education group, with particularly large gaps among college-educated women (green squares in figure 2, panel A). For men, there is a striking dichotomy by education. Like college-educated women, college-educated men have experienced wage growth well below what we would have expected given pre-2008 relationships; this is especially true for college-educated men aged 45–69. However, recent real wage growth among men with at most a high school diploma (red dots) is stronger than past associations would have predicted.

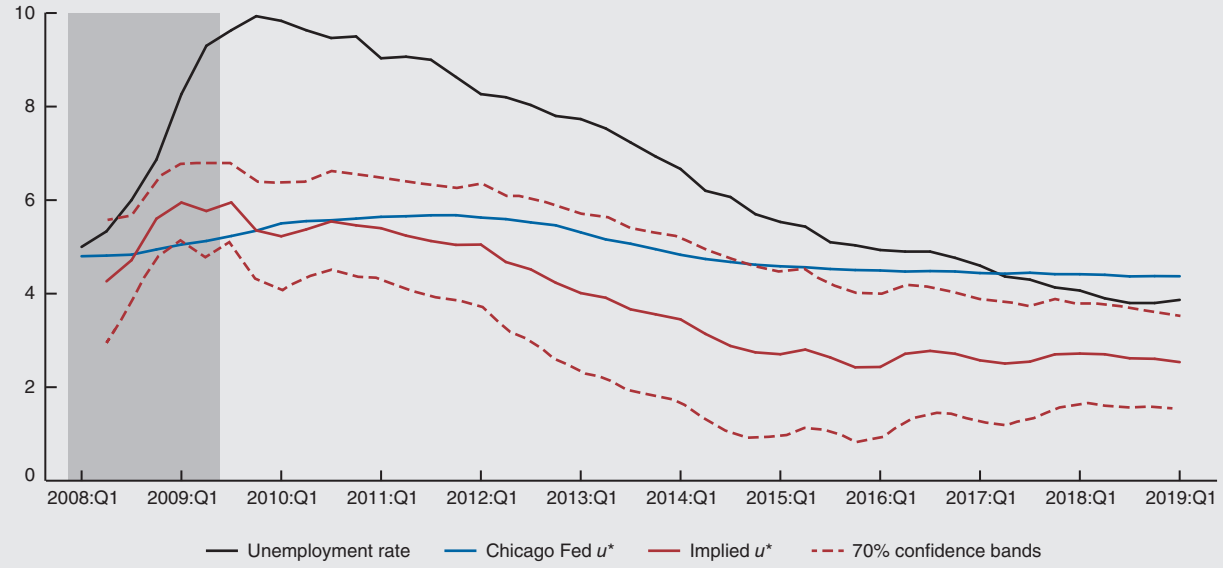
In figure 3, we show the counterfactual *aggregate* wage growth, using pre-2008 regression coefficients built up from our 24 demographic group forecasts with weights based on each group's size in the labor force. Actual real wage growth (black line) has consistently undershot pre-2008 expectations of aggregate real wage growth (blue line) by between 0.1 and 1 percentage points since 2012. As of 2019:Q1, the shortfall is 0.6 percentage points.[6]

## Implied trend unemployment rate over the current expansion

Another way to characterize the changing relationship between real wage growth and labor market slack since the financial crisis is to ask what the trend unemployment rate would need to be to make sense of observed real wage growth and the unemployment rate since 2008, assuming the pre-2008 relationship between real wage growth and the unemployment rate gap remained steady. The 16-quarter moving average of this implied $u^*$ is plotted as the red line in figure 4.[7] The red dashed lines provide 70% confidence bands.[8] For comparison, the actual unemployment rate and the Chicago Fed estimate of $u^*$ are displayed as the black and blue lines, respectively.

One compelling feature of this exercise is that our implied $u^*$ exhibits a hump shape during the last recession and early recovery, a pattern consistent with the Congressional Budget Office's path of $u^*$ and research documenting the increased difficulty of matching available jobs with available

**4. Implied *u** based on pre-2008 model**




NOTE: The dark gray bar indicates a period of recession as identified by the National Bureau of Economic Research.

SOURCES: National unemployment rate from the U.S. Bureau of Labor Statistics; implied *u** based on authors' calculations using data from the U.S. Bureau of Labor Statistics, *Current Population Survey* (see note 4).

workers during the financial crisis and its immediate aftermath.[9] Our implied $u^*$ peaks at 6% in 2009 and remains above 5% into early 2012. It then falls to under 3% by late 2014 and since then has stabilized between 2.5% and 3%. The current (2019:Q1) estimate of 2.5% has a 70% confidence band of 1.5% to 3.5%.

Intuitively, the aggregate implied $u^*$ needs to be low to be consistent with the undershooting of real wage growth over this expansion. But, again, there is considerable heterogeneity across demographic groups. For example, the current (2019:Q1) real wage growth of prime-age men with a high school diploma or less has been better than would have been predicted given historical patterns. Consequently, we estimate $u^*$ is 1.3 (25 to 34 year olds) to 2.2 (45 to 59 year olds) percentage points higher than their actual unemployment rate (i.e., a tight labor market). By contrast, current real wage growth has been low for college-educated men and therefore consistent with a $u^*$ that is 0.3 (25–34 year olds) to 1.5 (45–59 year olds) percentage points lower than their unemployment rate (i.e., a labor market with some remaining slack).

## Conclusion

Throughout this expansion, aggregate real wage growth has been slower than expected given its historical relationship with traditional measures of slack. However, that has not been uniformly the case. Of particular note, real wage growth of male high school graduates and dropouts has been relatively strong over this expansion. Much of the disappointing real wage growth has been among college-educated workers, especially college-educated workers in their fifties and sixties, who have seen virtually *no* cyclical improvement during this expansion. In the aggregate, our simple exercise implies some labor market slack may still exist, complementing recent research using more nuanced measures of labor market tightness. Based on wage data, much of this slack may be arising among the highest-educated and most-experienced workers in the labor force.

[1] See, for example, Katharine G. Abraham and John C. Haltiwanger, 2019, "How tight is the labor market?," paper presentation, Fed Listens: Conference on Monetary Policy Strategy, Tools & Communication Practices, Federal Reserve Bank of Chicago, June 4, and R. Jason Faberman, Andreas I. Mueller, Ayşegül Şahin, and Giorgio Topa, 2019, "The shadow margins of labor market slack," paper presentation, Conference Celebrating the 50th Anniversary of the *Journal of Money, Credit and Banking*, Federal Reserve Bank of New York, May 30.

[2] Our study complements recent studies that examine differences in cyclicality across demographic groups in other labor market indicators, including transition rates between labor force status (see Nicolas Petrosky-Nadeau and Robert G. Valletta, 2019, "Unemployment: Lower for longer?," *FRBSF Economic Letter*, Federal Reserve Bank of San Francisco, No. 2019-21, August 19, available online, https://www.frbsf.org/economic-research/publications/economic-letter/2019/august/unemployment-lower-for-longer/), employment experiences, and earnings and income (see Stephanie R. Aaronson, Mary C. Daly, William Wascher, and David W. Wilcox, 2019, "Okun revisited: Who benefits most from a strong economy?," *Brookings Papers on Economic Activity*, forthcoming, available online, https://www.brookings.edu/bpea-articles/okun-revisited-who-benefits-most-from-a-strong-economy/). Both papers provide evidence that the recent strong economy has particularly boosted the labor market performance of disadvantaged groups during this expansion.

[3] The CPS is a monthly mini-census of approximately 60,000 U.S. households. Real wages are computed from the self-reported earnings of hourly workers and the implied hourly wages of salaried workers, deflated by the core Consumer Price Index (CPI). To compute year-over-year wage growth, we match respondents aged 25 to 69 years in their outgoing rotation months (the fourth and eighth month of their participation in the CPS). Consequently, we drop individuals without paid employment in one or both surveys. If selection into employment is changing over time and over the business cycle, this may be problematic. Due to survey redesigns, workers cannot be matched between July 1985 and September 1986 and between June 1995 and August 1996.

[4] For details of the Chicago Fed $u^*$, see Daniel Aaronson, Luojia Hu, Arian Seifoddini, and Daniel G. Sullivan, 2015, "Changing labor force composition and the natural rate of unemployment," *Chicago Fed Letter*, Federal Reserve Bank of Chicago, No. 338, available online, https://www.chicagofed.org/publications/chicago-fed-letter/2015/338.

[5] This is essentially a decomposition exercise, as we use the same national measure of $u_t - u_t^*$ and $X_{it}$ for each regression. The results are broadly similar when we use a) the employment-to-population ratio gap, another standard measure of labor market conditions, or b) state of residence as the definition of a labor market. In the latter case, small sample sizes forced us to limit the sample to residents of the 15 largest states.

[6] Consistent with these estimates, aggregate labor productivity growth has slowed from 2.2% annually between 1983 and 2007 to 1.3% annually between 2008 and 2018.

[7] In particular, we calculate 24 demographic-specific $u^*$ as follows:

$$u^*_{(g)t} = UnemploymentRate_t - \left[\left(w_{(g)t} - \alpha_{(g)t}\right) / \beta_{1(g)}\right],$$

and then aggregate using population share weights to get a national $u_t^*$. The intercept $\alpha_{(g)t}$ is adjusted by coefficients on the control variables ($\delta_{(g)}$) based on weighted population shares in each category for each demographic group in each quarter.

[8] The standard errors are calculated via the bootstrap. Estimates were obtained from 500 bootstrap samples, and the reported 70% confidence interval is +/–1.04* (the interquartile range divided by 1.34). Because the standard errors are not corrected for clustering, it is likely they are somewhat wider than we report.

[9] See, e.g., Ayşegül Şahin, Joseph Song, Giorgio Topa, and Giovanni L. Violante, 2014, "Mismatch unemployment," *American Economic Review*, Vol. 104, No. 11, November, pp. 3529–3564. Crossref, https://doi.org/10.1257/aer.104.11.3529. The peak of the hump is somewhat sensitive to the specification of the post-period time frame (e.g., multiple time indicators rather than just one post-2008 indicator).

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**ISSN 0895-0164**