The Intensive and Extensive Margins of Real Wage Adjustment*

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Abstract

We decompose the aggregate measure of growth in real median usual weekly earnings for full-time workers into components due to contributions along the intensive margin–wage growth of the continuously full-time employed–and the extensive margin–wage differences of those moving into and out of full-time employment. The virtue of this decomposition is that it quantifies the importance of different margins for aggregate wage growth. The intensive margin is procyclical, dominates when labor markets are tight, and is largely driven by job changers. The extensive margin is counter-cyclical, important in labor market downturns and recoveries, and largely driven by part-time employment. Movements between full-time employment and unemployment account for little of the variation or cyclicality of aggregate real wage growth.

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1 Introduction

Aggregate real wages exhibit less variability over time than standard macroeconomic models predict and observed movements appear only modestly related to business cycle fluctuations.[1] Both of these patterns are evident in Figure 1 which plots growth in real median weekly earnings and the unemployment rate. As the figure shows, aggregate real wage growth, measured as median weekly earnings, varies less than the unemployment rate, a standard measure of business cycle movements.[2] Moreover, and in contrast to most models, there is no consistent pattern of comovement between wage growth and the unemployment rate.[3] From 1980-2019, aggregate wage growth has appeared procyclical, countercyclical, and acyclical.[4]

Two main forces have been identified as driving the cyclicality of aggregate real wage growth. The first is the procyclicality of real wage growth of individuals. Real wage growth of individuals tends to rise as the unemployment rate falls and vice versa. The size of the response is non-trivial. Several studies (Perry, 1972; Bils, 1985; Gary Solon, 1994; Devereux, 2001) find that a one percent increase in the unemployment rate reduces real-wage growth of individuals by about 1.3 percentage points. This is even larger for new hires (Haefke *et al.* , 2013), especially those hired from another job (Gertler *et al.* , 2016).[5] Wage growth of workers who remain in the same job is much less procyclical.[6] The growth in the real wage of an individual means that the person is employed at both the beginning and the end of the year.

[1]Several authors have concluded that wages are modestly tied to business cycle conditions: for example, Lucas (1977); Mankiw (1989); and Christiano & Eichenbaum (1992). See Abraham & Haltiwanger (1995) for a survey of empirical studies of real-wage growth over the business cycle.

[2]The limited variability of aggregate real wage growth fails the predictions of a variety of macro models including real business cycle models (Hansen, 1985) and models of frictional unemployment (Shimer, 2005). The flipside of this is that unemployment, employment, and hours tend to move more than these models predict, suggesting that most of the adjustments in the labor market come through quantities rather than prices.

[3]While most models expect wages to exhibit some cyclicality, the direction depends on the model. For example, Kydland & Prescott (1982), Robert J. Barro (1984), Rotemberg & Woodford (1992), and Bartelsman *et al.* (1994) all posit procyclical real wages while a countercyclical relationship is predicted by models with sticky wages and flexible prices. See Swanson (2007) for a brief review of these issues.

[4]In contrast to the movements of aggregate real wage growth,

[5]This evidence points to the importance of job ladders for aggregate wage growth, (Haltiwanger *et al.* , 2015; Kahn & McEntarfer, 2014; Moscarini & Postel-Vinay, 2016).

[6]This is largely explained by deviations from neoclassical assumptions, like wage rigidities (Card & Hyslop, 1997; Lebow *et al.* , 2003; Dickens *et al.* , 2007; Barattieri *et al.* , 2014; Daly & Hobijn, 2014). See Pissarides (2009) and Kudlyak (2010, 2014) for overviews and discussions.

It reflects the intensity with which the person is paid for their labor services. This is why we call this force the *intensive margin* of wage adjustment.

The second force, which partly offsets the procyclicality of the first one, is the countercyclical pressure on aggregate wages that comes from changes in the composition of the pool of employed workers over the business cycle. Previous studies of the composition effect on aggregate wages focus on the demographic characteristics of those employed (e.g. Aaronson & Sullivan, 2001). For example, previous studies have shown that employment losses during economic downturns disproportionately occur among workers with below average wages (Hines *et al.* , 2001). This upskilling implies less variation in aggregate real wages than implied by models where workers are homogeneous and wages adjust uniformly (Altonji & Devereux, 2000). In this paper we take a different approach. Changes in this composition are due to flows of people into and out of employment, i.e. because of people who are either employed at the beginning or the end of the year. With that in mind, we focus on the importance of each of these flows by origin or destination, depending whether they are into or out of employment. This is what we call the *extensive margin* of real wage growth.

Thus, the intensive and extensive margins we focus on in this paper encompass the two main cyclical forces that affect aggregate real wage growth. What distinguishes our analysis from previous studies is that we decompose aggregate wage growth into the contributions of these two forces, and their underlying components. The particular measure of aggregate wage growth that we use is real median usual weekly earnings for full-time workers. Two things are important to note here. First, the measure we decompose is a median, rather than a mean. This requires us to use a non-standard decomposition method. The decomposition we use relies on the mean value theorem to translate shifts in conditional earnings distribution functions into percent changes in deflated (real) dollars. It can be used to movements in any percentile of wage distribution. Our main focus here is on the median, but we also present results for the 10^{th} and 90^{th} percentiles. Second, we focus on the earnings of full-time workers. So, the extensive margin does not only include transitions into and out of unemployment and the labor force, but also into and out of part-time employment.

Our decomposition yields four main findings. The first is that both the intensive and extensive margins affect real wage growth, but their relative importance varies over the business cycle. Second, as expected, the intensive margin is procyclical and dominates when labor markets are tight. Over the entire sample this margin accounts for most of the variance of real wage growth. Third, the extensive margin is countercyclical and, in business cycle downturns, offsets more than half of the procyclicality of the intensive margin. Finally, most of the extensive margin adjustment comes from flows between full-time employment and part-time/self-employment and between full-time and not-in-the-labor-force. Movements between full-time employment and unemployment account for little of the variation or cyclicality of aggregate real wage growth.

The remainder of the paper is structured as follows. In Section 2 we describe the Current Population Survey (CPS) data and discuss its key advantages. In Section 3 we discuss an example of how the intensive and extensive margins affect median real wage growth. We formalize this intuition and introduce a decomposition method that allows us to decompose the percent change in median wages. Section 4 contains the results of our decomposition. We conclude with Section 5.

2 Usual Weekly Earnings and Labor Force Status Flows

There are four widely-used measures of aggregate real wage growth in the United States. average hourly earnings (AHE) and compensation per hour (CPH) are the two measures commonly analyzed by macroeconomists.[7] The Employment Cost Index (ECI) is the benchmark for the escalation of wages in many employment contracts. Finally, median usual weekly earnings (MWE) is based on self-reported earnings data that is often used in individual level analyses of earnings. It is this latter measure that we focus on in our analysis.

Though these four measures differ in the components of compensation they include and

[7] See Smets & Wouters (2007), Gertler & Trigari (2009), Justiniano *et al.* (2011), and Galí *et al.* (2011), for example.

in their scope, they exhibit similar cyclical patterns. This can be seen from Figure 2, which plots the growth rates of these measures, all deflated by deflated by the Personal Consumption Expenditures Price Index (PCEPI), so that the figure plots growth in real wages. Important for our work is that the MWE series captures the coincident movements of the different compensation growth measures very well. Visual inspection shows that MWE is rarely an outlier across the series in terms of fluctuations in growth.[8] The correlation of real wage growth measured by MWE with the other three measures is 0.6 or higher.

We focus on MWE in our analysis because it is the only one out of these four measures for which the underlying individual-level micro data, including information on earnings levels and labor market status are available. The CPS data, from which MWE growth is constructed, is a long-standing, nationally representative, publicly available data source.[9] These data can be used cross-sectionally or, as we do, to construct short panels of individual respondents.

To understand the type of information contained in each of these short panels it is useful to review the CPS survey structure. The CPS is a dwelling-based survey in which households are included for 16 months. Over this period, individual household members are interviewed monthly for the first four months, not interviewed for the next eight months, and then interviewed monthly again for the remaining four months before being retired from the sample.[10]

Table 1 provides an illustration of this structure. The regular monthly surveys collect very basic information about labor market status. Earnings information along with other details of jobs are collected twice during a households survey tenure, once in survey month 4 and again in survey month 16.[11] Earnings and job information are collected only for individuals who are

[8]The exception to this statement is 1994, when MWE rose much more rapidly than the other series. This coincides with the CPS redesign and the way the survey was changed to determine whether someone is a part-time or full-time employee.

[9]Previous research on the drivers of aggregate wage dynamics relied on smaller panel surveys which provide detailed data on individuals for shorter time periods. For example, Bils (1985) uses the National Longitudinal Survey of Youth (NLS/Y). Gary Solon (1994), Devereux (2001), and Hagedorn & Manovskii (2013) use the Panel Study of Income Dynamics (PSID). Gertler *et al.* (2016) and Barattieri *et al.* (2014) use data from the Survey of Income and Program Participation (SIPP).

[10]Because the CPS is a dwelling-based survey, individuals who change residences are dropped from the sample.

[11]Survey months 4 and 16 are commonly referred to as the outgoing rotation groups since they are individuals temporarily moving off the sample frame or permanently retiring from the survey. The matched samples of these outgoing rotation groups are known as the MORG files.

employed at the time of the interview.

The MWE aggregate derived from these data tracks the growth rate of median usual weekly earnings of full-time wage and salary earners.[12] MWE is published at a quarterly frequency. Usual weekly earnings are defined as "...earnings before taxes and other deductions and include any overtime pay, commissions, or tips usually received (at the main job in the case of multiple jobholders)."[13]

Following other researchers, we rely on the information collected in survey months 4 and 16. We use the match of individuals across surveys from Flood *et al.* (2020). [14] Since we are interested in disentangling the intensive and extensive margins of wage growth, we construct a series of short panels based on individuals who we observe in both months 4 and 16. That is, the published MWE series compares median earnings in the cross-section of workers in sample months 4 and 16 in one quarter with those in the same sample months a quarter before. We, instead, compare the growth in median earnings of those in sample month 16 from a year ago, when they were in sample month 4. This results in an alternative series of MWE growth. This alternative series, which we term "Matched MWE Growth"is what we decompose. Though our Matched MWE Growth measure does not exactly match the published series, the two are highly correlated, with a correlation of 0.79.[15]

To be able to link wage growth to different labor market states, we next classify individuals

[12]The focus on full-time wage earners still means that MWE is affected by fluctuations in overtime pay, as well as a trend in the average work week for full-time workers (See Perry, 1972, for a discussion of these issues).

[13]The CPS survey questions related to usual weekly earnings have evolved over time: Prior to 1994, respondents were asked how much they usually earned per week. Since January 1994, respondents have been asked to identify the easiest way for them to report earnings (hourly, weekly, biweekly, twice monthly, monthly, annually, other) and how much they usually earn in the reported time period. Earnings reported on a basis other than weekly are converted to a weekly equivalent. The term usual is as perceived by the respondent. If the respondent asks for a definition of usual, interviewers are instructed to define the term as more than half the weeks worked during the past 4 or 5 months (Bureau of Labor Statistics, 2011).

[14]One concern about using the CPS to track individuals over time is that the sample may not be representative of the population. Since the CPS is a dwelling based survey, when individuals change residences they are dropped from the sample and the new occupants of the unit are interviewed. While this does not alter the cross-sectional representativeness of the CPS, it can potentially interfere with representativeness of the individual-based short panels, especially if moving is related to the variables being analyzed. However, work by Nekarda (2009) and Kim (2009) that carefully corrects for this type of sample attrition finds that the biases introduced are empirically modest. Ahn & Hamilton (2019) suggest these biases might be more substantial.

[15]Due to the scrambling by the Census Bureau of identifiers that we use to match individuals across months, we are unable to perform this matching for two sub-periods of our sample, namely October 1985 through September 1986 and September 1995 through August 1996.

based on their reported labor market status. This allows us to divide individuals in our Matched MWE Growth series into five mutually exclusive groups. These are listed in Table 2. As the table shows, we first divide individuals into two groups: (*i*) those who are continuously full-time employed and have a reported wage in both survey month 4 and survey month 16, and (*ii*) those who move into or out of full-time employment and have a reported wage in either survey month 4 or survey month 16. We label these two groups the *intensive* and *extensive* margin, respectively. This nomenclature reflects how the *intensive* margin of wage growth captures the intensity with which continuously full-time employed workers get paid while the *extensive* margin captures the effect on aggregate wages of entry and exit into full-time employment.

To enable us to further track the drivers of real wage adjustment, we further divide these workers as follows. Within the *intensive* margin we distinguish between: (1) *Same job* (S), full-time employed in the same job in both periods, and (2) *Job changers* (C), full-time employed in a different job from one period to the next.[16] The *extensive* margin is split up by transitions to or from full-time employment and: (3) *part-time/self-employment* (P), (4) *unemployment* (U), and (5) *not in the labor force* (N).

Although most of these states can be directly observed in the survey data, the CPS provides no specific information on whether full-time employed earners have stayed at the same job or changed jobs over the sample. Following previous research, we impute the fraction of full-time workers who stay in the same job versus change jobs using reported information on industry and occupation. Our measure identifies as a job changers as individuals who report a either a different industry, or a different occupation, or both in survey month 16 versus survey month 4.[17]

[16] Making this distinction is important given the different cyclical patterns of wage growth among job stayers and job changers (Bils, 1985; Devereux, 2001; Hagedorn & Manovskii, 2013; Haefke *et al.* , 2013).

[17] This imputation is similar to that in Card & Hyslop (1997).

3 Decomposition of Median Real Wage Growth

Before we introduce our formal decomposition, it is useful to preview how the intensive and extensive margins of labor market adjustments affect median wage growth. Table 3 reports the average shares (1980-2019) of wage earners who occupy each of the five states at the beginning of the period (survey month 4) and at the end of the period (survey month 16) as well as the fraction of these workers who earned below median earnings in the period.

The first thing to note is that the vast majority (89 percent) of wage earners are continuously full-time employed over a 12 month period. About 41 percent of these workers stayed in the same job over the period while about 48 percent changed jobs. Of the remaining wage earners, 2.6 percent of those full-time employed at the beginning of the year end up unemployed at the end of it and about 2.6 percent of those full-time employed at the end of the year were unemployed at the beginning. In contrast, flows into and out of full-time employment from part-time/self-employed and not in the labor force are substantially larger. The fact that so many flows occur along these margins suggests that they could play a bigger role in real wage adjustments than previously realized.

The second thing to note is that the bulk of movements along the extensive margin occur below the median. This can be gleaned from columns III and IV in rows 3 through 5 of Table 3. About half of those continuously full-time employed earn wages below the median; job stayers have slightly higher earnings than job changers. In contrast, about two-thirds (63.9 percent) of full-time workers who exit to unemployment were earning below median wages. An even larger fraction, 72.5 percent, of those making the reverse transition, from unemployment to full-time employment, make less than median earnings. This means that in general when unemployment rises, it disproportionately pulls out workers making below median earnings. Holding the wages of other workers constant, this serves to increase in the aggregate median wage. The part-time/self-employed and not in the labor force margins contribute in a similar way. Most of their flows into and out of full-time employment occur below the median. Thus, when exits from full-time employment to part-time employment/self-employment and not-in-the-labor-force increase, the aggregate median wage tends to rise.

We formalize the intuition above in an additive decomposition MWE growth. The main issue is that the aggregate we decompose is a median, rather than a mean.[18] This requires the use of a non-standard decomposition method.

The problem is that percentiles, such as the median, are nonlinear functions of the underlying conditional percentiles. As such, there is no way to directly decompose the movements in the unconditional median into the contributions of the changes in the medians of different subgroups. To get around this, researchers have proposed two different approaches. Both of these approaches involve relating the change in the median to shifts in distribution functions over time.

The first approach, developed by DiNardo *et al.* (1996), decomposes the change in the distribution function by calculating a series of counterfactual distribution functions and implied medians based on iteratively altering the drivers of interest. This method is especially useful for evaluating large changes in distributions over long periods of time. The main drawback of this method is that it is *not additive*. Consequently, the decomposition can lead to over- or under-explaining the total change in the median.

As discussed in Fortin *et al.* (2011), a second possible approach is to linearize the change in the distribution function with respect to the log-level of the wage. By construction, this results in an additive decomposition of the change in the median. Our decomposition is an application of this second approach. Because it involves a linear approximation, this method is useful for analyzing small changes over relatively short periods of time. The annual changes in the distribution of log-wage levels that we analyze exactly fit this use.

Our decomposition works as follows. First, we decompose the shift in the earnings distribution function using a shift-share-type analysis. We then apply the mean value theorem to translate these changes in fractions of the full-time wage and salary workers into changes in real earnings.

[18] If we were interested in mean real wage growth this would be simple. We could apply a standard shift-share decomposition of the type used by Juhn & Potter (2006) to investigate changes in labor force participation or Bartelsman *et al.* (2004) to investigate average labor productivity growth.

3.1 "Shift-share" analysis of change in log real earnings distribution

A standard shift-share analysis is based on the fact that the unconditional mean is the marginal-density-weighted sum of conditional means. For our analysis we exploit that, similarly, the unconditional CDF is the marginal-density-weighted average of the conditional CDFs. In particular, we condition on the labor market states, l, listed in Table 2.

To see how a shift-share-type analysis can be applied to changes in distribution functions, consider Figure 3. It plots two log-earnings distribution functions, $F(W)$ and $G(W)$. These are the earnings distribution functions at the beginning and end of the period, respectively. The medians associated with these two distribution functions are given by w and w'.

To illustrate the relationship between changes in the median and changes in the underlying distribution function we assume, without loss of generality, that there is positive growth in the percentile over the period and that $w' > w$. These medians satisfy

$$^1\!/_2 = F\left(w\right) = G\left(w'\right). \tag{1}$$

We denote the fraction of full-time employed wage and salary workers in each of these states at the beginning of the period by $\phi\left(l\right)$ and their wage distribution conditional on their labor market state by $F\left(W \mid l\right)$. This allows us to write

$$F\left(W\right) = \sum_{l} \phi\left(l\right) F\left(W \mid l\right). \tag{2}$$

A similar decomposition can be applied to $G\left(W\right)$.

This observation allows us to use a shift-share analysis to decompose the change in the distribution functions at the median at the beginning of the period, i.e. at w. This yields

$$\begin{aligned} F(w) - G(w) &= \sum_{l \in \{S,C\}} \phi(l) \left[F(w \mid l) - G(w \mid l) \right] \qquad (3) \\ &+ \sum_{l \in \{P,U,N\}} \phi(l) \left[F(w \mid l) - 1/2 \right] - \sum_{l \in \{P,U,N\}} \gamma(l) \left[G(w \mid l) - 1/2 \right] \\ &- \sum_{l \in \{S,C\}} \left(\gamma(l) - \phi(l) \right) \left[G(w \mid l) - 1/2 \right]. \end{aligned}$$

Here $\gamma(l)$ and $G(W \mid l)$ are definined in a similar way to $\phi(l)$ and $F(W \mid l)$. Each of the three lines in the above equation capture a different reason for the shift in the distribution function.

For the job stayers, S, and the job changers, C, the first line measures the difference between the fraction of each of these groups that is below the median at the beginning of the period and the fraction that is below the median at the end of the period. For each of the two categories of continuously full-time employed the first line gives the fraction of them that moved across the median. This is equivalent to the *shift-part* of a conventional shift-share analysis. Because this line captures the effect on the distribution of wage changes for the continuously full-time employed, we denote this as the *intensive* margin effect on the distributional shift.

The two terms in the second line of equation (3) reflect the effect of exit out of and entry into full-time employment on the wage distribution respectively. For each group, the first term measures the fraction of those that exit from below the median. Exit from below the median, i.e. $F(w \mid l) > 1/2$, shifts the wage distribution rightward, increases $F(w) - G(w)$, and thus puts upward pressure on the median. Hence the plus sign in front of this first term. The second term measures the fraction that enters below the median. Such entry tends to shift the wage distribution leftward and pull down the median. This is why this term is preceded by a minus sign. Because the terms in the second line of equation (3) quantify the part of the distributional shift that is due to entry and exit, we include this in the *extensive* margin effect on the wage distribution dynamics.

As for the third line of equation (3), if net entry is zero, such that

$$\sum_{l\in\{P,U,N\}} \phi(l) = \sum_{l\in\{P,U,N\}} \gamma(l), \tag{4}$$

then, by definition, $\gamma(S) = \phi(S)$ and $\gamma(C) = \phi(C)$, and the third line is zero.

It is not necessarily zero when there is net entry into or exit out of full-time employment. This line captures the effect of the net entry share on the wage distribution. For example, consider the case in which net entry is negative and there is no full replacement of outflows out of full-time employment, $\gamma(l) > \phi(l)$. If exit exceeds entry for groups that generally earn less than the median, such that, $G(w \mid l) > 1/2$, then this shifts the wage distribution rightwards and pushes up the median wage. This is the distributional version of a conventional *share effect*. Because this share effect is only non-zero in case there is net entry or exit, we include it in the *extensive* margin of the dynamics of the wage distribution.

In terms of Figure 3, equation (3) decomposes $F(w) - G(w)$, which is the downward arrow at the median at the beginning of the period, w. Similarly, one can apply the same decomposition at the median at the end of the period, w'. As is most commonly done in shift-share analyses, we do not take a stance on which one of these decompositions is preferred. Instead, we decompose the sum of the both of them. That is, we use

$$\begin{aligned}
&[F(w) - G(w)] + [F(w') - G(w')] \\
&= \textstyle\sum_{l\in\{S,C\}} \{\phi(l)[F(w \mid l) - G(w \mid l)] + \gamma(l)[F(w' \mid l) - G(w' \mid l)]\} \\
&\quad + \textstyle\sum_{l\in\{P,U,N\}} \phi(l)\{[F(w \mid l) - 1/2] + [F(w' \mid l) - 1/2]\} \\
&\quad - \textstyle\sum_{l\in\{P,U,N\}} \gamma(l)\{[G(w \mid l) - 1/2] + [G(w' \mid l) - 1/2]\} \\
&\quad - \textstyle\sum_{l\in\{S,C\}} (\gamma(l) - \phi(l))\{[F(w' \mid l) - 1/2] + [G(w \mid l) - 1/2]\}.
\end{aligned} \tag{5}$$

Though the terms in this equation are longer than in equation (3), the main intuition of what makes up the *intensive* and *extensive* margins of the shift in the earnings distribution remains the same. Using this method we are able to divide the change in the wage distribution function in every period into the parts driven by the *intensive* and *extensive* margins of interest.

3.2 Translating changes in CDFs into changes in the median

The shift-share-type decomposition of the shift in the distribution function introduced above divides changes along the vertical axis in Figure 3 into parts due to the intensive and extensive margins. However, our aim is not to decompose the shift in the earnings distribution function but, instead, to decompose changes in the median. These changes in the median are movements along the horizontal axis in Figure 3. The final step then is to translate the change in the CDFs into changes in the median.

This translation can be done by applying the Mean Value Theorem. To apply the Mean Value Theorem, we first use the fact that w and w' satisfy equation (1) to write

$$[F(w) - G(w)] + [F(w') - G(w')] = [G(w') - G(w)] + [F(w') - F(w)]\,. \tag{6}$$

If $F(W)$ and $G(W)$ are continuously differentiable with associated density functions $f(W)$ and $g(W)$ then, according to the Mean Value Theorem, there exists $w^* \in [w, w']$ such that

$$[G(w') - G(w)] + [F(w') - F(w)] = q^* \times (w' - w)\,, \text{ where } q^* = [f(w^*) + g(w^*)]\,. \tag{7}$$

The constant, q^*, that translates changes in the distribution function into change in the median is the sum of the earnings density at the beginning and end of period evaluated in w^*. Since these densities, by definition, reflect the fraction of the population, i.e. the y-axis variable in Figure 3, per unit of the wage, i.e. the x-axis variable in Figure 3, q^* is a well-defined and interpretable translation factor.

Another way of interpreting this translation factor is to consider a linearization of the change in the distribution function. For illustrative purposes we consider this linearization with w as the expansion point. Such a log-linearization yields that

$$[G(w') - G(w)] + [F(w') - F(w)] \approx q \times (w' - w), \text{ where } q = [f(w) + g(w)]. \tag{8}$$

The error of this first Taylor Approximation tends to be small when we evaluate relatively small changes in the median. If the changes in the median are small then

$$q = f(w) + g(w) \approx q^* = f(w^*) + g(w^*) \approx q' \equiv f(w') + g(w') \tag{9}$$

Thus, for the relatively small changes in the median that we study in this paper, the translation factor, q^*, can be interpreted as sum of the earnings densities at the beginning and end of the period evaluated at the median.

The most important insight from the application of the Mean Value Theorem in equation (7) is that, because q^* is the same for all subgroups, the shares of the contributions of the intensive and extensive margins in the change in the distribution functions are the same as those in the change in the median. We use this result for our decomposition. In particular, we use equation (5) to divide the change in the distribution function into parts due to the different subgroups from Table 2. We then use the translation constant to rescale these contributions such that they reflect changes in the median log wage rather than the earnings distribution function.

4 Results

We present our results in three steps. First, we review how the contributions of the intensive and extensive margins to aggregate median wage growth vary over time. We then discuss the main reasons behind one of our key results; that the unemployment margin matters very little for aggregate wage growth. We conclude by adding it all up and calculate the average contributions of the intensive and extensive margins to fluctuations in and the cyclicality of real wage growth.

4.1 Time series of decomposition results

Figure 4 plots the time series of the contributions of the intensive and extensive margins to median real wage growth. The first thing to note is that the intensive margin is the dominant driver in all decades of our sample and was especially important during the strong labor markets of the mid 1980's and the late 1990's and the 2010''s. The second thing to note is that the extensive margin, i.e the net effect of entry and exit, is to depress wage growth, as workers with higher wage levels are replaced by entrants into full-time employment with wages below the median. During recessions, the extensive margin becomes less negative, partially offsetting the procyclical slowdown in wage growth among the continuously full-time employed. Although the magnitude of the effect varies from recession to recession, it generally is not very large.

The exception to this general characterization is the Great Recession. During this period, the extensive margin contribution turned from negative to positive, something previously unseen in the data. The decline in the drag from entry and exit owed to a surge of exits from full-time employment that largely occurred from below the median. This pushed aggregate median wage growth above that of the continuously full-time employed.

Figure 5 further decomposes the intensive and extensive margins into the more detailed labor market states. Panel 5a of the figure shows the contributions of job stayers and job changers to the total intensive margin effect. The results reveal that those who change jobs over the year contribute more to the intensive margin than those who remain in the same job. This owes to the fact that the share full-time employed who change jobs, C , is larger than the share who stay in the same job S, while the earnings changes, or shifts, of C and S are similar.

When labor markets are tight, job changers contribute more to wage growth; the C effect is amplified by an increase in the share of job changers and an increase in the fraction who move from below to above MWE. In labor market downturns, job changing and the wage returns to changing fall such that job changers contribute roughly the same to wage growth as those who stay in the same job. This means that the contributions of individual wage growth of C and S converge. In general, during labor market expansions the strong performance in terms of wages of those who are in S and C (displayed in Figure 4) is amplified by an increase in their share. The result is that the intensive margin contributes procyclically to real wage growth.

Turning to the sub-groups that are part of the extensive margin displayed in Panel 5b, all of them contribute to the countercyclicality of the extensive margin on real wage fluctuations. Though small, even the replacement components for same job and job changers move countercyclically.

Relative to standard models, the contributions to fluctuations in the extensive margin are surprising. The part-time/self employment margin contributes the most of any sub-group. The magnitude of the part-time/self employment effect relative to other margins owes to the fact that a larger fraction of flows into and out of part-time/self-employment occur from below MWE. In business cycle downturns, more workers move from full-time to part-time boosting the share of exits to this margin. At the same time there is little change in the earnings differences associated with these flows, with nearly all of it taking place below the median.[19] Focusing on the Great Recession highlights the impact of this part-time/self-employment margin. The incidence of involuntary part-time employment increased sharply during the Great Recession, causing the countercyclical contribution of the part-time and self-employed, P, to the extensive margin of real wage growth to increase substantially after 2008.

Another surprisingly large contributor to the fluctuations in the extensive margin is movements across the participation margin. The N effect is always larger or as large as the unemployment margin. During labor market expansions, a larger share of individuals enter full-time employment from not-in-the labor force. Since the vast majority, around 80 percent, enter at below median earnings, the larger share pulls down wage growth. In recessions, this effect is tempered by a reduction in the share of workers flowing into full-time employment

[19] The importance of the part-time/full-time margin for hours growth, rather than wage growth, was emphasized by Borowczyk-Martins & Lal (2019)

from not-in-the-labor force and an increase in workers flowing out of full-time employment to not-in-the-labor force. This causes the N effect to be countercyclical.[20]

4.2 The relative unimportance of the unemployment margin

Unemployment is the prevalent extensive adjustment margin considered in most macroeconomic models. However, the results in Figure 5b show that unemployment is less important than other margins, both in terms of contributions to extensive margin fluctuations and in terms of the countercylicality of the extensive margin. To see why this is the case, we refer to Table 3 which reports the average share and shifts components of unemployment, Figure 6a which shows the time series of the share of full-time employed exiting to and entering from unemployment, and Figure 6b which shows the accompanying fraction of flows into and out of unemployment from below the median.

Consider first the average effect of U on the extensive margin adjustment Table 3, row 4. As with the other extensive margin sub-groups, entrants to full-time employment from unemployment are more likely to come from below the median than are exits from full-time employment. However, the impact of this difference is attenuated by the fact that the flows into and out of unemployment are relatively small when compared to the flows into and out of part-time/self-employment and not-in-the-labor-force. Moreover, exits to and entry from unemployment are, on average, roughly equal, so that only relative wages of entrants and exiters contribute to U.

The effect of U on wage growth varies over the business cycle, however. During expansions, more workers enter from unemployment than exit to unemployment, see Figure 6a. This serves to amplify the drag on aggregate wage growth coming from U. In recessions, the opposite occurs, more workers exit full-time employment, than enter full-time employment, from unemployment. At the same time, as Figure 6b shows, the incidence of unemployment

[20]This impact of movements into and out of participation on wage growth is unexplained in the theoretical literature. Currently, models that explain the cyclicality of three-state labor market flows ignore movements in wages (Krusell *et al.* , 2017).

rises in the wage distribution such that the fraction of exits coming from below the median falls. This is consistent with the facts highlighted by Mueller (2017). This means that the share effect (flows) and the shift effect (relative wages) are moving in opposite directions. On net, this serves to temper the impact of unemployment on wages as the share and shift effects partially offset.

4.3 Contributions to aggregate wage fluctuations and cyclicality

Our decomposition allows us to express the time series of 4-quarter log changes of real MWE, $\Delta \ln (w_t)$, as the sum of the seven components shown in Figure 5. We index these components by $c_{i,t}$, where $i = 1, \ldots, 7$, such that we can write

$$\Delta \ln (w_t) = \sum_i c_{i,t}. \tag{10}$$

The fact that the individual components add up to the aggregate time series that we study allows us to assess how important they are, on average, over our sample period 1980-2019Q4, for the variance and cyclicality of real MWE growth.

To measure the contribution of each of the components to the variance of real wage growth, we apply a simple variance decomposition. The additive relationship in equation (10) allows us to write the variance of aggregate real wage growth as the sum of the covariances between each of the individual components, $c_{i,t}$, and the aggregate, $\Delta \ln (w_t)$. Column I of Table 4 lists the share of each of the components in the variance of real wage growth. Rows 3 through 7 of the table show that each of the composition effects only account for a small share of the variance of real wage fluctuations. In total, the *extensive* margin accounts for only 10.4 percent of the variance of real MWE growth. The other 89.6 percent is due to the *intensive* margin. In fact, wage changes of job changers, C, alone account for half of the fluctuations in real wage growth over the past three decades (row 2, column I).

As for the cyclicality of real wage growth, we measure it by the slope coefficient, β, from a simple regression of real wage growth on the level of the unemployment rate, u_t. Both real wage growth as well as the unemployment rate are measured in percentage points in this regression. The particular regression equation is

$$\Delta \ln (w_t) = \alpha + \beta u_t + \varepsilon_t \tag{11}$$

The coefficient is reported in the top row of column II of Table 4 and equals -0.124 and is not significant. This indicates that, over our sample period, real wage growth has only been mildly procyclical; real wage growth has tended to be high when the unemployment rate was low and vice versa.

By construction, the cyclicality coefficient, β , is the sum of seven component-specific cyclicality coefficients, β_i for $i = 1, \ldots, 7$, obtained using regressions of the form

$$c_{i,t} = \alpha_i + \beta_i u_t + \varepsilon_{i,t}, \text{ where } i = 1, \ldots, 7. \tag{12}$$

These component-specific coefficients are listed in rows 1 through 7 of column II of Table 4. As can be seen from the table, on the one hand, each of the components of the *extensive* margin, except that for unemployment, are significantly *counter*cyclical. On the other, each of the components of the *intensive* are significantly *pro*cyclical. Though the intensive margin is more important than the extensive margin for the cyclicality of real wage growth, half of its movements over the business cycle are undone by entry into and exits out of full-time employment. This is why the aggregate cyclicality coefficient is negative but statistically insignifant.

5 Conclusion

Using data from the Current Population Survey from 1980 through 2019 we examined what drives the variance and cyclicality of the growth rate of real wages over time. To do this, we employed a novel decomposition technique that allows us to divide changes in percentiles of aggregate usual weekly earnings growth into the part associated with the wage growth of continuously full-time employed workers–the intensive margin–and the part associated with relative wage levels of individuals entering and exiting full-time employment–the extensive margin.

The relative importance of these two margins varies significantly over the business cycle. When labor markets are tight, continuously full-time employed workers drive wage growth. During labor market downturns, the procyclicality of the intensive margin is largely offset by net exits out of full-time employment among workers with lower earnings. This leads aggregate real wages to be largely acyclical. Most of the extensive margin effect works through the part-time employment margin. Notably, the unemployment margin accounts for little of the variation or cyclicality of median weekly earnings growth.

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Table 1: CPS survey design

	Survey tenure month	1	2	3	4	...	13	14	15	16
1.	Month in sample (MIS)	1	2	3	4	...	5	6	7	8
2.	Labor force status	✓	✓	✓	✓		✓	✓	✓	✓
3.	Earnings data				✓					✓

Group	Share at Beginning	Share At End	Share Below Median Beginning	Share Below Median E
S	41.5	41.3	45.2	4
C	45.2	45.0	50.2	4
P	6.1	7.4	64.1	6
U	2.5	2.5	63.7	7
N	4.7	3.7	64.3	7

Table 2: Labor market states used in decomposition

	I State	II Flow	III Beginning of year	IV End of year
		Intensive margin		
1.	Same job (S)	Continuously full-time employed	Full-time employed	Still employed in the same job
2.	Job changers (C)	Continuously full-time employed	Full-time employed	Employed in a different job
		Extensive margin		
3.	Part-time/self-employed (P)	Entry	Part-time or self-employed	Full-time employed
		Exit	Full-time employed	Part-time or self-employed
4.	Unemployed (U)	Entry	Unemployed	Full-time employed
		Exit	Full-time employed	Unemployed
5.	Not-in-labor-force (N)	Entry	Not in the labor force	Full-time employed
		Exit	Full-time employed	Not in the labor force

Table 3: Summary statistics by labor market state

		I	II	III	IV
		Share of full-time wage earners in state		Share of group below the median	
	Intensive margin	Beginning of period	End of period	Beginning of period	End of period
1.	Same job (S)	40.7	40.7	45.5	44.0
2.	Job changers (C)	48.4	48.3	50.1	48.3
	Extensive margin	Exit	Entry	Exit	Entry
3.	Part-time/self-employed (P)	3.9	5.1	76.5	80.7
4.	Unemployed (U)	2.6	2.6	63.9	72.5
5.	Not-in-labor-force (N)	4.3	3.2	65.3	80.1

Note: All shares reported are average shares 1980-2015Q1 and are reported in percentages.

Table 4: Decomposition of variance and cyclicality of real MWE growth: 1980-2015Q1

	State	I Variance	II Cyclicality
	Total	1.9	−0.124 (−1.73)
	A. Intensive margin		
1.	Same job (S)	39.6	−0.081 (−2.37)
2.	Job changers (C)	50.0	−0.135 (−2.96)
	Subtotal	89.6	−0.216
	B. Extensive margin		
	Entry and exit components		
3.	Part-time of self-employed (P)	4.5	0.053 (2.90)
4.	Unemployed (U)	3.8	−0.008 (−0.60)
5.	Not in the labor force (N)	1.2	0.033 (2.31)
	Share components		
6.	Same job (S)	0.7	0.012 (4.44)
7.	Job changers (C)	0.3	0.002 (2.54)
	Subtotal	10.4	0.092

Note: Rows 1 through 7 in column I are reported in percent of the total variance reported in the top row. Totals do not add up to 100 due to rounding. Column II reports regression coefficients, β, of cyclicality regression $\Delta \ln(w_t) = \alpha + \beta u_t + \varepsilon_t$. Here u_t is the unemployment rate in percentage points. The right-hand side variable is either the log change in MWE multiplied by 100 or one of its seven subcomponents we calculated as part of our decomposition.

Figure 1: Real wage growth and the unemployment rate

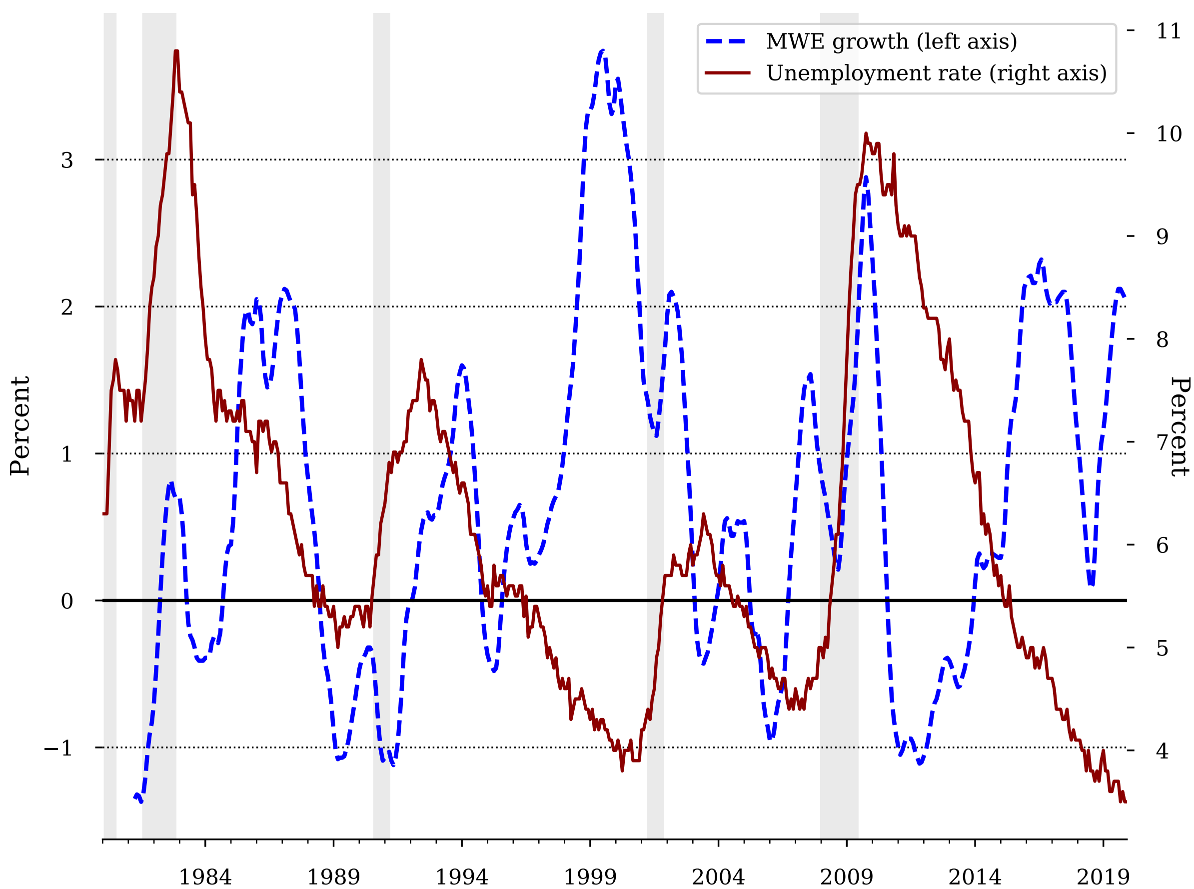


Figure 2: Four aggregate measures of real wage growth

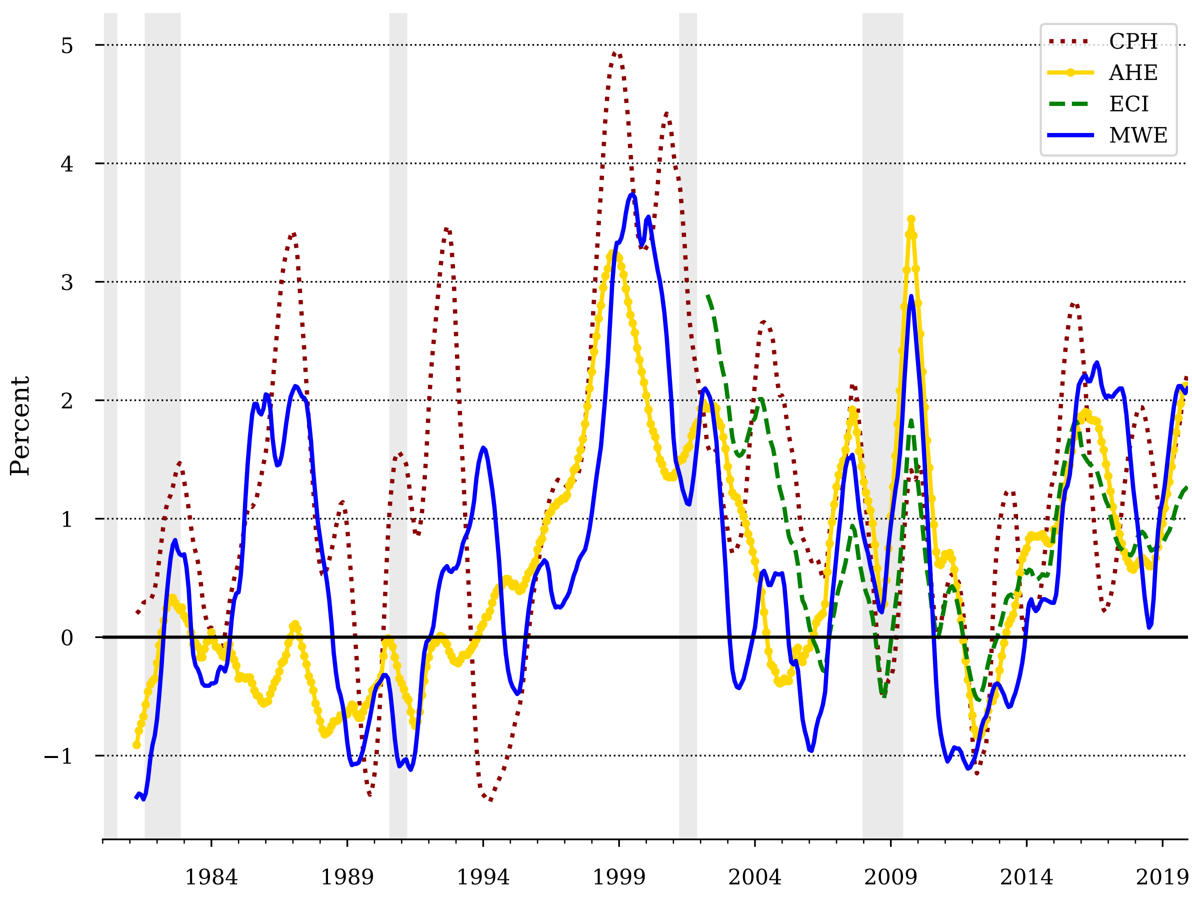


Figure 3: Changes in the earnings distribution and the log change of MWE

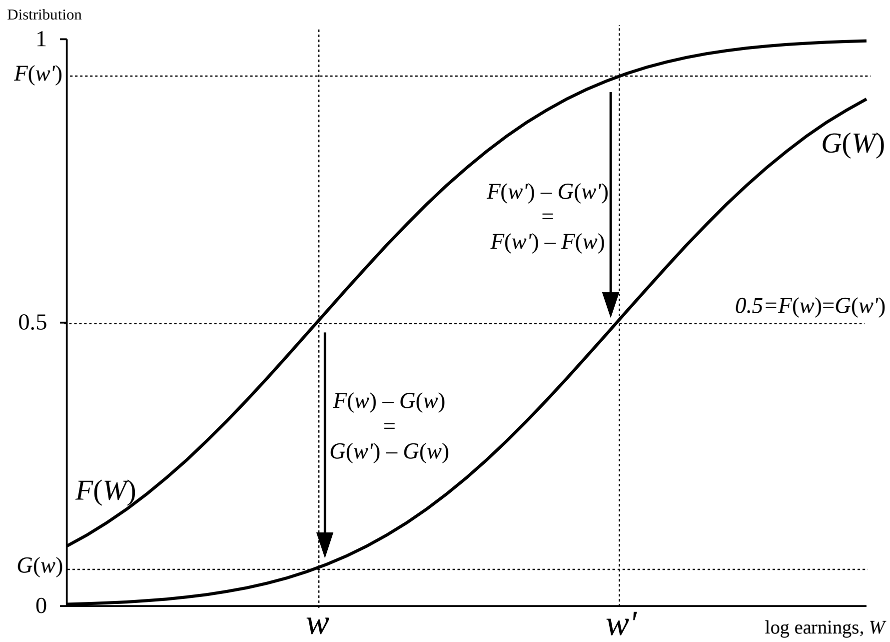


Figure 4: The intensive and extensive components of real MWE growth

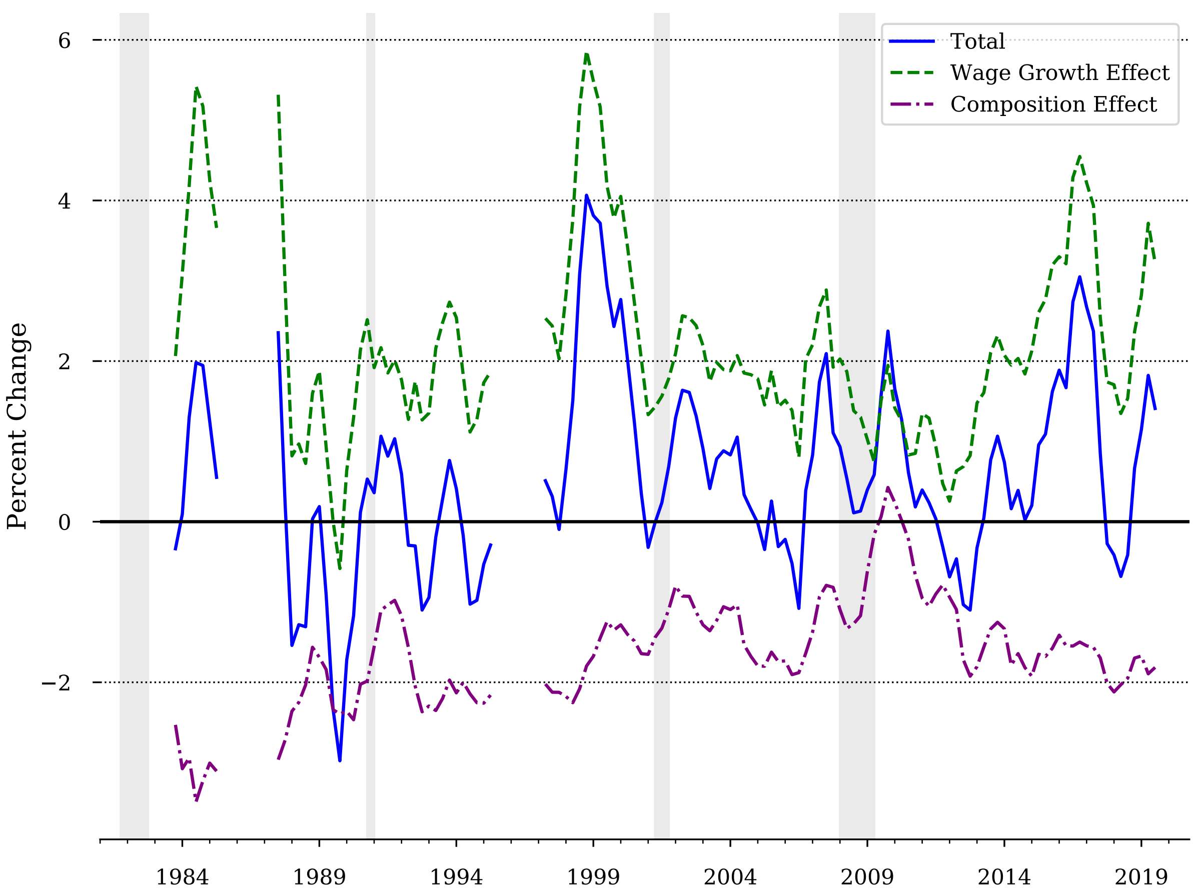
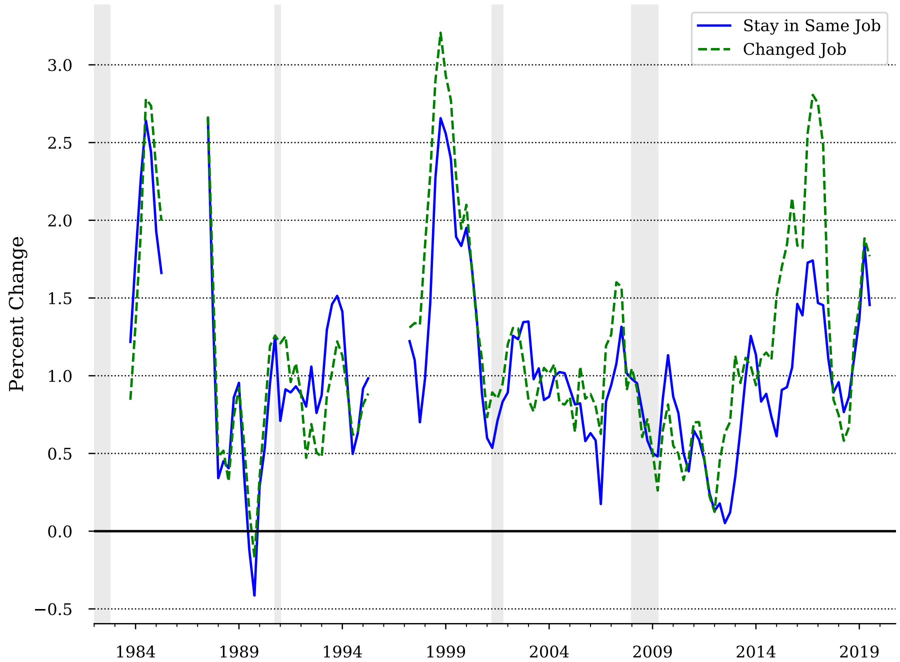
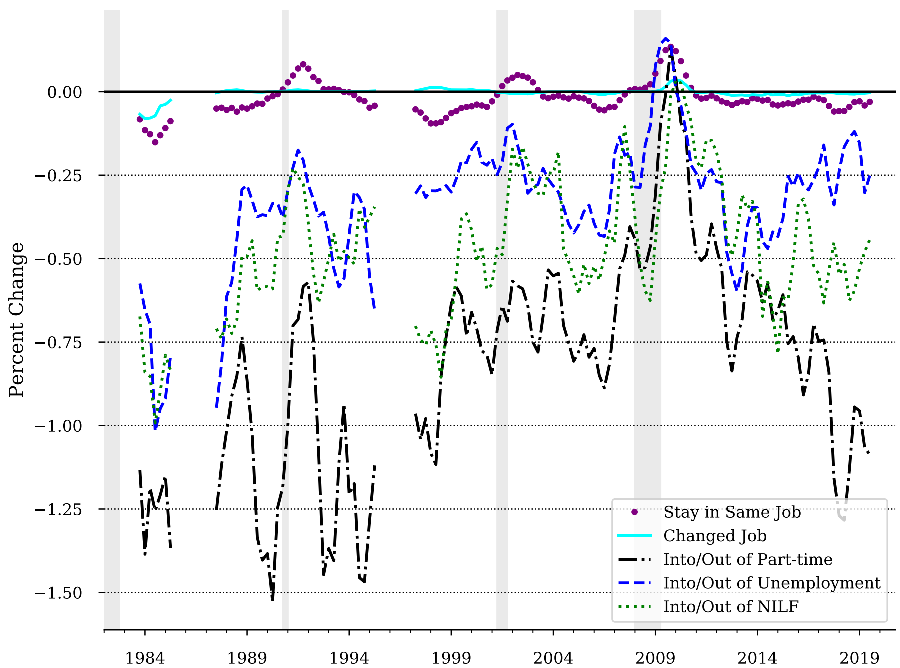


Figure 5: Decomposition of intensive and extensive margins by labor market state.

(a) Intensive margin



(b) Extensive margin

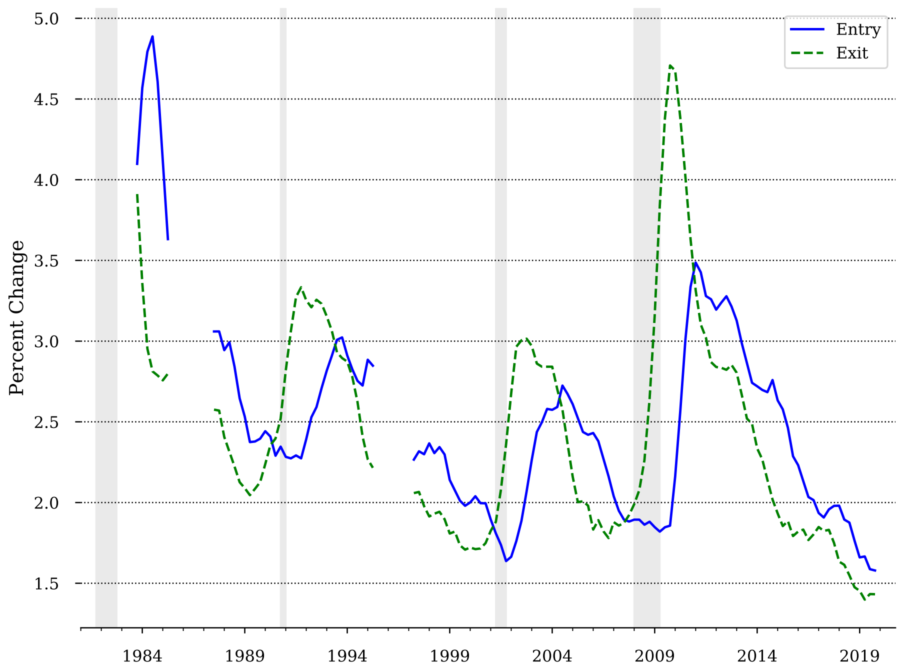


Note: All panels contain 4-quarter moving averages

	Growth (LN)	Cyclicality	t-value
EXT Margin	12.0	0.050	1.165
Ext C	0.1	-0.002	-1.656
Ext N	1.7	0.030	1.963
Ext P	8.6	0.039	1.772
Ext S	0.2	0.008	2.893
Ext U	1.4	-0.026	-1.818
Growth (LN)	3.1	-0.131	-1.473
INT Margin	88.0	-0.185	-2.116
Int C	46.2	-0.123	-2.539
Int S	41.8	-0.062	-1.393

Figure 6: Shift- and share-parts of unemployment contributions to real wage adjustments

(a) Share of full-time employed exiting to and entering from unemployment



(b) Fraction of flows into and out of unemployment below MWE