JOB POLARIZATION AND THE LABOR MARKET: A WORKER FLOW ANALYSIS

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Abstract

This paper provides an analysis of the effects of Job Polarization on the labor market through the study of worker flows and transition rates disaggregated by occupations. I use the Current Population Survey (CPS) for the period 1976-2010 and the occupation classification of Autor and Dorn (2013) to rank occupations between high, middle and low skill. I then use the variance decomposition of Elsby et al. (2015) to measure the percentage point contributions of each hazard rate to labor market stocks fluctuations. This flow rate analysis is used to study 3 phenomena. Firstly, the decrease in middle skill (or routine) employment between 1980 and 2006. The results highlight the role of employment to employment transition rates in the early part of Polarization between 1980 and 1999. After the year 2000, hazard rates between middle skill employment and unemployment/inactivity account for the decrease in employment of these occupations. Secondly, I analyze Jobless recoveries (Jaimovich and Siu (2012)) and the hazard rate contributing to the slow rebound in aggregate employment after the recent recessions. I find that hazard rates from unemployment to employment of all 3 groups of occupations contribute negatively to aggregate employment fluctuations during recoveries. Lastly, I analyze fluctuations of labor force participation as Foote and Ryan (2015) and Cortes et al. (2017) suggest that Polarization lead middle skill workers to exit the labor force. I confirm this observation as the results show that hazard rates between middle skill employment and inactivity contribute negatively to labor fluctuations between 1990 and 2006.

Keywords: Worker flows; occupations; unemployment; labor force participation; Job Polarization.
JEL-codes: E0, J0.

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1 Introduction

Over the past 40 years, the US economy has been subject to Job Polarization (Autor and Dorn (2013)), which leads to a concentration of employment at the top and bottom of the wage distribution. Job Polarization is likely to have an impact on the labor market and some papers have linked this phenomenon to Jobless Recoveries and to the decrease in labor force participation after 2000.

Jobless Recoveries have been pointed out by Gordon (1993) and Groshen and Potter (2003) and stand for the slow rebound of aggregate employment in the aftermath of recessions since 1990, in spite of the recovery in activity and GDP. No consensus on the mechanisms behind this phenomenon has yet emerged. Some emphasize that firms use recessions to reorganize (Koenders and Rogerson (2005)) or restructure (Berger (2012)). This process is time and resource consuming and allows firms to raise their productivity which affects hiring in the periods following the end of recessions. On the other hand, Mitman and Rabinovich (2019) point the extension of unemployment benefits and other programs (like food stamps) which raise the reservation wages of workers and lowers the job finding probability. Another strand of the literature highlights the role of structural change (Groshen and Potter (2003), Burger and Schwartz (2015)). In his speech on Jobless recoveries, Bernanke (2003) mentions an increase in the pace of structural change[1] affecting the U.S economy. One of such structural change is Job Polarization and Jaimovich and Siu (2012) claim that Polarization is responsible for Jobless recoveries. They argue that the bulk of job destructions in routine-intensive tasks (or middle skill) occupations occurs during recessions and that the slow rebound of aggregate employment can be attributed to the moderate rebound of employment in these middle skill occupations. This explanation recently received support from Gaggl and Kaufmann (2019).

The labor force participation rate has been showing signs of a change in its trend. Between 1980 and 1989, the participation rate increased significantly by 2.6 percentage points (from 64.0% to 66.6%). Its increase slowed down over the 1990 decade and labor force participation peaked around 67.3% at the end of this decade. It then decreased by 1 pp between 2000 and 2006 before the Great Recession.[2] The trend in labor force participation over this period is usually attributed to the ageing of the workforce and the increase in women participation (Barnichon and Mesters (2018), Hornstein and Kudlyak (2019)). Barnichon (2019) also highlights the role of the secular decline in the unemployment rate to explain the peak of labor force participation at the end of the 1990 decade.[3] Moreover, Foote and Ryan (2015) and Cortes et al. (2017) argue that Job Polarization created a lack of job opportunities in middle skill occupations and pushed young and prime-aged low educated male workers out of the labor force. This suggests that Polarization could matter to explain the decrease of participation after 2000.

This paper provides an analysis of the effects of Job Polarization on the labor market through the study of worker flows and transition rates disaggregated by occupations. I use the Current Population Survey (CPS) for the period 1976-2010 and the occupation classification of Autor and Dorn (2013) to rank occupations between high, middle and low skill. I compute labor market stocks and flow rates by groups of occupations and adjust these time series for various issues affecting the CPS over this period (Ounnas (2019a)). I then use the variance decomposition of Elsby et al. (2015) to measure the percentage point contributions of each hazard rate to labor market states (e.g. employment) fluctua-

[1]A fact that can also be related to the increase in turbulences mentioned by Ljungqvist and Sargent (1998).

[2]The Great Recession saw participation drop even further by 1.9 pp between the start of the recessions and December 2010. These figures are from my own computations and do not exactly match the official numbers from the BLS, mostly because of some restrictions I need to impose on my sample. See Section 2.1

[3]Elsby et al. (2019) or Ounnas (2019b) show that fluctuations in the unemployment rate, through their impact on transition rates out of the labor force, are important to understand labor force fluctuations.

tions and identify transition rates contributing positively or negatively to fluctuations in stocks. This flow analysis is used to look at the relationships between occupation-specific transition rates (between employment, unemployment and inactivity) and 3 phenomena:

- the long-term evolution of the stock of middle-skilled employment;
- the cyclical phenomenon of jobless recoveries;
- the long-term evolution of participation to the labor market.

I start by analyzing transition rates which account for the decrease in middle skill employment between 1980 and 2006, before the start of the Great Recession. Cortes et al. (2016) have taken a similar approach. They fix specific groups of transition rates (e.g. transition rates from unemployment to routine employment) at their average value before Job Polarization (1976-1982) and generate counterfactual time series for middle-skill employment from 1983 to 2012, assuming that labor market states evolve as a first-order Markov chain. By comparing their counterfactual series with the actual one, they are able to identify sets of transition rates that would have lead to higher employment in middle skill occupations, if these transition rates had stayed constant at their value before Polarization. They find that inflows to middle skill employment, both from unemployment and from inactivity, as well as transition rates from middle skill employment to inactivity, account for most of the decrease in employment of these occupations, after the year 2000.[4]

Using the variance decomposition of Elsby et al. (2015) allows to measure the contributions of each transition rate and avoid having to fix these rates at specific values. The results confirm the role of inflows from unemployment and inactivity and of outflows to inactivity. However, I find that the negative impact of inflows to middle skill employment is already present prior to the year 2000. Declining trends in the separation rates from employment to both unemployment and inactivity (outflows) over the same period, compensate the negative effect and limit the decrease in middle skill employment. Furthermore, the results indicate that employment to employment transition rates between occupations are important to explain the decrease in middle skill employment over the 1980-2000 period. Due to substantial breaks in employment to employment time series originating from the CPS redesign of 1994, Cortes et al. (2016) study the role of these transition rates only for the period 2001-2012 whereas the adjustments performed in Ounnas (2019a) allow to analyze the role of these series in the previous decades as well.

The study of Jobless Recoveries reveals that after the 1990, 2001 and 2007 recessions, aggregate employment fluctuations are affected by a negative contribution of the job finding transition rate which is not present during the recovery after the 1980 recession. Unemployment to employment transitions of all occupations groups (high, middle and low skill) contribute negatively which tends to cast doubts on Jobless Recoveries being driven solely by Job Polarization. Explanations, such as the extension of unemployment benefits of Mitman and Rabinovich (2019), that could affect unemployment to employment transition rates of all occupation groups, are also likely to contribute to Jobless recoveries.

Finally, the analysis of labor force participation confirms the evidence of Foote and Ryan (2015) and Cortes et al. (2017) as hazard rates between middle skill employment and inactivity have a substantial contribution to the decrease in labor force participation after 2000. The results of the decomposition also confirm the prominent role of the unemployment rate to understand fluctuations in

[4]Prior to 2000, their counterfactual series are similar to the actual one indicating that their methods is not really able to account for the decrease in middle-skill employment before this date.

labor force participation and I show that Jobless Recoveries have a negative effect on the dynamics of participation in the years following the end of recessions. The secular decline in the unemployment rate up to the year 2000 has positive effect on labor force participation fluctuations and is the main driver behind the peak of participation observed around the same period (Barnichon (2019)).

The paper is organized as follows. In Section 2, I briefly present the data and the variance decomposition before reviewing some trends present in series of labor market stocks and hazard rates. The results of the decomposition for middle skill employment, aggregate employment and labor force participation are discussed in Section 3. Section 4 concludes the paper.

2 Data and decomposition methods

2.1 Data

I use the monthly Current Population Survey (CPS) over the period 1976-2010 and restrict the sample to individuals aged 16 and over. Autor and Dorn (2013) use CPS detailed occupation (3-digit) codes to classify individuals into the 6 main occupation groups found in Table 1. The CPS occupation codes are assigned based on the current job for employed individuals or the last job for the unemployed. This implies that no occupation codes are assigned to *New Unemployed Entrants* which are dropped from the sample. I further aggregate their 6 occupations groups into 3 groups of occupations: high skill or cognitive task intensive occupations, middle skill or routine task intensive occupations and low skill or manual task intensive occupations. The classification is the same as the one used in Ounnas (2019a) and Ounnas (2019b) and Table 1, taken from these 2 papers, displays the classification.

Occupations	Abstract tasks	Routine tasks	Manual tasks	skill level
Managers/prof/tech/finance/public safety	+	-	-	*high*
Production/craft	+	+	-	*middle*
Transport/construct/mech/mining/farm	-	+	+	*low*
Machine operators/assemblers	-	+	+	*middle*
Clerical/retail sales	-	+	-	*middle*
Service occupations	-	-	+	*low*

The first 4 columns of this Table are taken from Table 2 of Autor and Dorn (2013). A "+" indicates that the task value of a given occupation-group is above the task value averaged over all occupation-groups. The shaded cells give the maximum task value for each occupation-group. I assign a skill level to an individual occupation according to whether the task value of the occupation-group she belongs to is more abstract (high skill), routine (middle skill) or manual (low skill).

Table 1: Skill classification

Alternative occupation classifications can be found in the literature. For instance, Jaimovich and Siu (2012) and Cortes et al. (2016) disaggregate routine occupations into routine cognitive which are *Clerical/retail* occupations and routine manual corresponding to the two remaining groups of middle skill occupations displayed in Table 1. Furthermore, they classify the occupation group *Transport/construct/mech/mining/farm* as routine manual while I consider this group of occupations as manual or low skill occupations. On the other hand, Foote and Ryan (2015) argue that the construction sector is not affected by the Polarization trend and the classification they use is the same as Jaimovich and Siu (2012) except that construction occupations are removed from routine manual occupations. Gaggl and Kaufmann (2019) build another classification based on the cyclical dynamics of employment of these various occupations and identify 2 groups of occupations which essentially comes down to classifying occupations as routine and non routine. Jaimovich and Siu (2012) review (most of) these different classifications and show that they all capture the Polarization trend and the decrease of employment in middle skill (routine) occupations. However, the results found in Section 3.2 on Jobless recoveries might be affected by the different classification used in this paper and in Jaimovich and Siu (2012).

I compute labor market stocks from CPS monthly files and match these files for 2 consecutive months to obtain gross worker flows. There are 7 labor market states in total; high, middle and low skill employment (E^h, E^m and E^l) and unemployment (U^h, U^m and U^l), and I stands for inactivity. These stocks are normalized by total populations such that $E^h + E^m + E^l + U^h + U^m + U^l + I = 1$. With 7 states there are 49 possible worker flows.

As explained in Ounnas (2019a), the time series retrieved from basic CPS files suffer from various problems and breaks related to changes in data collection technique or updates in the occupational classification used by the Bureau of Labor Statistics (BLS). I therefore adjust series for these issues to obtain stocks and gross worker flows consistent over a longer timespan. From these adjusted gross worker flows, I compute transition rates which are further adjusted for the time aggregation bias (see Shimer (2012)). Following Elsby et al. (2015), I also apply a Margin of Adjustment correction that ensures that transition rates are consistent with the evolution of stocks. All the details on these adjustments can be found in Ounnas (2019a). Note however, that I do not adjust series for misclassification errors between unemployment and inactivity (Abowd and Zellner (1985) and Poterba and Summers (1986)).

2.2 Decomposition of labor market stocks fluctuations

Elsby et al. (2015) develop a framework to decompose fluctuations of stocks and compute the contributions of each transition rate.[5]. This decomposition assumes that labor market stocks evolve as a first-order Markov Chain:

$$s_t = P_t s_{t-1}$$

$$p_t^{ij} \geq 0$$
$$p_t^{ii} = 1 - \sum_{j \neq i} p_t^{ij}$$

[5]I only sketch the main steps of the decomposition in this section and much more details can be found in Ounnas (2019b)

with $s_t = [E_t^h\ E_t^m\ E_t^l\ U_t^h\ U_t^m\ U_t^l\ I_t]'$ and P_t the 7×7 matrix of transition rates p_t^{ij}. Using the fact that total population is normalized to 1, this Markov chain can be reduced to:

$$\tilde{s}_t = \tilde{P}_t \tilde{s}_{t-1} + v_t \tag{1}$$

where $\tilde{s}_t = [E_t^h\ E_t^m\ E_t^l\ U_t^h\ U_t^m\ U_t^l]'$, $\tilde{P}_t$ is a 6×6 matrix and $v_t = [p_t^{IE^h}\ p_t^{IE^m}\ p_t^{IE^l}\ p_t^{IU^h}\ p_t^{IU^m}\ p_t^{IU^l}]'$. Elsby et al. (2015) show that fluctuations in stocks, $\Delta\tilde{s}_t$ can be expressed as:

$$\Delta\tilde{s}_t = A_t \Delta\bar{\tilde{s}}_t + B_t \Delta\tilde{s}_{t-1} \tag{2}$$

where $\bar{\tilde{s}}_t$ is the vector of steady state stocks and A_t and B_t are given by:

$$\begin{aligned} A_t &= I - \tilde{P}_t \\ B_t &= A_t \tilde{P}_{t-1} A_{t-1}^{-1} \\ \bar{\tilde{s}}_t &= A_t^{-1} v_t \end{aligned}$$

Switching to a continuous time framework, steady state fluctuations can be computed from a first order approximation of $\bar{\tilde{s}}_t$ around lagged values of continuous time transition (hazard) rates:

$$\Delta\bar{\tilde{s}}_t \approx \sum_i \sum_{j \neq i} \frac{\partial \bar{\tilde{s}}_t}{\partial f_t^{ij}} \Delta f_t^{ij} \tag{3}$$

where f_t^{ij} are hazard rates from state i to state j.
These steps show that fluctuations in hazard rates Δf_t^{ij} generate variations in steady-stocks (equation (3)) which then affects the stocks fluctuations through equation (2). Therefore, for each hazard rate f_t^{ij}, we can compute its effect on the stock steady states:

$$\Delta\bar{\tilde{s}}_t^{ij} = \frac{\partial \bar{\tilde{s}}_t}{\partial f_t^{ij}} \Delta f_t^{ij} \tag{4}$$

with $\Delta\bar{\tilde{s}}_t \approx \sum_i \sum_{j\neq i} \Delta\bar{\tilde{s}}_t^{ij}$. These quantities can then be used to obtain the stocks fluctuations originating from the hazard rate f_t^{ij}:

$$\Delta\tilde{s}_t^{ij} = A_t \Delta\bar{\tilde{s}}_t^{ij} + B_t \Delta\tilde{s}_{t-1}^{ij} \tag{5}$$

and we have $\Delta\tilde{s}_t \approx \sum_i \sum_{j\neq i} \Delta\tilde{s}_t^{ij}$.[6]

The CPS allows to retrieve stocks and transition rates at monthly frequency and $\Delta\tilde{s}_t, \Delta\bar{\tilde{s}}_t$ and Δf_t^{ij} therefore measure fluctuations between two consecutive months. The effect of *Job Polarization* are likely to be small and hard to detect at such a (high) frequency. It is however possible to study the fluctuations between month t and month $t+i$, $\Delta\tilde{s}_{t+i} = \tilde{s}_{t+i} - \tilde{s}_t$:

$$\Delta\tilde{s}_{t+i} = \sum_{j=1}^{i} \Delta\tilde{s}_{t+j} \tag{6}$$

Hence, labor market stocks fluctuations between any interval of time (e.g. 1 year or 12 months) can be computed as the sum of monthly fluctuations over the selected time interval.
The contribution of the hazard rate f^{ij} to the fluctuations $\Delta\tilde{s}_{t+i}$ is then given by:

$$\Delta\tilde{s}_{t+i}^{ij} = \sum_{j=1}^{i} \Delta\tilde{s}_{t+j}^{ij} \tag{7}$$

[6] These individual hazard rate contributions are slightly adjusted in Ounnas (2019b) such that $\Delta\tilde{s}_t = \sum_i \sum_{j\neq i} \Delta\tilde{s}_t^{ij}$.

where $\Delta\tilde{s}^{ij}_{t+j}$ is computed from equations (4) and (5). Therefore for a fixed t, I can compute hazard rates contributions to the fluctuations in stocks at time $t+1, t+2, \ldots$ or cumulative fluctuations.[7] The contributions given by equation (7) are those studied in Section 3.

The framework presented up to now applies to disaggregated stocks by occupations and Ounnas (2019b) proposes a way to use this framework to study fluctuations in aggregate stocks. Firstly, aggregate hazard rates can be computed as:

$$f_t^{EU} = f_t^{E^hU^h}\frac{E_t^h}{E_t} + f_t^{E^mU^m}\frac{E_t^m}{E_t} + f_t^{E^lU^l}\frac{E_t^l}{E_t} \tag{8}$$

$$\begin{aligned} f_t^{UE} = &\left(f_t^{U^hE^h} + f_t^{U^hE^m} + f_t^{U^hE^l}\right)\frac{U_t^h}{U_t} \\ &+ \left(f_t^{U^mE^h} + f_t^{U^mE^m} + f_t^{U^mE^l}\right)\frac{U_t^m}{U_t} + \left(f_t^{U^lE^h} + f_t^{U^lE^m} + f_t^{U^lE^l}\right)\frac{U_t^l}{U_t} \end{aligned} \tag{9}$$

$$f_t^{EI} = f_t^{E^hI}\frac{E_t^h}{E_t} + f_t^{E^mI}\frac{E_t^m}{E_t} + f_t^{E^lI}\frac{E_t^l}{E_t} \tag{10}$$

$$f_t^{UI} = f_t^{U^hI}\frac{U_t^h}{U_t} + f_t^{U^mI}\frac{U_t^m}{U_t} + f_t^{U^lI}\frac{U_t^l}{U_t} \tag{11}$$

$$f_t^{IE} = f_t^{IE^h} + f_t^{IE^m} + f_t^{IE^l} \tag{12}$$

$$f_t^{IU} = f_t^{IU^h} + f_t^{IU^m} + f_t^{IU^l} \tag{13}$$

and I can then analyse the fluctuations in aggregate stocks in the 3 states framework (E, U and I) of Elsby et al. (2015).[8] The steps presented above apply[9] and I need to compute steady-state variations from each aggregate hazard rate (equation (3)). I show in Ounnas (2019b), that the fluctuations in aggregate hazard rates, can be decomposed into an hazard rate effect coming from variations in disaggregated hazard rates and a compositional effect. For instance, the fluctuations in the aggregate hazard rate Δf_t^{EU}, can be decomposed into the variations $\Delta f_t^{E^hU^h}$, $\Delta f_t^{E^mU^m}$ and $\Delta f_t^{E^lU^l}$. These are the (disaggregated) hazard rates effects and the compositional effect originate from fluctuations in the employment share of high, middle and low skill occupations (e.g. $\Delta\hat{e}_t^l = E_t^l/E_t - E_{t-1}^l/E_{t-1}$).[10] On average, $f_t^{E^lU^l} > f_t^{E^mU^m} > f_t^{E^hU^h}$ such that when the low skill employment share increases, f_t^{EU} increases too. This framework is used to study aggregate employment fluctuations in Section 3.2.

It is possible to further aggregate the 3 states framework to analyse labor force participation, $\text{lf}_t = E_t + U_t$. The aggregate hazard rates are computed as:

$$f_t^{\text{lf}I} = f_t^{EI}\frac{E_t}{\text{lf}_t} + f_t^{UI}\frac{U_t}{\text{lf}_t} \tag{14}$$

$$f_t^{I\text{lf}} = f_t^{IE} + f_t^{IU} \tag{15}$$

where the hazard rates f^{IE}, f^{IU}, f^{EI} and f^{UI} are given in expressions (10)-(13).
In addition to the occupation compositional effect, fluctuations in the hazard rate out of the labor force, $f_t^{\text{lf}I}$, are affected by variations in the labor force composition between unemployment and employment, $\Delta u_t = U_t/\text{lf}_t - U_{t-1}/\text{lf}_{t-1}$. When the unemployment rate increases, $f_t^{\text{lf}I}$ increases as well since $f_t^{UI} >> f_t^{EI}$. It is shown in Ounnas (2019b) that occupation compositional effect do not account for much of the quarterly fluctuations in aggregate stocks but unemployment variations are important to explain

[7]Note that it is also possible to fix i and study fluctuations between t and $t+i$ for all periods t in the sample. For instance, setting $i = 120$ allows to study monthly variations over a period of 10 years (e.g. between January 1976 and January 1986, between February 1976 and February 1986 ...).

[8]Note that, within this framework, I can no longer study the impact of employment to employment transition rates given that $f_t^{EE} = -(f_t^{EU} + f_t^{EI})$. See Elsby et al. (2015) for more details on this 3 states framework.

[9]The main adjustment concerns the dimensions of the vectors $s_t, \tilde{s}_t$ and the matrices, P_t and F_t.

[10]Note that $\Delta\hat{e}_t^h = -(\Delta\hat{e}_t^m + \Delta\hat{e}_t^l)$ such that I can study the compositional effects of 2 groups occupations out of the 3. In Sections 3.2 and 3.3, I study $\Delta\hat{e}_t^m$ and $\Delta\hat{e}_t^l$.

quarterly fluctuations in labor force participation. I use this 2 states framework (lf and I) to study labor force participation fluctuations in Section 3.3.

2.3 Trends in stocks and hazard rates

This section discusses the trends in series of stocks and transition rates as it can help understanding some results obtained in Section 3. Trends in aggregate stocks and hazard rates[11] have been documented by Shimer (1999), Hall (2005) and Elsby et al. (2009) among others. Results for stocks by occupations have been studied by the *Job Polarization* literature but less is known about disaggregated transition rates. The trend is obtained from monthly series[12] using the HP-filter with a smoothing parameter $\lambda = 129,600$ (see Ravn and Uhlig (2002)). Figure 1 displays the trends for stocks which are employment to population ratios, unemployment rates and the labor force participation rate. Figures 2 and 3 show trends for hazard rates. In order to avoid the potential end point problem of the HP-filter, I plot series up to December 2006.

The secular movements in aggregate unemployment and labor force participation rates have recently been studied in detail by Barnichon and Mesters (2018) and Hornstein and Kudlyak (2019). These two papers do not fully agree on the drivers behind the trends. However, they both show a decline in the unemployment rate and a hump-shaped trend in the labor force participation rate which reaches a maximum around the year 2000.[13] Overall, the trends displayed in Figure 1 are consistent with these observations and we can see a negative trend in the aggregate unemployment rate, and a peak of the labor force participation rate around the year 2000.

The decreasing trend in the aggregate unemployment rate appears to be mostly driven by the trends in middle and low skill unemployment rates. For employment to population ratios, the trends are mostly consistent with those reported by the *Job Polarization* literature. Employment in high skill occupations increases throughout the period while middle skill employment decreases continuously from the start of the 1980 recession. The trend in low skill employment is flat over the 1977-2006 period, which appears to be in contradiction with the rise of the employment share of *service occupations* over the same period (Autor and Dorn (2013)). This is explained by the choice of classification (discussed in Section 2.1), since low skill occupations are both *service occupations* and *transport/construct/mech/mining/farm* occupations.

A couple of facts are worth noticing in Figures 2 and 3. Firstly, inflows to unemployment (f^{EU} and f^{IU}, Panels (a) and (f) in Figure 2) show a declining trend for both low and middle skill occupations and consequently for these two aggregate hazard rates. The secular decline in f^{EU} is pointed out by Hall (2005) and discussed by Shimer (2012) who argues that most of the decreasing trend can be traced back to the ageing of the workforce. The decreasing trends in inflow rates to unemployment are likely to contribute to the decline in unemployment rates discussed above, which is shown to mostly

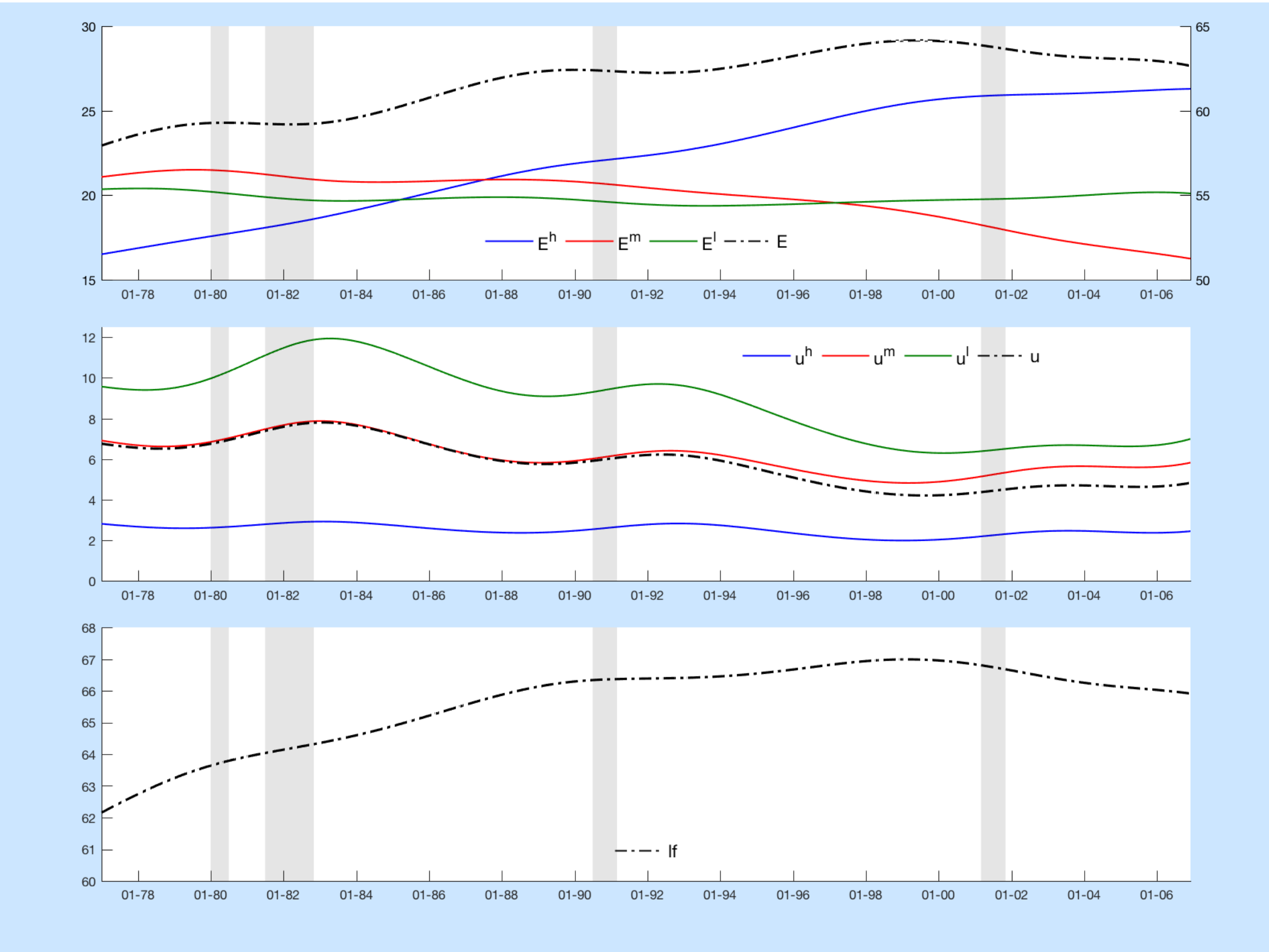
[11]The results available in the literature (usually) focus on discrete time transition rates but the trends are not affected when working with continuous time transition rates.

[12]Usually, these trends are computed from quarterly data by taking (quarterly) averages of stocks and flow rates. However, the actual transition rates associated to quarterly averages of stocks are not equal to the average of monthly flow rates. Working with monthly series avoids this inconsistency.

[13]For the unemployment rate, Hornstein and Kudlyak (2019) argue that most of the downward trend can be explained by demographic factors, namely ageing and the increase in educational attainment. The increase in education is also important for the trend in labor force participation as are changes in the participation rate of women. On the other hand, Barnichon and Mesters (2018) argue that usual shift share analysis of the unemployment rate over-estimate the decrease in its trend coming from ageing of the workforce. They further find that the trends in women and young workers (aged 15-24) participation rates are important to explain the decreasing trend in the unemployment rate.

affect middle and low skill unemployment.

Trends in outflows, f^{UE} and f^{UI} (Panels (b) and (e) in Figure 2) are also probably contributing to the decline in the unemployment rate.[14,15] We see that aggregate outflows to employment increase between the end of the 1980 recession and the end of the 1990 decade. The aggregate hazard rate to inactivity, f^{UI}, also increases over the same period, particularly after the end of the 1990 recession. It is worth mentioning that the trends in these hazard rates, which directly affect the unemployment rate, are also likely contributing to the trend in labor force participation. As explained at the end of the previous section, variations in the unemployment rate affect the transition rate from the labor force to inactivity. Therefore, the decline in the unemployment rate should lower outflows from the labor force and contribute to the increase in the labor force participation rate. This mechanism is discussed in the following section but it can be hinted from the fact that labor force participation peaked when the unemployment rate reached a minimum (see Figure 1).

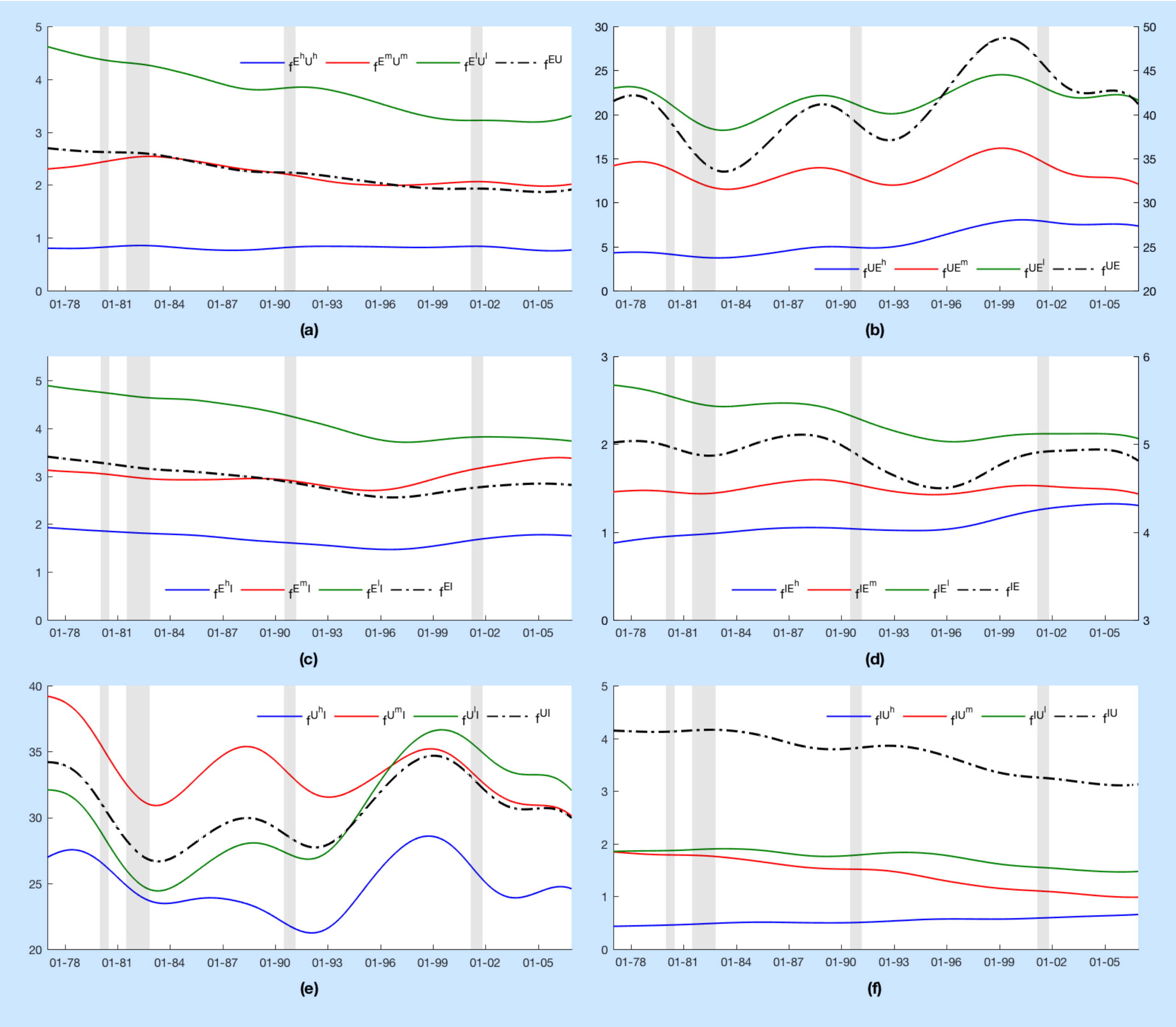


Trends in monthly employment to population ratio, unemployment rates and labor force participation rate extracted using the HP-filter with smoothing parameter $\lambda = 129,600$. The aggregate employment to population ratio and labor force participation rate are displayed on the right axis. These stocks are expressed in percentages. Shaded areas display recessions as defined by the NBER.

Figure 1: Trends in Stocks

[14] Without a formal analysis of long term fluctuations in the unemployment rate, it is hard to claim that the trends in hazard rates are indeed contributing to the unemployment rate trend.

[15] Trends in hazard rates from unemployment appear to be still affected by medium run cycles. Using a higher value for the smoothing parameter, λ, would remove these cycles. For instance, Shimer (2012) uses $\lambda = 10^5$ for quarterly data. Applying Ravn and Uhlig (2002)'s formula would lead to $\lambda = 10^5 \times 3^4$ and remove these medium term cycles.

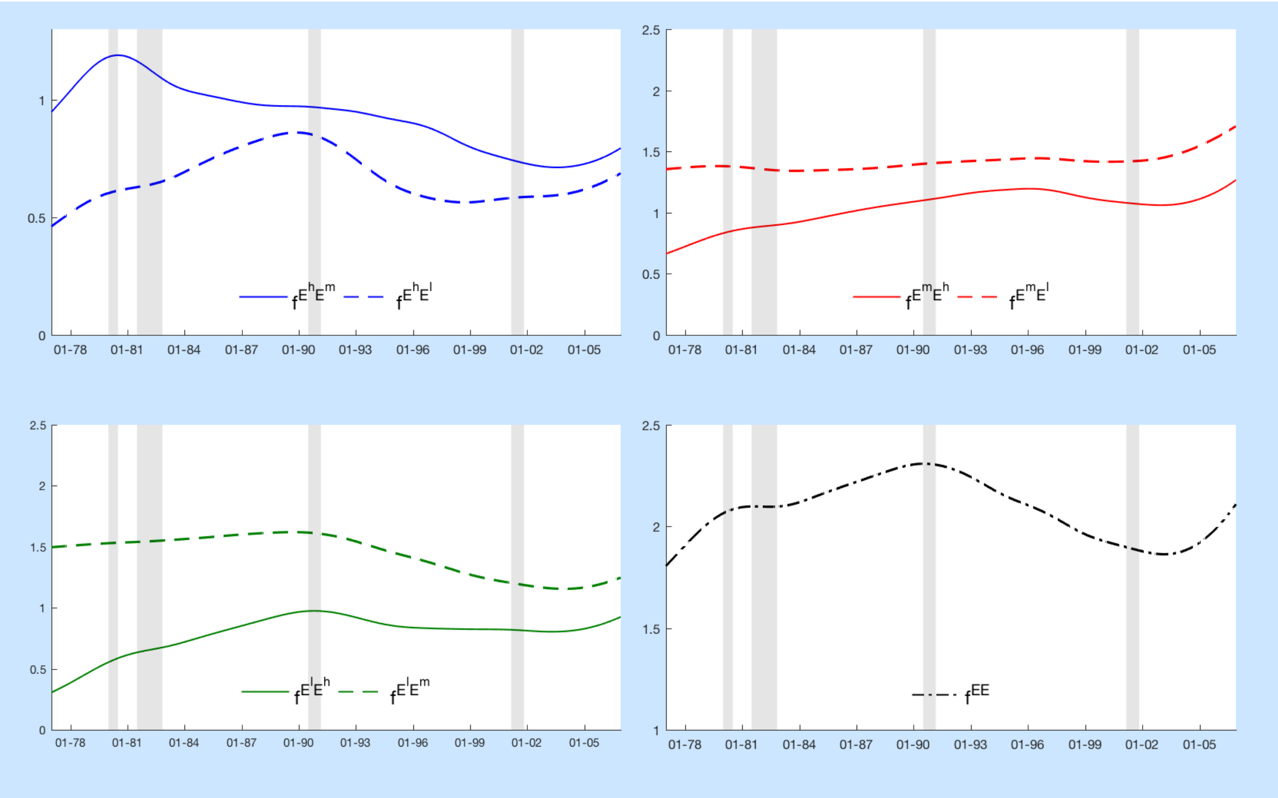


Trends in monthly flow rates between employment and unemployment, f^{EU} and f^{UE}, between employment and inactivity, f^{EI} and f^{IE} and between unemployment and inactivity, f^{UI} and f^{IU}. These trends are extracted using the HP-filter with smoothing parameter $\lambda = 129,600$. The job finding hazard f^{UE} is computed according to the occupation group k of employment or $f_t^{UE^k} = f_t^{U^hE^k}\frac{U_{t-1}^h}{U_{t-1}} + f_t^{U^mE^k}\frac{U_{t-1}^m}{U_{t-1}} + f_t^{U^lE^k}\frac{U_{t-1}^l}{U_{t-1}}$ with $f^{UE} = f^{UE^h} + f^{UE^m} + f^{UE^l}$. The aggregate hazard rates to employment, f^{UE} and f^{IE} are displayed on the right axis. Hazard rates are expressed in percentages. Shaded areas display recessions as defined by the NBER.

Figure 2: Trends in Hazard Rates (1)

Hazard rates from employment to inactivity (Panel (c) in Figure 2) exhibit decreasing trends, particularly the low skill employment transition rate, f^{E^lI}. These trends appear to change around 1995-2000, which corresponds to the period in which the labor force participation rate peaked. The change in trends seems to affect all occupations groups but we can see that the transition rates from high and middle skill employment starts increasing after 2000 while the trend becomes flat for the low skill employment hazard rate. On the other hand, Panel (d) shows that the trend in the aggregate hazard rate from inactivity to employment is stable over the 1976-2006 period. However, this stable trend results from a decrease in the transition rate to low skill employment and an increase in the trend of the inactivity to high skill employment hazard rate.

Finally, Figure 3 focuses on employment to employment (EE) hazard rates.[16] Hall (2005) discusses the trend in EE (discrete time) transition rates but the series he studies is different from the aggregate series displayed in Figure 3. I measure employment to employment transition between only 3 groups of occupations while he looks at any employment to employment transition leading to a change in employer. Overall, it is worth mentioning the inflows to middle skill employment from high and low skill employment start decreasing after the 1980 and 1990 recessions respectively. Outflows from middle skill employment appear to be increasing over the 1976-2006 period. Higher outflows from and lower inflows to middle skill employment should contribute to the decrease in employment in these occupations. Hazard rates between high and low skill employment both display similar trends with an increase up to the 1990 recession and a decrease afterwards.



Trends in monthly flow rates from employment to employment, f^{EE}, extracted using the HP-filter with smoothing parameter $\lambda = 129,600$. Hazard rates are expressed in percentages. Shaded areas display recessions as defined by the NBER.

Figure 3: Trends in Hazard Rates (2)

3 Results

This section discusses the results obtained from the decomposition presented in Section 2.2. The hazard rates contributions displayed in all the following figures are cumulative contributions computed from

[16]Working with hazard rates implies that the transition rates are adjusted for the time aggregation bias.

equation (7). I analyze long-run fluctuations in middle skill employment in Section 3.1 and provide a flow analysis of Jobless recoveries in Section 3.2, by studying hazard rates contributions to aggregate employment variations in the 2 years before and after the end of recessions. In Section 3.3, the focus is again on long-run fluctuations but for the labor force participation rate.

3.1 Employment in middle skill occupations

To analyze the fluctuations in middle skill employment, E^m, I split the sample in 3 sub-periods corresponding to the 2 decades between January 1980 and December 1999 and the 2000-2006 period.[17] I then study the hazard rates contributions (equation (7)) to the cumulative fluctuations in middle skill employment over these 3 distinct periods. Figures 4 and 5 display the sum of contributions (7) computed by fixing t at the start of the period of interest (January 1980, 1990 and 2000) and letting i increase. In Figures 4, I aggregate hazard rate contributions along the occupation dimension:

$$\Delta\tilde{s}^{EE}_{t+i} = \Delta\tilde{s}^{E^hE^m}_{t+i} + \Delta\tilde{s}^{E^hE^l}_{t+i} + \Delta\tilde{s}^{E^mE^h}_{t+i} + \Delta\tilde{s}^{E^mE^l}_{t+i} + \Delta\tilde{s}^{E^lE^h}_{t+i} + \Delta\tilde{s}^{E^lE^m}_{t+i} \tag{16}$$

$$\Delta\tilde{s}^{EU}_{t+i} = \Delta\tilde{s}^{E^hU^h}_{t+i} + \Delta\tilde{s}^{E^mU^m}_{t+i} + \Delta\tilde{s}^{E^lU^l}_{t+i} \tag{17}$$

$$\Delta\tilde{s}^{EI}_{t+i} = \Delta\tilde{s}^{E^hI}_{t+i} + \Delta\tilde{s}^{E^mI}_{t+i} + \Delta\tilde{s}^{E^lI}_{t+i} \tag{18}$$

$$\begin{aligned}\Delta\tilde{s}^{UE}_{t+i} = {}& \Delta\tilde{s}^{U^hE^h}_{t+i} + \Delta\tilde{s}^{U^hE^m}_{t+i} + \Delta\tilde{s}^{U^hE^l}_{t+i} + \Delta\tilde{s}^{U^mE^h}_{t+i} + \Delta\tilde{s}^{U^mE^m}_{t+i} + \Delta\tilde{s}^{U^mE^l}_{t+i} \\ & + \Delta\tilde{s}^{U^lE^h}_{t+i} + \Delta\tilde{s}^{U^lE^m}_{t+i} + \Delta\tilde{s}^{U^lE^l}_{t+i}\end{aligned} \tag{19}$$

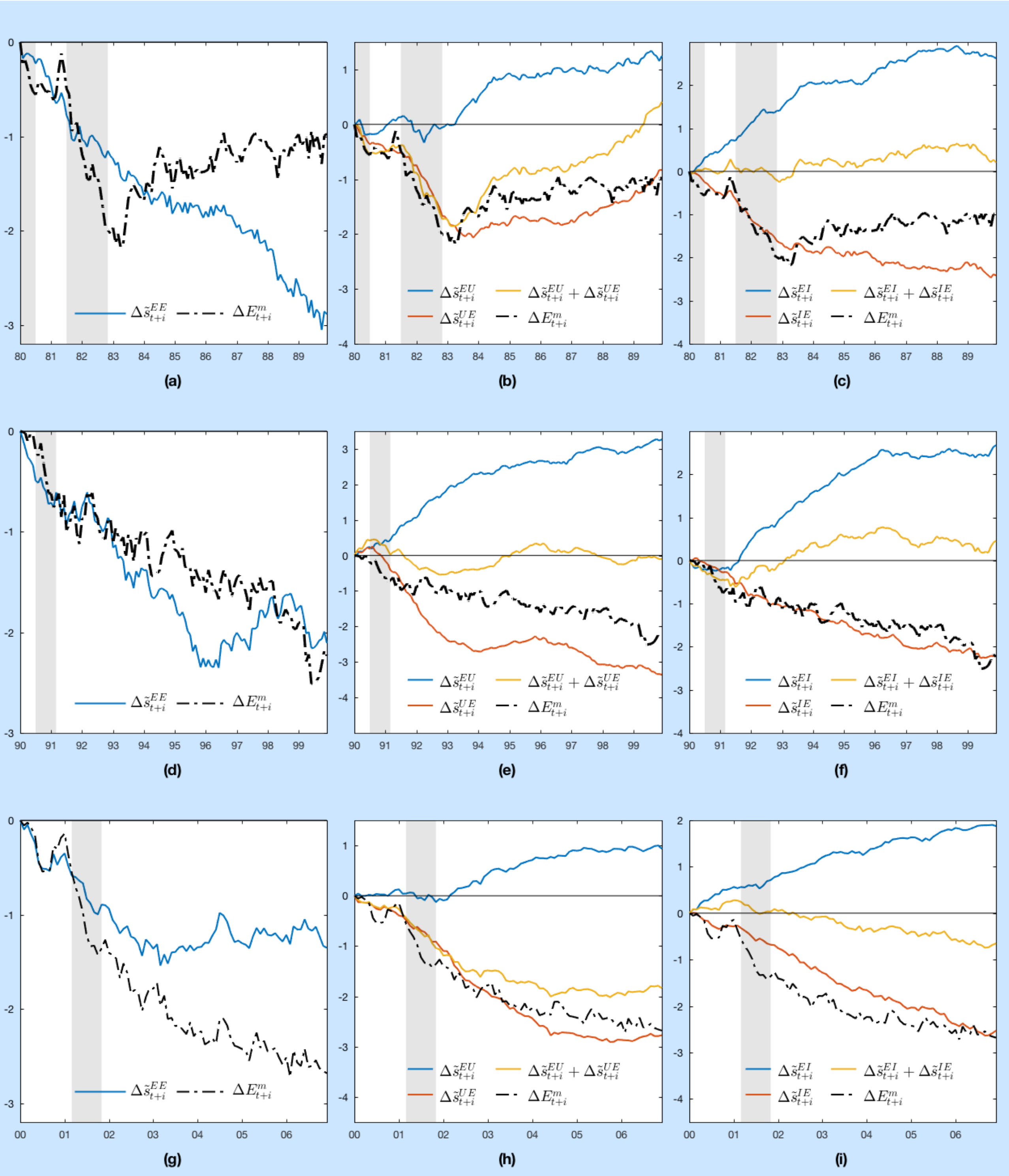
$$\Delta\tilde{s}^{IE}_{t+i} = \Delta\tilde{s}^{IE^h}_{t+i} + \Delta\tilde{s}^{IE^m}_{t+i} + \Delta\tilde{s}^{IE^l}_{t+i} \tag{20}$$

It is important to note that the above contributions do not represent the effects of aggregate hazard rates as derived in equations (8)-(13) in Section 2.2 and which apply to aggregate stocks. The aggregate contributions (16)-(20) are simply the sum of (disaggregated) hazard rates contributions from and to specific aggregate states (e.g. from U to E). Starting the analysis of E^m fluctuations from these aggregate contributions allows to identify important groups of hazard rates. The first column in Figure 4 (Panels (a), (d) and (g)) focus on the contributions of hazard rates between employment, the second on transitions rates between employment and unemployment ($\Delta\tilde{s}^{EU}_{t+i}$ and $\Delta\tilde{s}^{UE}_{t+i}$) and the last columns on hazard rates between employment and inactivity ($\Delta\tilde{s}^{EI}_{t+i}$ and $\Delta\tilde{s}^{IE}_{t+i}$) . In addition each Panel (except for EE transition rates) plots the sum of the both contributions, or net contributions, as these contributions are usually of opposite signs. Hazard rates between unemployment and inactivity are not directly related to middle skill employment and their contributions are displayed in Figure 12 in Appendix A.1.1.

Before looking at theses contributions, it is worth noting that these 3 periods are associated with different dynamics for E^m. We can see from Figure 4 that between January 1980 and December 1989 (first row of Figure 4), there is a substantial decrease in E^m during the recession but it slightly recovers afterwards. At the end of the decade, E^m is around 1 percentage point (pp) smaller than its level of January 1980. Over the other two decades (second and third rows of Figure 4), there are also sharp decrease during the 1990 and 2001 recessions[18] but E^m does not recover and continues to decrease after these recessions. Over the 1990-1999 and 2000-2006 periods, E^m decreases by about 2.2 pp and 2.7 pp.

[17] I stop in 2006 such that the 3 periods are marked by a recession at their start. The occurrence of the Great Recession at the end of the 2010 decade strongly affect middle skill employment and implies that the drop in employment is much larger than observed over the previous decades.

[18] These significant decreases in E^m during recessions have been pointed out by Jaimovich and Siu (2012).



Hazard rates contributions in percentage point, to monthly cumulative fluctuations in middle skill employment. Each row displays contributions for the 3 different periods: 1980-89, 1990-99 and 2000-06. Each column shows contributions aggregated along the occupation dimension (e.g. $\Delta\tilde{s}^{EU}_{t+i} = \Delta\tilde{s}^{E^hU^h}_{t+i} + \Delta\tilde{s}^{E^mU^m}_{t+i} + \Delta\tilde{s}^{E^lU^l}_{t+i}$ where the disaggregated contributions $\Delta\tilde{s}^{E^hU^h}_{t+i}, \Delta\tilde{s}^{E^mU^m}_{t+i}$ and $\Delta\tilde{s}^{E^lU^l}_{t+i}$ are computed from (7)). See equations (16)-(20). The first column show contributions for hazard rates between employment, the second, for transition rates between employment and unemployment and the third for hazard rates between employment and inactivity. Shaded areas display recessions as defined by the NBER.

Figure 4: Aggregate contributions of hazard rates to middle skill employment fluctuations

Figure 4 reveals that over the 1980 decade, the moderate decrease in E^m appears to be driven by the contribution of employment to employment hazard rates (Panel (a)). At the end of 1989, these hazard rates contribute for around -2.9 pp whereas E^m decreases by 1 pp. The contributions of transition rates between[19] unemployment and employment ($\Delta\tilde{s}^{EU}_{t+i} + \Delta\tilde{s}^{UE}_{t+i}$ in Panel (b)), are negative and substantial around the 1980 recession (approximately -2 pp) but the contributions increase after and become positive at the end of the decade. The net contributions increase after the recession because both contributions $\Delta\tilde{s}^{EU}_{t+i}$ and $\Delta\tilde{s}^{UE}_{t+i}$ rise. The contribution of hazard rates between employment and inactivity (Panel (c)) are small but positive as the negative contribution of the inactivity to employment hazard rate (around -2 pp at the end of 1989) is compensated by a similar positive contribution from the employment to inactivity hazard rate.

Over the 1990 decade (second row of Figure 4), we can see that employment to employment hazard rates are again contributing negatively to middle skill employment fluctuations. The contributions stabilizes around 1995-96 but these hazard rates still contribute for -2.1 pp at the end of 1999. The contributions from transitions rates between employment and unemployment fluctuates around zero. Compared to the 1980-89 decade, the difference originates primarily from the contributions of the employment to unemployment hazard rate which are equal to 1.2 pp and 3.3 pp at the end of 1989 and 1999, respectively. It is also worth noting that the contributions of unemployment to employment hazard rates are negative and keep on decreasing (except for a couple of years around 1995-96) to reach a minimum (-3.4 pp) at the end of the decade

Between 2000 and 2006 (last row of Figure 4), the contributions of employment to employment hazard rates become less important than observed for the 1980 and 1990 decades. Panel (g) shows that their contributions are still negative but become stable after 2003 and account for around -1.4 pp at the end of the period. The main negative contributions originate from transition rates between employment and unemployment, $\Delta\tilde{s}^{EU}_{t+i} + \Delta\tilde{s}^{UE}_{t+i}$. Unemployment to employment hazard rates, have similar contributions between 1990-99 and 2000-06 (around -3 pp at the end of the respective periods). It is smaller positive contributions from employment to unemployment hazard rates (0.9 pp at the end of 2006) that accounts for the difference in the net contribution across the 2 decades. Furthermore, the contributions of transitions between employment and inactivity become negative after the 2001 recessions and reach -0.7 pp in December 2006. Comparing the contributions at the end of the 3 decades, $\Delta\tilde{s}^{EI}_{t+i}$ are equal to 2.6 pp, 2.7 pp and 1.9 pp in 1989, 1999 and 2006, respectively. On the other hand, the contributions $\Delta\tilde{s}^{IE}_{t+i}$ are equal to -2.4 pp, -2.2 pp and -2.7 pp respectively. This suggests that the negative contributions of hazard rate between employment and inactivity are explained mostly by a smaller positive contribution of outflows from employment.

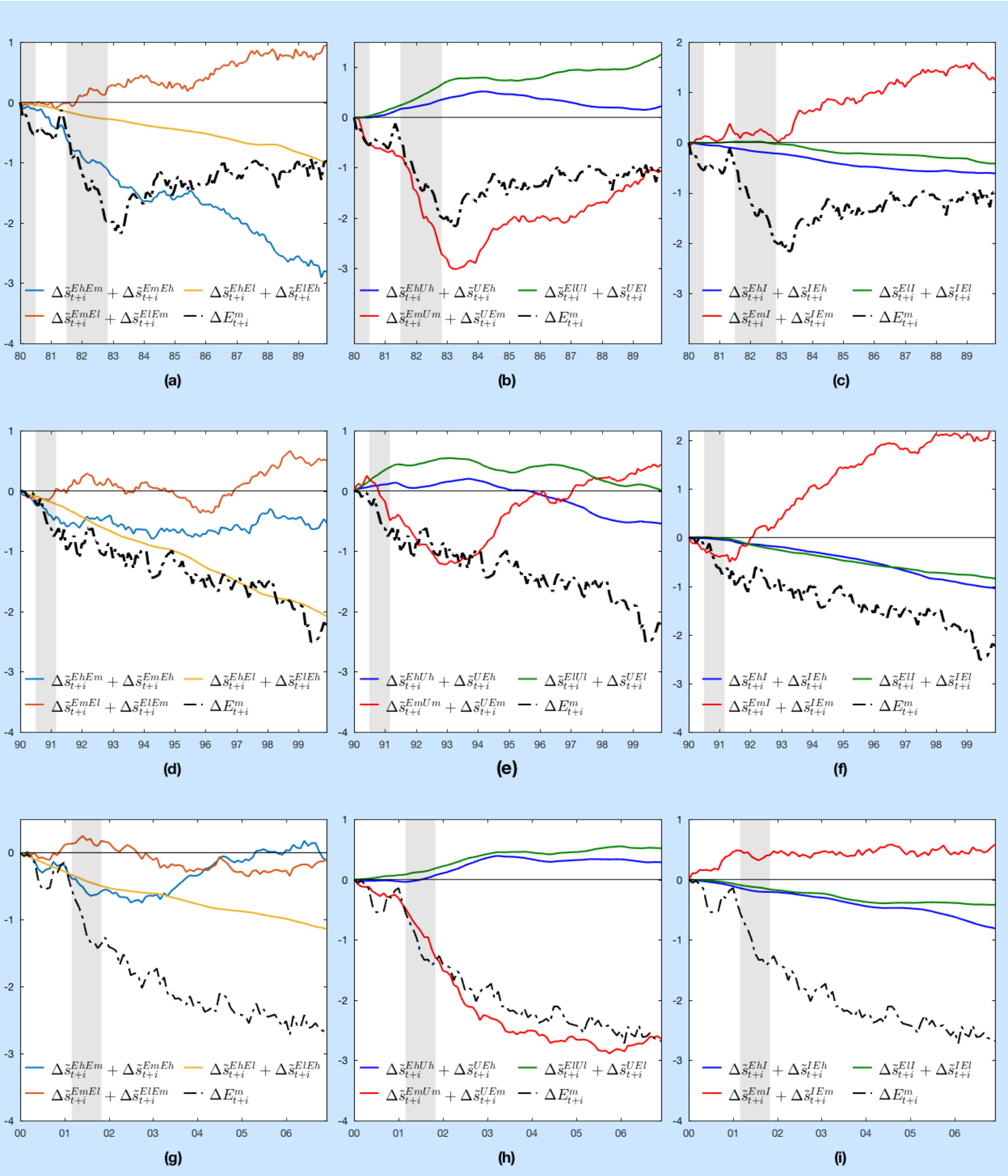
Overall the analysis of aggregate contributions suggests that employment to employment transition rates are particularly important to explain the decrease in middle skill employment between 1980 and 2000. Unemployment to employment hazard rates also have important negative contributions over all 3 decades, but the contributions increase after the 1980 recession while they keep decreasing after the 1990 and 2001 recessions.[20] Over the 1980-1999 periods, the decrease in E^m appears to be dampen by positive contributions of outflows from employment to unemployment and inactivity. The positive contributions of these hazard rates decrease over the 2000-2006 period, which explains the negative (net) contributions of hazard rates between employment and unemployment and between employment and inactivity.

Figure 5 plots net contributions[21] by occupations and allows to learn more about the aggregate contributions highlighted in the above paragraphs. One important take away from this figure regards employment to employment hazard rates. From Panel (a), we see that the negative

[19]Note that when I mention transitions between some states, I refer to transitions from and to these states. For instance, transitions between employment and unemployment refer to (disaggregated) hazard rates from employment to unemployment and to (disaggregated) hazard rates from unemployment to employment.

[20]An observation that we could relate to Jobless recoveries studied in Section 3.2.

[21]I focus on net contributions mainly to save space and avoid displaying figures with too many hazard rates contributions. Individual contributions can be seen in Figures 13-16 in Appendix A.1.1.



Hazard rates contributions in percentage point, to monthly cumulative fluctuations in middle skill employment. Each row displays contributions for the 3 different periods: 1980-89, 1990-99 and 2000-06. Each column shows net contributions from a subset of hazard rates and computed using equation (7). The first column focuses on hazard rates between employment, the second on hazard rates between employment and unemployment with $\Delta\tilde{s}^{UE^k}_{t+i} = \Delta\tilde{s}^{U^hE^k}_{t+i} + \Delta\tilde{s}^{U^mE^k}_{t+i} + \Delta\tilde{s}^{U^lE^k}_{t+i}$. The last column displays results for hazard rates between employment and inactivity. Shaded areas display recessions as defined by the NBER.

Figure 5: Hazard rates contributions by occupations to middle skill employment fluctuations

contributions $\Delta\tilde{s}^{EE}_{t+i}$ over the 1980-89 period originate primarily from the contributions of transitions between high and middle skill employment, $\Delta\tilde{s}^{E^hE^m}_{t+i}$ and $\Delta\tilde{s}^{E^mE^h}_{t+i}$. Figure 3 shows that the hazard rate from high to middle skill employment, $f^{E^hE^m}$, is affected by a negative trend while there is a positive trend in $f^{E^mE^h}$. Therefore, this indicates that the decrease in E^m in the early years of Job Polarization is related to lower inflows from E^h but also to higher outflows to E^h. The contributions from these 2 hazard rates are still negative in the following 2 decades but less substantial compared to the 1980-89 period. The larger (less negative) contributions, $\Delta\tilde{s}^{E^hE^m}_{t+i} + \Delta\tilde{s}^{E^mE^h}_{t+i}$ can be related to the change of trend in $f^{E^mE^h}$ which start decreasing around 1995 and results in lower outflows from E^m.[22]

Moreover, Figure 5 reveals that the negative contributions of EE hazard rates over the 1990 decade highlighted in Figure 4, originate mostly from transition between high and low skill employment. These 2 hazard rates contribute for -2.1 pp at the end of the 1990 decade and -1 pp and -1.1 pp over the 2 others periods. Bearing in mind that $f^{E^hE^m} < f^{E^lE^m}$ and that I study long term fluctuations in E^m,[23] a possible explanation for this results is the decrease in the trend in $f^{E^hE^l}$ after 1990 until around the end of the 1990 decade (see Figure 2). This implies that high skill workers are less likely to enter low skill employment and then transition to middle skill employment.

Contributions of hazard rates from and to middle skill employment, $f^{E^mU^m}$ and $f^{U^iE^m}$ account for most of the aggregate contribution, $\Delta\tilde{s}^{EU}_{t+i} + \Delta\tilde{s}^{UE}_{t+i}$ displayed in Figure 4. As a result, $f^{E^mU^m}$ and $f^{U^iE^m}$ have substantial negative contributions to middle skill employment fluctuations over the 2000-2006 period in Figure 5. A similar conclusion can be reached for the aggregate contributions, $\Delta\tilde{s}^{EI}_{t+i} + \Delta\tilde{s}^{IE}_{t+i}$ which originate mostly from hazard rates between middle skill employment and inactivity, f^{E^mI} and f^{IE^m}. Furthermore, Panel (i) shows that the negative aggregate contributions of hazard rate between employment and inactivity (Figure 4) comes from a much smaller positive contributions of hazard rates between E^m and I. Finally, it is interesting to relate these contributions to the trends displayed in Figure 2. In particular, outflows from middle skill employment to unemployment and inactivity appear to exhibit a change in their trends during the second part of the 1990 decade. The trend in $f^{E^mU^m}$ becomes stable while the trend in f^{E^mI} starts increasing. A quick look at Figures 13 and 14, confirms that the contributions of these outflows, $\Delta\tilde{s}^{E^mU^m}_{t+i}$ and $\Delta\tilde{s}^{E^mI}_{t+i}$ are smaller than observed during the previous decades. This further highlights that without the positive contributions of these outflows, the decrease in E^m during the 1980 and 1990 decades would probably have been much more important than observed.

For the most part, these results are consistent with those reported by Cortes et al. (2016). Their analysis consists in fixing a set of transition rates to their average value before the Polarization era (1976-1982) and then generate counterfactual series for E^m over the period 1983-2012 using a first-order Markov Chain. By comparing the counterfactual and actual series, they identify some transition rates that lead to higher employment in middle skill occupations, had these transition rates stayed constant at their value before Polarization. After the year 2000, they find an important role for transition rates from unemployment to middle skill employment, f^{UE^m} and between inactivity and middle skill employment, f^{E^mI} and f^{IE^m}. These results are similar to what is found and displayed in Figure 5 for the period 2000-2006. However, it is interesting to note that their methods does not account well for the decrease in E^m before 2000 (their counterfactual series are similar to the actual one). Cortes et al. (2016) cannot study the impact of employment to employment transitions given the effect of the 1994 redesign which created large breaks in these series. It is therefore interesting to relate these 2 observations to the results discussed in the previous paragraph which emphasize the role of EE transition rates to explain the decrease in E^m prior to 2000.

[22]This can also be confirmed from Figure 13 in Appendix A.1.1 which shows larger positive contributions $\Delta\tilde{s}^{E^mE^h}_{t+i}$ after 1990.

[23]Note that computing cumulative fluctuations implies that, for instance in December 1999, I am studying variations in middle skill employment between January 1990 and December 1999 or over a 10 years period. Intuitively, transitions $E^h \Rightarrow E^l \Rightarrow E^m$ are more likely to matter for such long term fluctuations in E^m.

To summarize, the graphical evidence of Figures 4 and 5 suggest that there are 4 main explanations to the decrease in middle skill employment:

1. Between 1980 and 1999, job to job transitions contribute significantly to the decrease in E^m. Higher outflows to E^h and lower inflows from E^h are particularly important at the start of the Polarization era. Hazard rates between high and low skill employment have a higher contribution between 1990 and 1999.

2. Transitions from unemployment to middle skill employment, f^{UE^m}, have substantial negative contributions throughout the entire period. However, the secular decline in the employment to unemployment hazard rate, $f^{E^mU^m}$, compensate this negative contribution between 1980 and 2000. From 2000 onwards, $f^{E^mU^m}$ and f^{UE^m} become the main contributor to the decrease in E^m.

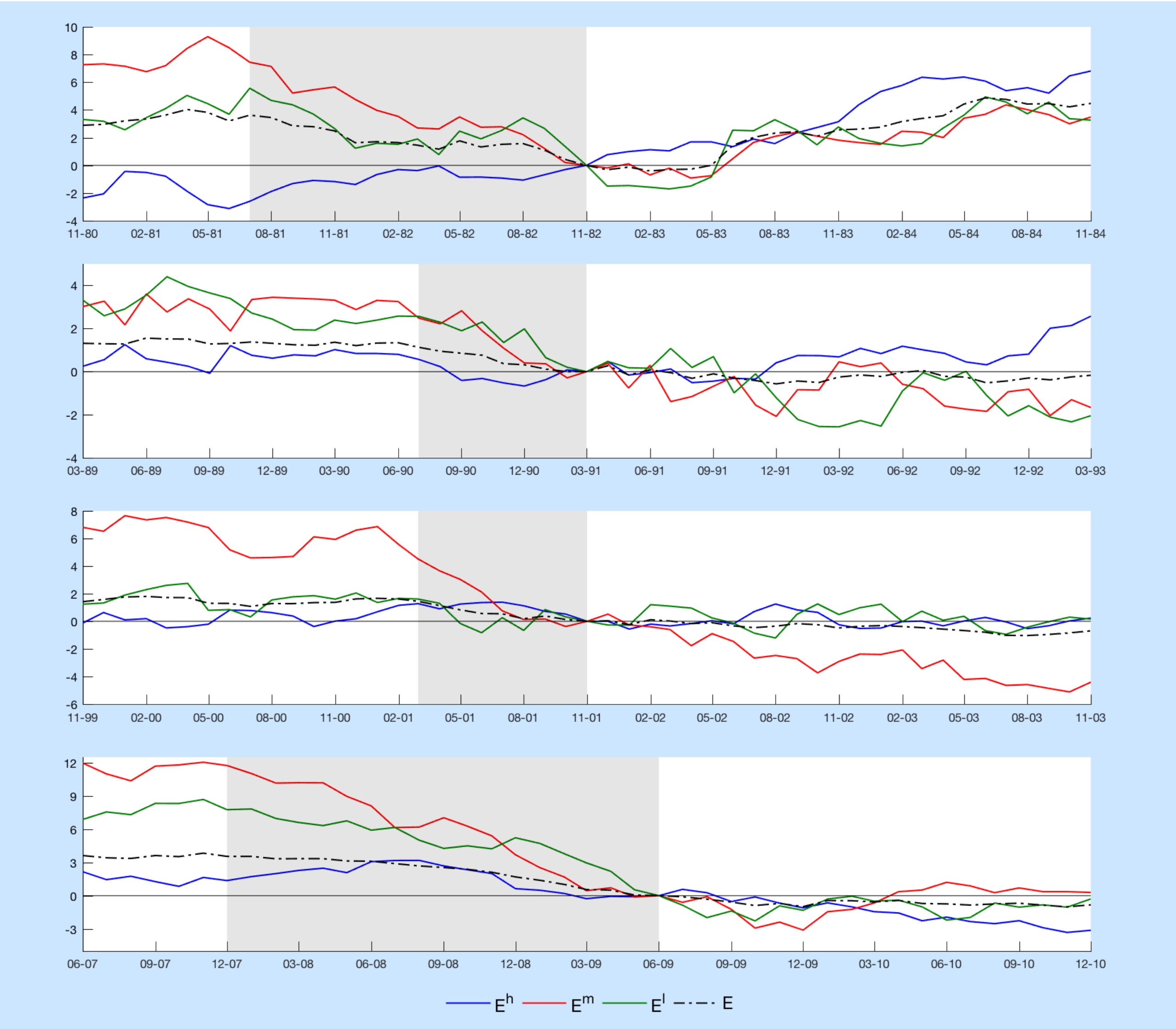
3. After the year 2000, hazard rates between inactivity and employment start contributing negatively to E^m fluctuations. This can be related to the change in the trend in the hazard rate f^{E^mI} which starts increasing during the 2nd half of the 1990 decade. The contributions from f^{E^mI} remains positive but become much smaller than observed during the 1980 and 1990 decades.

4. Overall, the decreasing trends in outflows, $f^{E^mU^m}$ and f^{E^mI}, between 1980 and around 1998, played an important role to dampen the decrease in middle skill employment over these periods.

3.2 Jobless Recoveries

Jobless recoveries refer to the slow rebound of aggregate employment that followed recessions after 1990. No consensus on the mechanisms behind these sluggish recoveries has yet emerged (see Panovska (2017) for a review of the literature). Jaimovich and Siu (2012) have recently argued that Jobless recoveries can be linked to Job Polarization. They show that most of the employment loss in routine occupations occurs during recessions and that the slow recovery of aggregate employment originates from jobless recoveries in middle skill employment. Their analysis focuses on employment stocks. Using the variance decomposition, I propose a flow rate analysis of jobless recoveries with a particular focus on whether hazard rates from and to middle skill employment can account for the sluggish rebound of aggregate employment.

Before doing so, Figure 6 displays the percentage difference between employment during the 24 months prior and after the end of recessions and its level at the trough. This figure shows that after the 1980 recession, it took 6 months (until May 1983) for employment to surpass its level at the end of the recession and employment was around 4.5% higher 2 years after. On the other hand, aggregate employment never recovered its level at the trough in the following 3 recessions (except for few months right after the end of the 1990 recession) and 2 years after the 1990, 2001 and 2007 recessions, aggregate employment was smaller by 0.3%, 1.1% and 1.4% respectively. Looking at employment by occupations, we can see that sluggish recoveries appear to affect employment in all occupation groups. More precisely, both middle and low skill employment were smaller than their level at the trough after the 1990 recession and it's mostly high skill employment that seems to suffer from a slow recovery after the 2007 recession. It is only after the 2001 recessions that middle skill employment clearly seems to drive the slow recovery of aggregate employment. Note however that, high and low skill employment stagnate in the 2 years after the 2001 recessions and they were only around 0.2% above their levels at the end of the recession in November 2003. The evidence on Jobless recoveries being only related to middle skill employment is therefore more mixed than reported by Jaimovich and Siu (2012). The difference is likely to come from the differences in occupational classification for middle and low skill occupations (see Section 2.1) but it seems that high skill employment is also affected by jobless recoveries.



Monthly employment fluctuations in the 24 months before and after the end of recessions. Each graphics display the percentage difference between the level of employment and its level at the trough. The dotted-dash line displays aggregate employment fluctuations. High, middle and low skill employment variations are displayed in blue, red and green, respectively. Shaded areas show recessions periods as defined by the NBER.

Figure 6: Employment fluctuations during recessions and recoveries

Figures 7 and 8 display hazard rate contributions in percentage points (pp) in the 24 months prior and after the end of recessions. Note that we can use equation (7) to compute cumulative contributions for the 24 months after the trough. For the contributions in the month prior to the trough, we can use the fact that:

$$\begin{aligned}\tilde{s}_t - \tilde{s}_{t-i} &= -(\tilde{s}_{t-i} - \tilde{s}_t) \\ &= -\sum_{j=1}^{i} \Delta\tilde{s}_{t-i+j} \end{aligned} \tag{21}$$

where t is the date of the trough. Therefore, for any months $t-i$ prior to t, we can compute the negative of the cumulative contributions between month $t-i$ and the month of the trough t.[24] Figure 7 focuses on (aggregate) contributions computed from the aggregate hazard rates in equations (8)-(13). As explained in Section 2.2, aggregate hazard rates fluctuations can be decomposed into disaggregated hazard rate effect and a compositional effect. Figure 8 focuses only on disaggregated hazard rates effects.[25] Compositional effects are small and displayed in Figure 18 in Appendix A.1.2.

The first column in Figure 7 shows that recoveries after the 1990, 2001 and 2007 recessions (Panels (d), (g) and (j)) are characterized by substantial negative contributions of hazard rates from unemployment to employment. The contributions of employment to unemployment hazard rates are positive but do not compensate the negative effect coming from f^{UE}. In March 1993, November 2003 and December 2010, the net contributions of these hazard rates are equal to -1.4 pp, -1.7 pp and -1.3 pp respectively.

Transition rates between employment and inactivity (2nd column) display similar behavior to what is described for middle skill employment in the previous section. The hazard rate from employment to inactivity contributes positively while the hazard rate from inactivity to employment has negative contributions during all 4 recoveries. The net contributions evolve around zero after the 1980, 1990 and 2001 recessions but they are negative after the 2007 recessions. The similar effects observed during the 1980 and the 1990/2001 recoveries suggest that these hazard rates do not explain the slow rebound in aggregate employment.

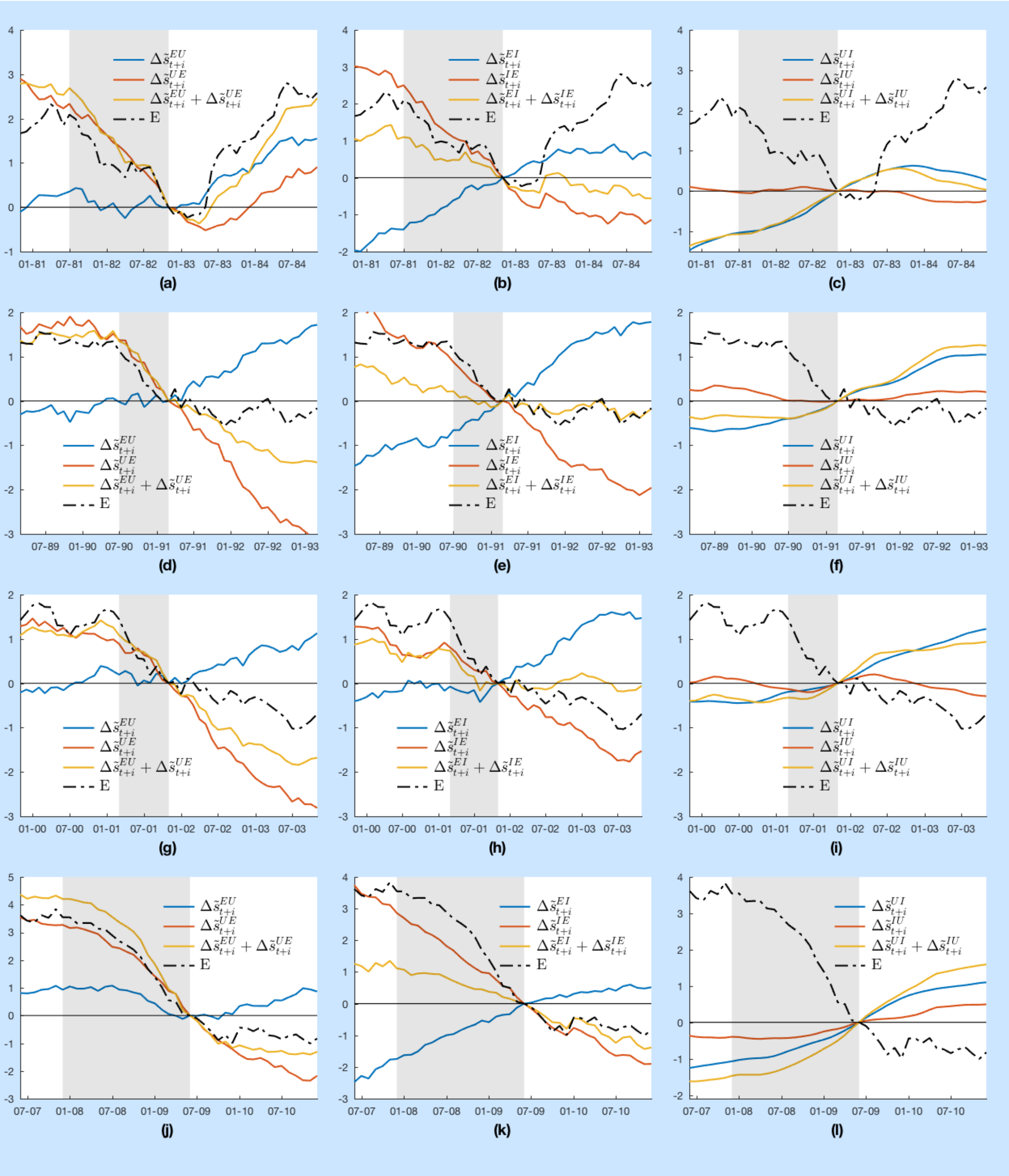
Hazard rates between unemployment and inactivity (3rd column) contribute positively to employment fluctuations in the aftermath of all 4 recessions. However, the net contributions stays positive after the 1990, 2001 and 2007 recessions and contribute for, respectively, 1.2 pp, 0.9 pp and 1.6 pp, 2 years after the trough. Therefore, these hazard rates are important to limit the slow recovery of aggregate employment. We can further see that the contribution of the hazard rate f^{UI} is the most substantial. As explained by Elsby et al. (2015), this hazard rate decreases during recessions as the composition of the unemployment pool changes towards more attached workers. Therefore a possible explanation for the persistent positive contribution of f^{UI} is that the slow rebound of employment implies that more attached workers stay unemployed longer after the end of recessions. This prevents f^{UI} from increasing and recovering its pre-recession level and contributes positively to aggregate employment fluctuations.[26]

Figure 8 allows to determine whether (disaggregated) hazard rates related to specific occupations account for the contributions discussed in the previous paragraph. To save space, this figure plots net contributions and contributions for each individual hazard rate can be found in Figures 17 and 18 in Appendix A.1.2. The first column of Figure 8 focuses on net contributions of hazard rates between employment and unemployment. It shows that transitions from and to employment of the 3 occupation groups contribute negatively to aggregate employment fluctuations in the 3 recoveries

[24]Note that these contributions should be labeled $\Delta\tilde{s}^{ij}_{t-i}$ while contributions after the trough are labeled $\Delta\tilde{s}^{ij}_{t+i}$. In what follows, I only comment on contributions after the through, $\Delta\tilde{s}^{ij}_{t+i}$. To avoid having to use both notations in Figures 7 and 8, the legends in these figures label contributions before and after the trough $\Delta\tilde{s}^{ij}_{t+i}$.

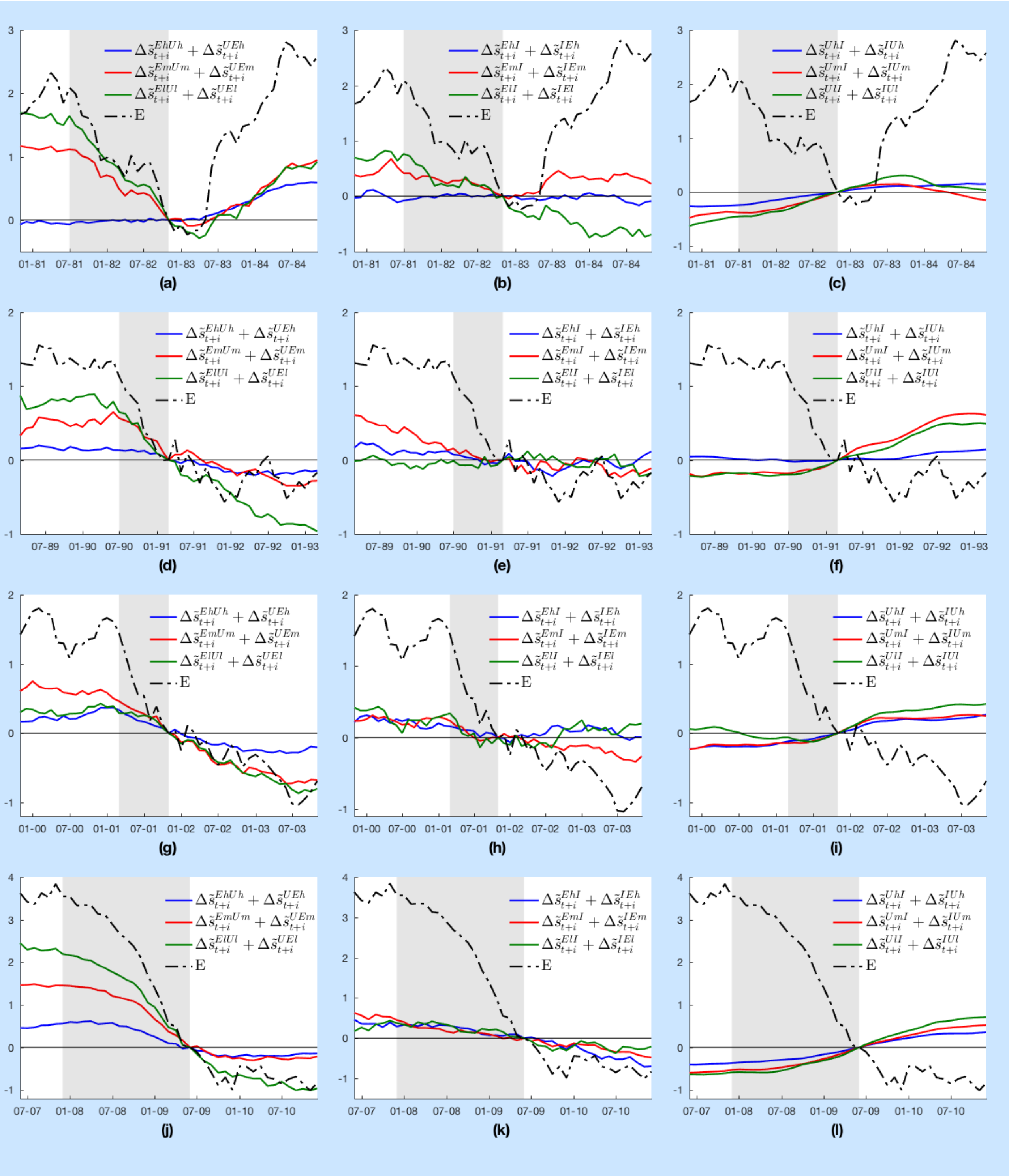
[25]Note that there is an exception for unemployment to employment hazard rates as I sum the disaggregated hazard rates contributions according to the skill level k of employment: $\Delta\tilde{s}^{UE^k}_{t+i} = \Delta\tilde{s}^{U^hE^k}_{t+i} + \Delta\tilde{s}^{U^mE^k}_{t+i} + \Delta\tilde{s}^{U^lE^k}_{t+i}$.

[26]Note that lower a hazard rate to inactivity, f^{UI} implies that workers are more likely to stay in unemployment and the job finding hazard rate is much greater from unemployment than from inactivity, $f^{UE} >> f^{IE}$. This provides an explanation for the sign of the f^{UI} contributions.



Hazard rates contributions in percentage points to monthly cumulative fluctuations in aggregate employment in the 24 months before and after the end of recessions. Each row focuses on a different recessions and each column shows contributions from a subset of hazard rates. These contributions are obtained by computing aggregate hazard rates (8)-(13) and applying (7) and (21). The first column displays the contributions of hazard rates between employment and unemployment, $\Delta\tilde{s}^{EU}_{t+i}$ and $\Delta\tilde{s}^{UE}_{t+i}$. Results for hazard rates between (un)employment and inactivity, $\Delta\tilde{s}^{EI}_{t+i}$, $\Delta\tilde{s}^{IE}_{t+i}$ and $\Delta\tilde{s}^{UI}_{t+i}$, $\Delta\tilde{s}^{IU}_{t+i}$, are shown in the second and third columns. Shaded areas display recessions as defined by the NBER.

Figure 7: Aggregate hazard rates contributions to aggregate employment fluctuations



Hazard rates contributions in percentage points to monthly cumulative fluctuations in aggregate employment in the 24 months before and after the end of recessions. Each row focuses on a different recessions and each column shows contributions from a subset of hazard rates. The first column shows results for hazard rates between employment and unemployment, $\Delta\tilde{s}^{E^kU^k}_{t+i}+\Delta\tilde{s}^{UE^k}_{t+i}$. The second column displays net contributions of hazard rates between employment and inactivity, $\Delta\tilde{s}^{E^kI}_{t+i}+\Delta\tilde{s}^{IE^k}_{t+i}$. Results for hazard rates between unemployment and inactivity, $\Delta\tilde{s}^{U^kI}_{t+i}+\Delta\tilde{s}^{IU}_{t+i}$, are displayed in the last column. Shaded areas display recessions as defined by the NBER.

Figure 8: Hazard rates contributions by occupations to aggregate employment fluctuations

after the 1990 recessions. Moreover, we can see that transitions between unemployment and low skill employment have the largest negative contributions among the 3 occupation groups after the 1990 and 2007 recessions. A similar conclusion can be reached for hazard rates between inactivity and the labor force as in general, the net contributions are of the same signs for high, middle and low skill occupations. Two exceptions are noticeable. First, the net contributions of hazard rates between low skill employment and inactivity are negative after the 1980 recovery (Panel (b)) and second, hazard rates between inactivity and middle skill employment contribute negatively after the 2001 recession (Panel (h)). However, these observations are specific to these recoveries.

To sum up, the graphical evidence seems to suggest that recoveries after the 1990, 2001 and 2007 recessions, are affected by persistent and substantial negative contributions of the hazard rate from unemployment to employment, f^{UE}. However, a Polarization effect is hard to identify as I find that hazard rates between employment and unemployment of all 3 occupation groups contribute negatively to aggregate employment fluctuations. The use of a different occupational classification for middle and low skill occupations compared to Jaimovich and Siu (2012) (see Section 2.1), could partly account for this observation but it is worth noting that transition rates between unemployment and high skill employment also contribute negatively.

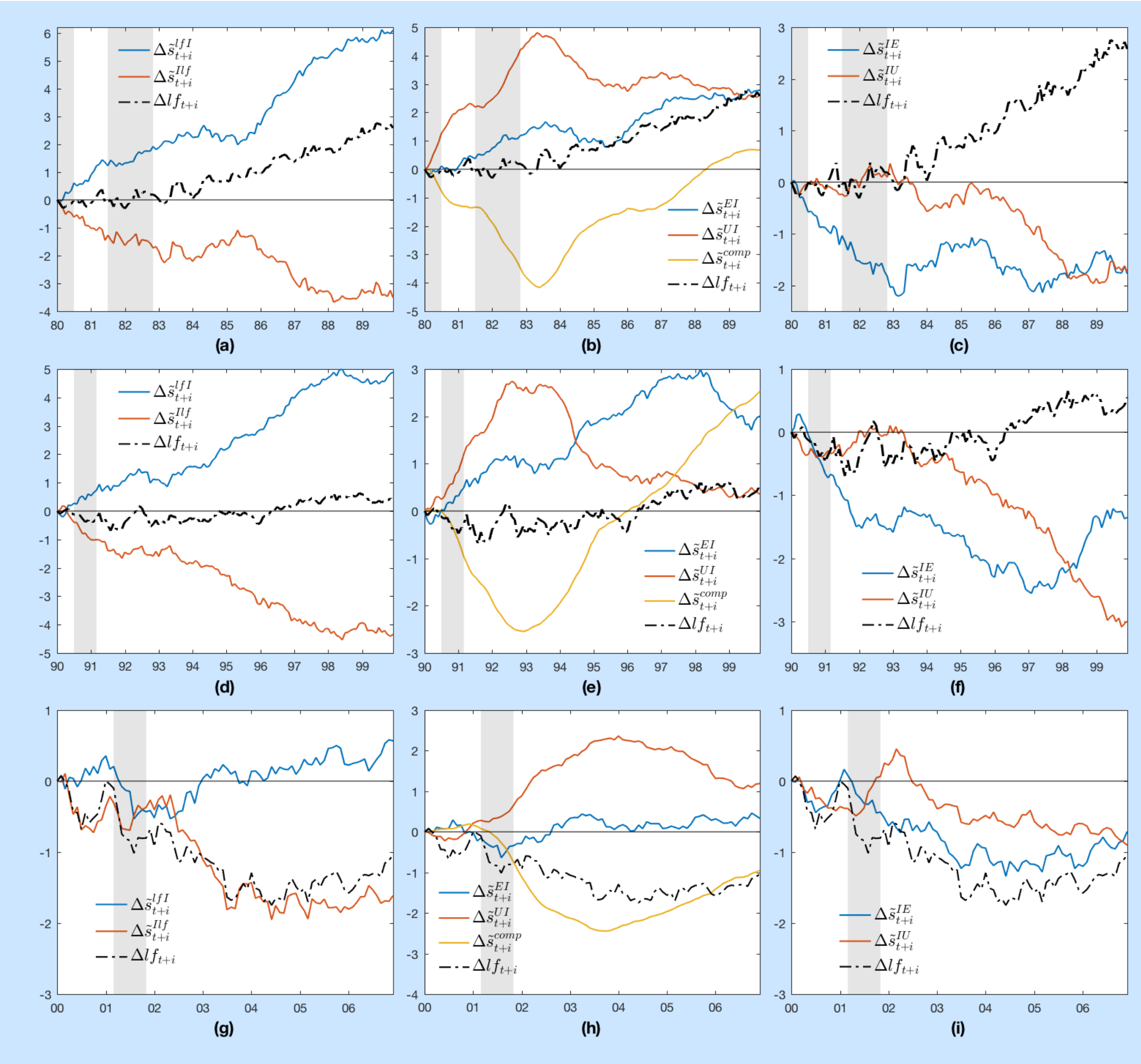
3.3 Labor force Participation

To study long run fluctuations in labor force participation, I apply the framework presented at the end of Section 2.2 which rely on the aggregate hazard rates out of the labor force, $f_t^{\text{lf}I}$ and into the labor force, $f_t^{I\text{lf}}$ (equations (14) and (15)). Throughout this section, the term outflows always refers to transitions from the labor force to inactivity while inflows refers to the opposite transitions. I then proceed as for middle skill employment by splitting the sample into the same 3 sub-periods and compute the hazard rate contributions to cumulative fluctuations in labor force from the start of each period (using equation (7)).

These 3 sub-periods capture different dynamics for labor force which increased by 2.6 pp between 1980-89, by only 0.5 pp from 1990 to 1999 and then decreased by 1 pp between 2000 and 2006. Figure 9 focuses on aggregate contributions of outflows and inflows. The first column (Panels (a), (d) and (g)) of Figure 9 displays the contributions of the hazard rates out and into the labor force, $f^{\text{lf}I}$ and $f^{I\text{lf}}$ (equations (14) and (15)). The other 2 columns decompose the outflows and inflows contributions in terms of aggregate hazard rates, $\Delta\tilde{s}_{t+i}^{EI}, \Delta\tilde{s}_{t+i}^{UI}, \Delta\tilde{s}_{t+i}^{IE}$ and $\Delta\tilde{s}_{t+i}^{IU}$ and a compositional effect for outflows, $\Delta\tilde{s}_{t+i}^{comp}$. As explained in Section 2.2, outflows are affected by 2 different types of compositional effects. A first one that relates to the occupational composition of employment and unemployment and affect the aggregate hazard rates, f^{EI} and f^{UI} (equations (10) and (11)). The second compositional effect captures changes in the composition of the labor force between unemployment and employment which generate fluctuations in the hazard rate out of the labor force, $f^{\text{lf}I}$. The contributions, $\Delta\tilde{s}_{t+i}^{comp}$, sum all these compositional effects.[27]

The comparison of Panels (a) and (d) in Figure 9 reveals that the stagnation of labor force participation over the 1990 decade originates both from smaller positive contributions of outflows and larger negative contributions of inflows (in absolute value). At the end of the 1980 decade, outflows and inflows contribute for 6.1 pp and -3.5 pp against 4.9 pp and -4.3 pp in December 1999. On the other hand, the decrease in the labor force between 2000 and 2006 is explained by small contributions of outflows which fluctuates around zero and do not compensate the negative contribution of inflows.

[27] Figure 11 disaggregate this compositional effect.



Hazard rates contributions in percentage point, to monthly cumulative fluctuations in labor force participation. Each row displays contributions for the 3 different periods: 1980-89, 1990-99 and 2000-06. Each column shows contributions from a subset of hazard rates. The first column shows the sum of contributions from outflows, $\Delta\tilde{s}^{\text{lfI}}_{t+i}$, and inflows, $\Delta\tilde{s}^{I\text{lf}}_{t+i}$. The second column decomposes the outflows contribution in terms of aggregate hazard rates effect, $\Delta\tilde{s}^{EI}_{t+i}$ and $\Delta\tilde{s}^{UI}_{t+i}$, and a compositional effect $\Delta\tilde{s}^{comp}_{t+i}$. The third column disaggregates the inflows contributions between $\Delta\tilde{s}^{IE}_{t+i}$ and $\Delta\tilde{s}^{IU}_{t+i}$. See Section 2.2 for more details. Shaded areas display recessions as defined by the NBER.

Figure 9: Outflows and Inflows contributions to labor force fluctuations

The decomposition of the outflows contributions (2nd column) shows that the compositional effect has substantial negative contributions. These negative contributions result from the rise in unemployment during recessions (see also the 3rd column of Figure 11). Since the exit rate from unemployment, f^{UI}, is much greater than from employment, f^{EI}, increases in the unemployment rate have a positive effect on outflows which negatively affects labor force participation. This compositional effect comes together with opposite contributions from unemployment to inactivity hazard rate that capture the procyclical behavior of this hazard rate. It is interesting to note, that the negative contribution from the compositional effect reaches a minimum quickly after the end of the 1980 recession (between 1983 and 1984 in Panel (b)) but the trough is reached later after the end of the 1990 recession (around 1993-94 Panel (e)) and the end of the 2001 recession (around 2003-04 Panel (h)). This highlights that, in the aftermath of recessions after 1990, labor force participation, is also affected by Jobless recoveries. The slow rebound of aggregate employment implies that the unemployment rate stays at high levels after recessions. This has positive effect on the outflow rate, $f_t^{\text{lf}I}$ and prevent labor force participation from recovering.

Regarding the 1990-99 period, we can further see that the labor force surpasses its level of January 1990 between 1996 and 1997, around the time when the contributions of the (unemployment rate) compositional effect become positive. In December 1999, the compositional effect contributes for 2.5 pp (2.2 pp for the unemployment rate alone) which tends to confirm the point made by Barnichon (2019), on the fact that the peak of labor force participation around the years 1999-2000 is explained mostly by the low unemployment rate of this period (see also Figure 1). From Panel (f), we can also note that the large negative contributions of inflows, $\Delta\tilde{s}_{t+i}^{I\text{lf}}$, during the 1990 decade originates from the contributions of the hazard rate to unemployment, $\Delta\tilde{s}_{t+i}^{IU}$. This negative contribution can be understood from the decreasing trend affecting this transition rate between 1992 and 1999 (see Panel (f) in Figure 2) which implies that less workers are entering the labor force.

Over the 2000-06 period, the small contributions of outflows are explained by the contribution of employment to inactivity hazard rates, $\Delta\tilde{s}_{t+i}^{EI}$ in Panel (h). Panel (e) also shows that the contributions of this hazard rate are already decreasing at the end of the 1990 decade. We can relate this observation to the change of trend in f^{EI} around the same period (see Section 2.3 and Panel (c) in Figure 2).

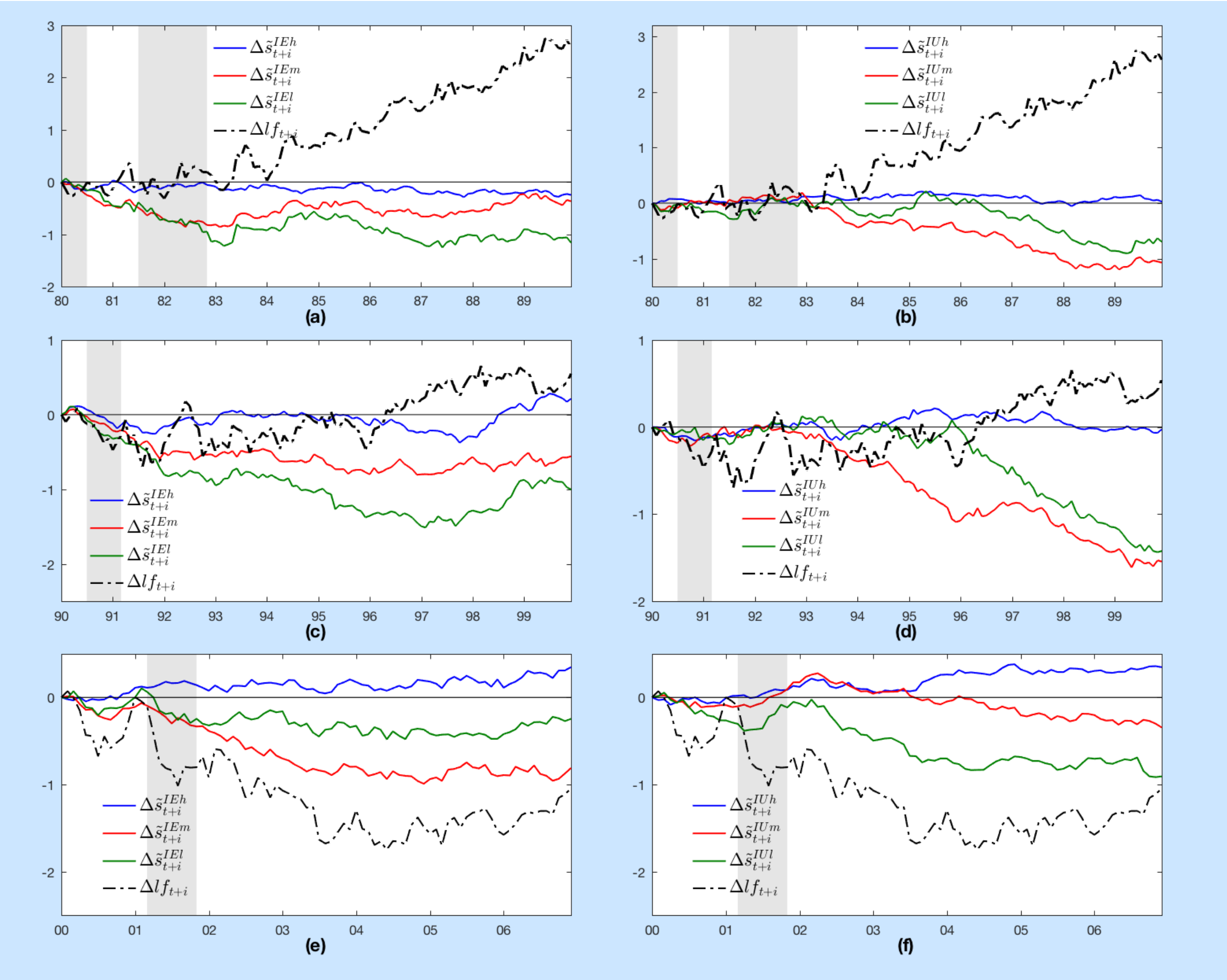
Figures 10 and 11 display the contributions of occupation-specific hazard rates. The transitions from and to (un)-employment in occupation k, $f^{E^kI}, f^{U^kI}, f^{IE^k}$ and f^{IU^k} affect the aggregate hazard rates, f^{EI}, f^{UI}, f^{IE} and f^{IU} (equations (10)-(13)), and therefore, the outflows and inflows hazard rates, $f^{I\text{lf}}$ and $f^{I\text{lf}}$ (equation (14) and (15)). Figure 11 on outflows, also displays results for the compositional effect.

Panel (d) in Figure 10 shows that negative contributions from f^{IU} over the 1990 decade come mostly from inflows to middle and low skill unemployment. This observation is consistent with the declining trends in these 2 hazard rates displayed in Figure 2. Furthermore, the negative contributions of hazard rates to employment, f^{IE}, originates almost exclusively from the negative contributions of inflows to middle and low skill employment. After the year 2000, the contribution of inflows to middle skill employment is the largest negative contributions (Panel(g) in Figure 10).

Regarding outflows, Panel (g) in Figure 11 reveals that the small aggregate contribution from f^{EI} over the 2000-2006 period, is explained mostly by the contributions of outflows from high skill employment. This hazard rate contributes negatively to labor force participation fluctuations between 2000 and 2006 (around -0.6 pp in December 2006). However, the contribution of outflows from middle skill employment are also small over this decade.[28] Furthermore, it is worth noting that in terms of net contributions, $\Delta\tilde{s}_{t+i}^{E^kI} + \Delta\tilde{s}_{t+i}^{IE^k}$ (Figure 19 in Appendix A.1.3), hazard rates between middle skill employment and inactivity contribute negatively to labor force fluctuations between 1990 and 1999 and between 2000 and 2006. This seems to confirm the point made by Foote and Ryan (2015) and Cortes et al. (2017) on the links between middle skill workers, Polarization and the dynamics of labor force participation. Note also that over this period, the compositional effect from unemployment rate fluctuations (Panel (i) in Figure 11) only contributes negatively, which is not the case during the 1980 and 1990 decades.

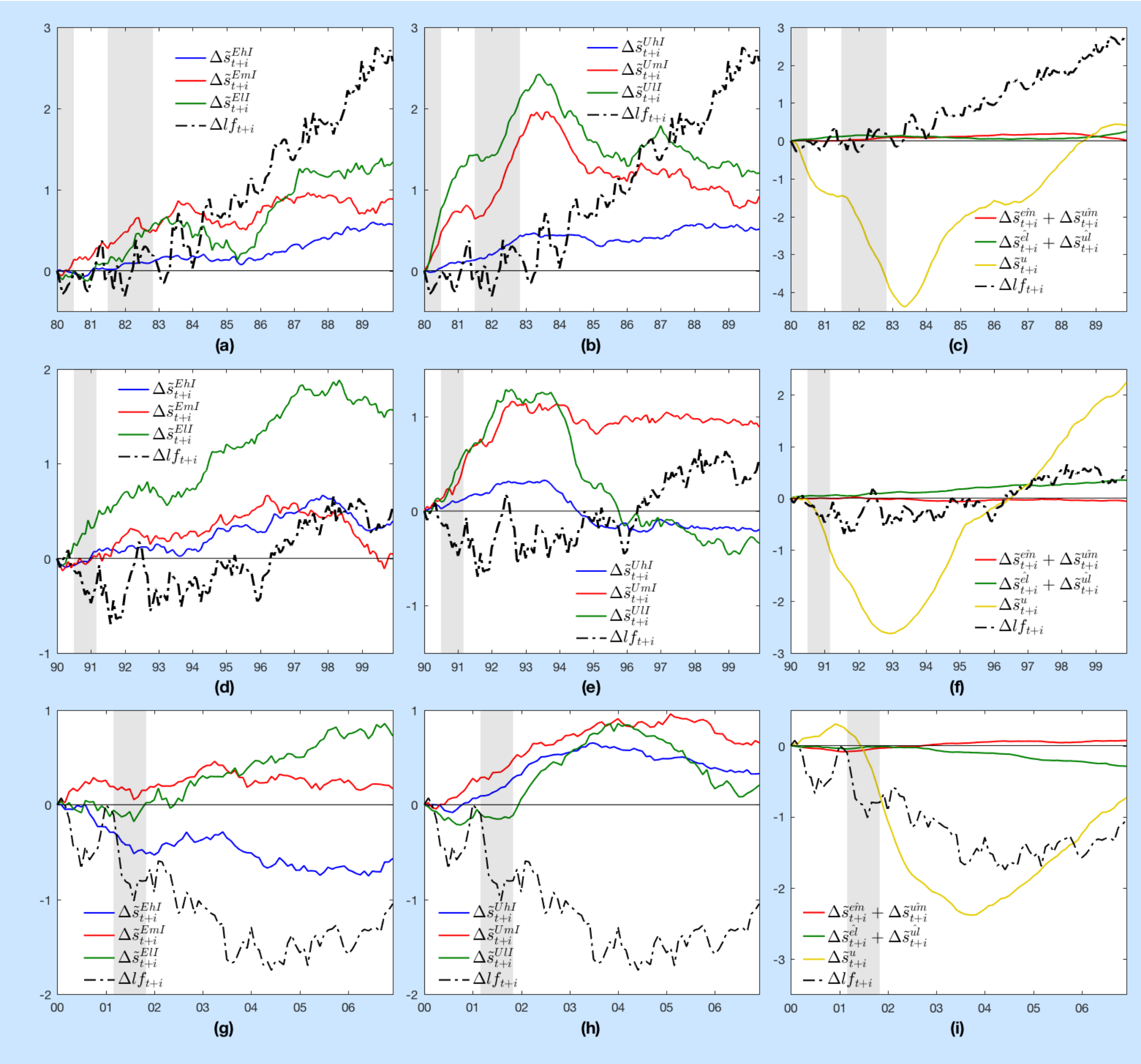
[28]Note that Panel (d) shows that there is a decrease in $\Delta\tilde{s}_{t+i}^{E^mI}$ starting in 1998. This indicates that if I had started the analysis around this period instead of January 2000, the contributions of this hazard rate would also be negative. See Figure 20 in Appendix A.1.3 which plots contributions from January 2007 and confirms this observation.

To summarize, the key role played by the unemployment rate on labor force fluctuations implies that Jobless recoveries have negative effects on labor force fluctuations following the end of recessions. The small increase in labor force participation over the 1990 decade, results from 2 opposing contributions. The unemployment rate is, on a decreasing trend during this decade which lowers outflows and contribute positively to labor force participation. On the other hand, hazard rates from inactivity to middle and low skill unemployment decrease which lowers inflows to the labor force and leads to substantial negative contributions from these 2 hazard rates. The decrease of labor force participation after 2000 originates mostly from the contributions of outflows from employment, f^{EI}. The hazard rate from high skill employment to inactivity contributes negatively but the contributions of the hazard rate from middle skill employment $f^{E^m I}$ is also smaller than observed during the previous decades. Moreover, the net contributions of hazard rates between middle skill employment and inactivity are negative over the 1990 decade and the 2000-2006 period. These observations tend to confirm that Job Polarization had a negative effect on labor force fluctuations.



Hazard rates contributions in percentage point, to monthly cumulative fluctuations in labor force participation. Each row displays contributions for the 3 different periods: 1980-89, 1990-99 and 2000-06. Each column shows contributions from a subset of hazard rates. The first column shows the contributions of hazard rates to employment in occupation k, $\Delta\tilde{s}^{IE^k}_{t+i}$, and the second column displays contributions of hazard rates to unemployment in occupation k, $\Delta\tilde{s}^{IU^k}_{t+i}$. Shaded areas display recessions as defined by the NBER.

Figure 10: Decomposition of the inflows contributions to labor force fluctuations



Hazard rates contributions in percentage point, to monthly cumulative fluctuations in labor force participation. Each row displays contributions for the 3 different periods: 1980-89, 1990-99 and 2000-06. Each column shows contributions from a subset of hazard rates. The first column shows the contributions of hazard rates from employment in occupation k to inactivity, $\Delta\tilde{s}_{t+i}^{E^kI}$, the second column displays contributions of hazard rates from unemployment in occupation k to inactivity, $\Delta\tilde{s}_{t+i}^{UI^k}$. The last column decomposes the compositional effect between the contributions of variations in middle-skill (un)employment shares, $\Delta\tilde{s}_{t+i}^{e\hat{m}} + \Delta\tilde{s}_{t+i}^{u\hat{m}}$, variations in low-skill (un)employment shares, $\Delta\tilde{s}_{t+i}^{\hat{el}} + \Delta\tilde{s}_{t+i}^{\hat{ul}}$ and variations in the unemployment rate, $\Delta\tilde{s}_{t+i}^{u}$. See Section 2.2 for more details. Shaded areas display recessions as defined by the NBER.

Figure 11: Decomposition of the outflows contributions to labor force fluctuations

4 Conclusion

Using CPS data for the period 1976-2010 and the occupational classification of Autor and Dorn (2013), this papers proposes a study of the potential effect of Job Polarization on the labor market. The classification of Autor and Dorn (2013) allows to rank occupations between cognitive, routine and manual (high, middle and low skills) and I use the decomposition of Elsby et al. (2015) to provide a flow analysis of the medium/long term fluctuations in labor market stocks that could be affected by Polarization.

I first focus on middle skill employment which decreases between 1980 and 2010. The sample is split in 3 periods (1980-1989, 1990-1999 and 2000-2006) and I compute the contribution of hazard rates over these decades. The results are consistent with those reported by Cortes et al. (2016) as I find important negative contributions from the unemployment to middle skill employment transition rate and from hazard rates between employment and inactivity after the year 2000. Prior to this period, the decrease of middle skill employment appears to be mostly driven by employment to employment hazard rates. In particular, transitions between high and middle employment have substantial negative contributions between 1980 and 1989. On the other hand there is large negative contribution of hazard rates between high and low skill employment during the 1990 decade.

Next I look at the link between Polarization and Jobless recoveries. Jaimovich and Siu (2012) have argued that Job Polarization explains Jobless recoveries or the slow rebound of aggregate employment that followed the end of recessions after 1990. I therefore analyze aggregate employment fluctuations in the 2 years following the 1980, 1990, 2001 and 2007 recessions, and focus on which hazard rates can account for the sluggish rebound of employment. The results highlight the role of hazard rates from unemployment to employment after the last 3 recessions. Transition rates to middle skill employment contribute negatively to aggregate employment fluctuations, but so are hazard rates to high and low skill employment. Overall, these results suggest that Job Polarization is not the sole contributor to Jobless recoveries and alternative explanations, such as the extension of unemployment benefits (Mitman and Rabinovich (2019)) or changes in firms behavior during recessions and recoveries (Koenders and Rogerson (2005)), are also likely affecting aggregate employment in recent recoveries.

In the last part of the paper, I focus on labor force participation fluctuations. Foote and Ryan (2015) and Cortes et al. (2017) claim that Job Polarization has lead middle skill workers to exit the labor force contributing to the decrease of participation after 2000. Between 2000-2006, the results show negative effects of hazard rates between middle skill employment and inactivity but the hazard rate from high skill employment to inactivity also contributes negatively. These results can be related to the trends in these hazard rates. In particular the trends in outflows from high and middle skill employment appear to change around the end of the 1990 decade. These hazard rates start increasing which provides an explanation for their small contributions to labor force fluctuations. Moreover, the results emphasize the importance of unemployment fluctuations. I show that Jobless recoveries, which results in a slow decrease of unemployment, have also a negative effect on labor force participation following the end of recessions. The negative trend in the unemployment rate until the end the 1990 is also key to understand the peak of labor force participation (Barnichon (2019)).

The work accomplished in this paper allows to better understand the role of hazard rates to shape medium/long term fluctuations for some labor market stocks. I mostly rely on the trends present in some hazard rate series to explain the results but without studying the factors behind these trends. For instance, I find that labor force participation peaks at the end of the 1990 decade around the time when the unemployment trend reaches a minimum. The trend in the unemployment rate has been shown to be affected by ageing or the increase in women participation (Barnichon and Mesters (2018)) and it would be interesting to study the role of these factors on hazard rates trends (e.g. on the change of trend affecting hazard rate from employment to inactivity around the end of the 1990 decade). Furthermore, one important results of this paper regards middle skill employment and the role of employment to employment hazard rates. However, more robustness checks to validate this results are required given that these transition rates could be subject to misclassification errors (see Ounnas (2019a)).

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A Appendix

A.1 Results

A.1.1 Middle skill employment

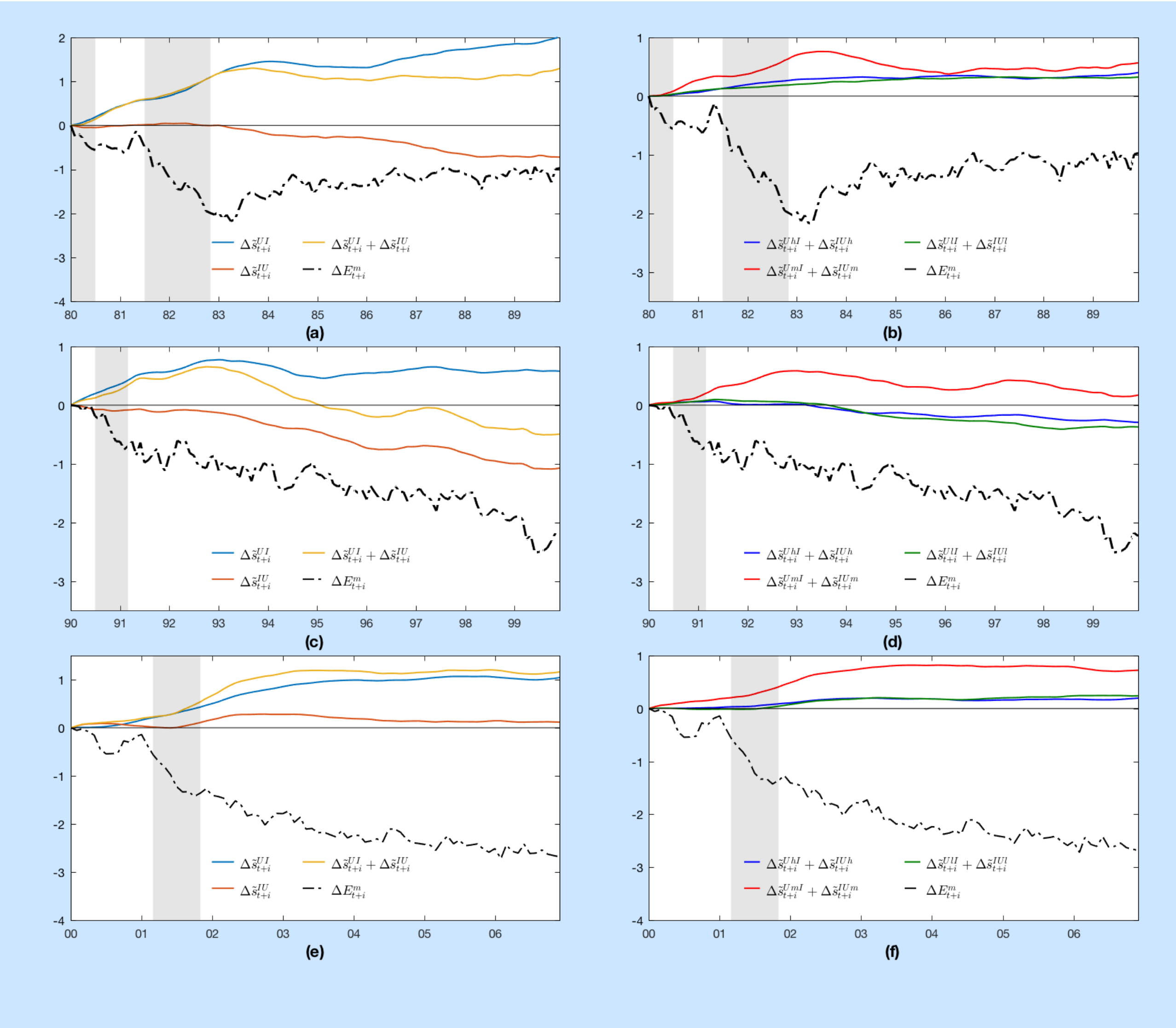

Figure 12: Contributions of hazard rates between Unemployment and Inactivity to middle skill employment fluctuations

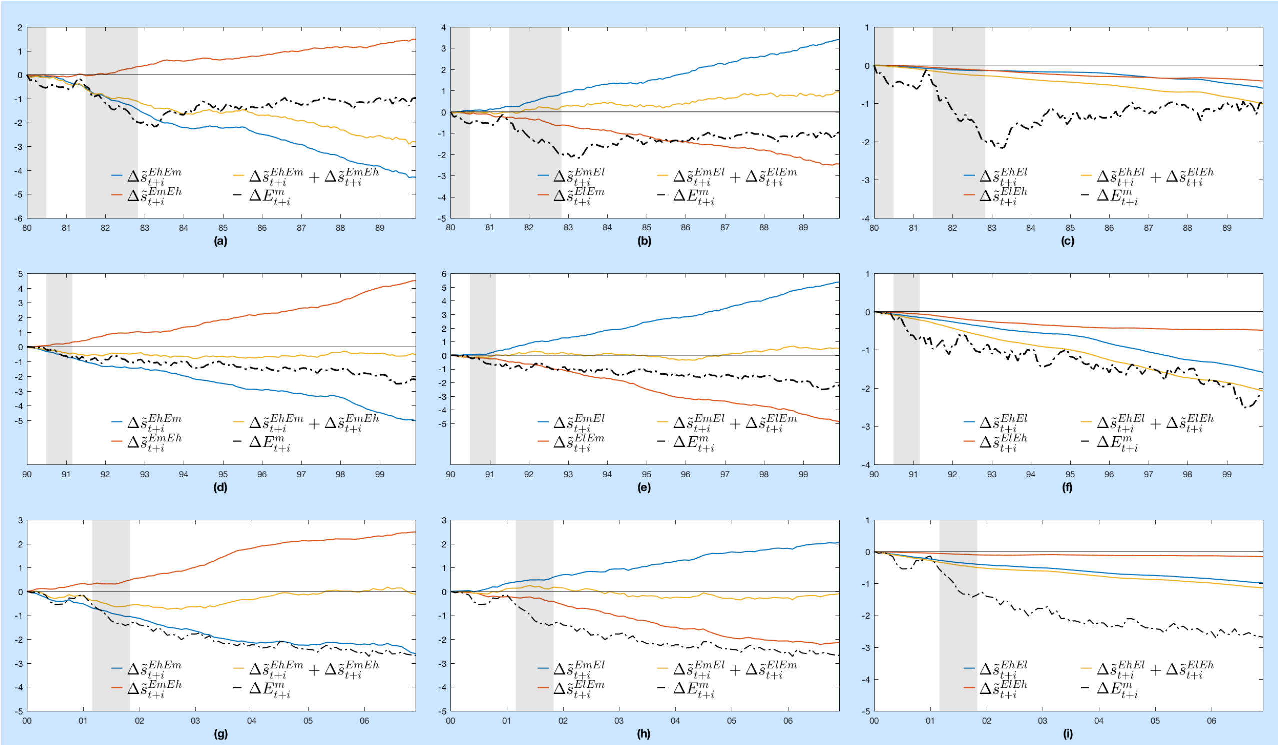

Figure 13: Detailed contributions to middle skill employment fluctuations (1)

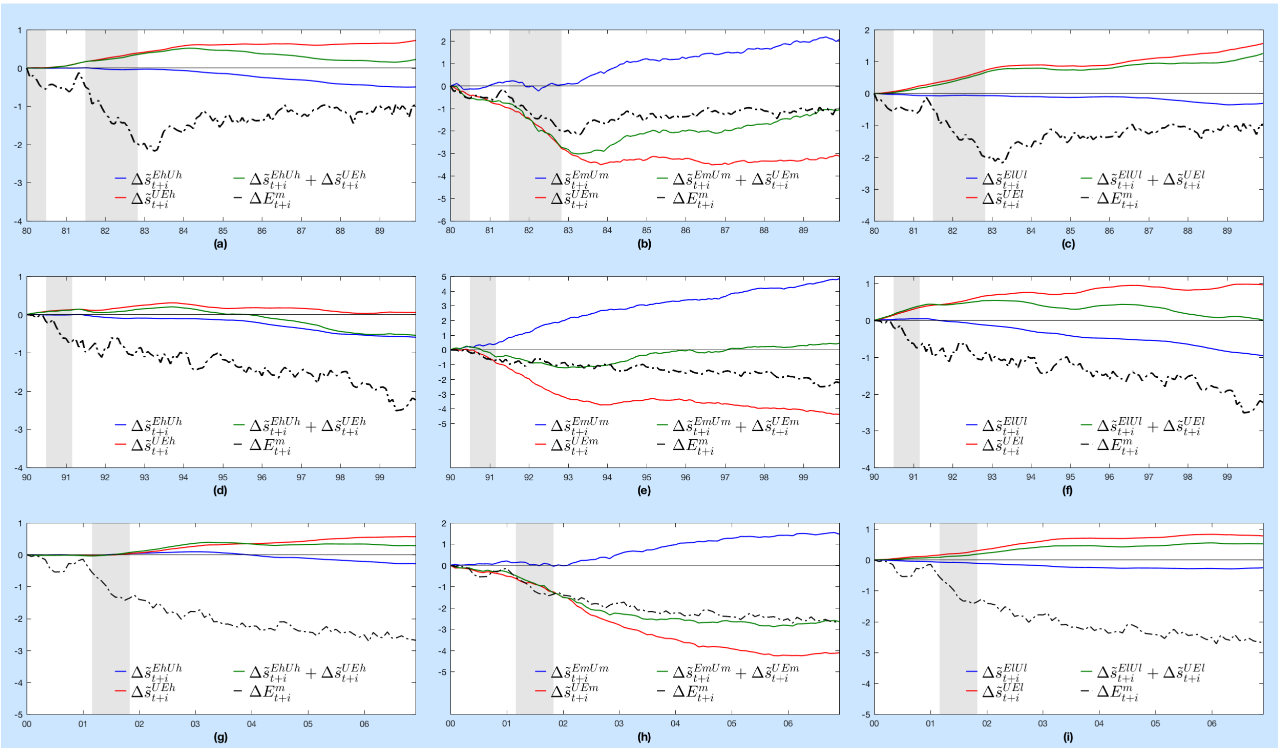

Figure 14: Detailed contributions to middle skill employment fluctuations (2)

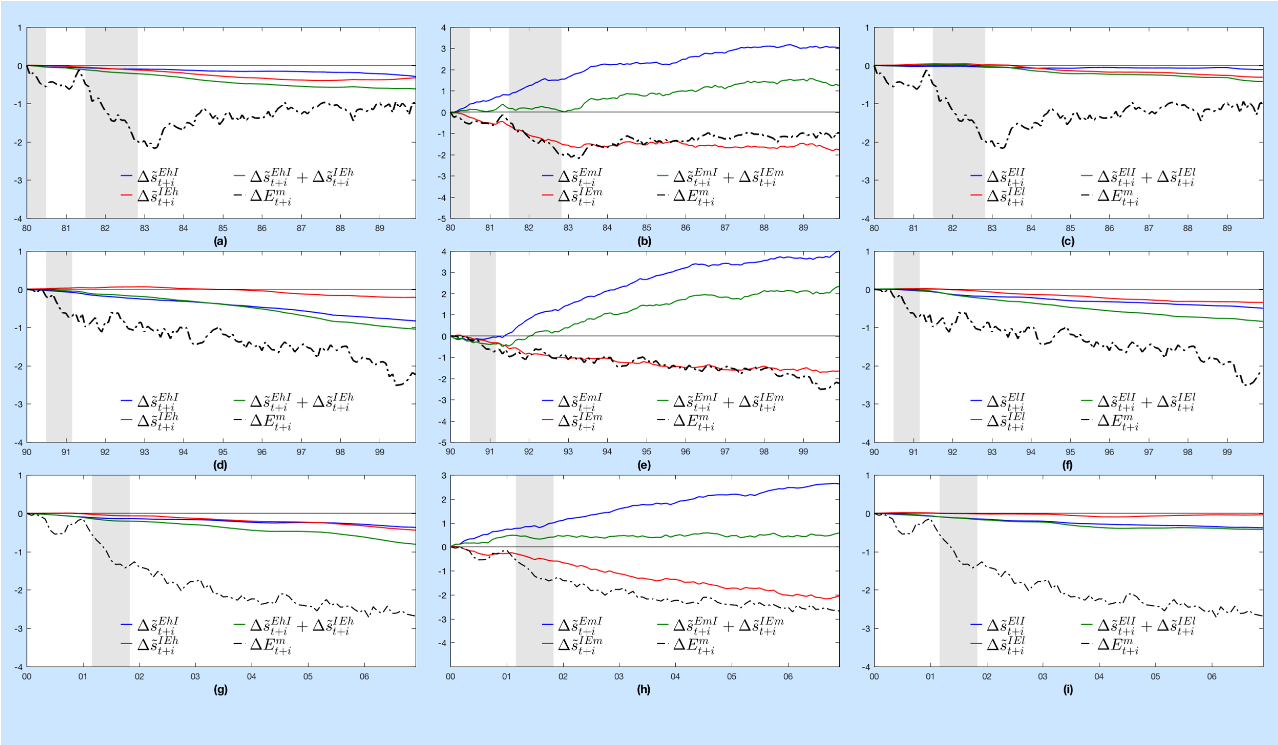

Figure 15: Detailed contributions to middle skill employment fluctuations (3)

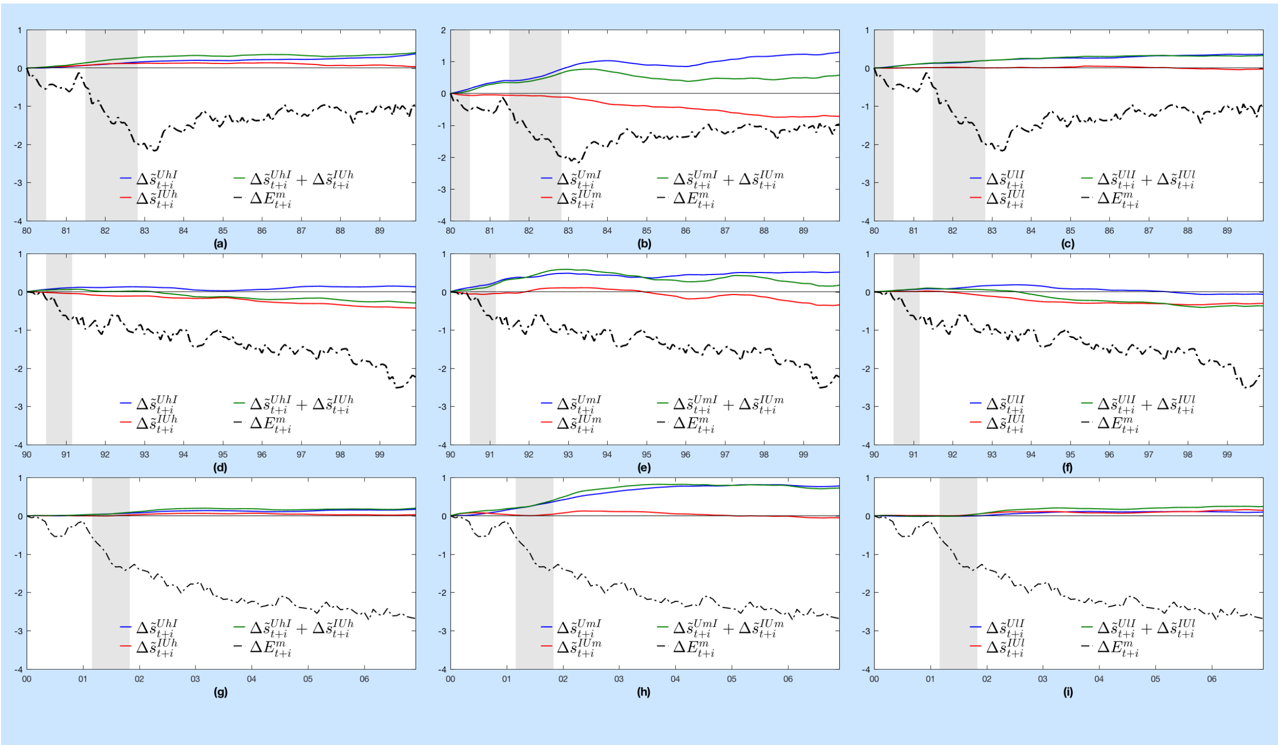

Figure 16: Detailed contributions to middle skill employment fluctuations (4)

A.1.2 Jobless recoveries

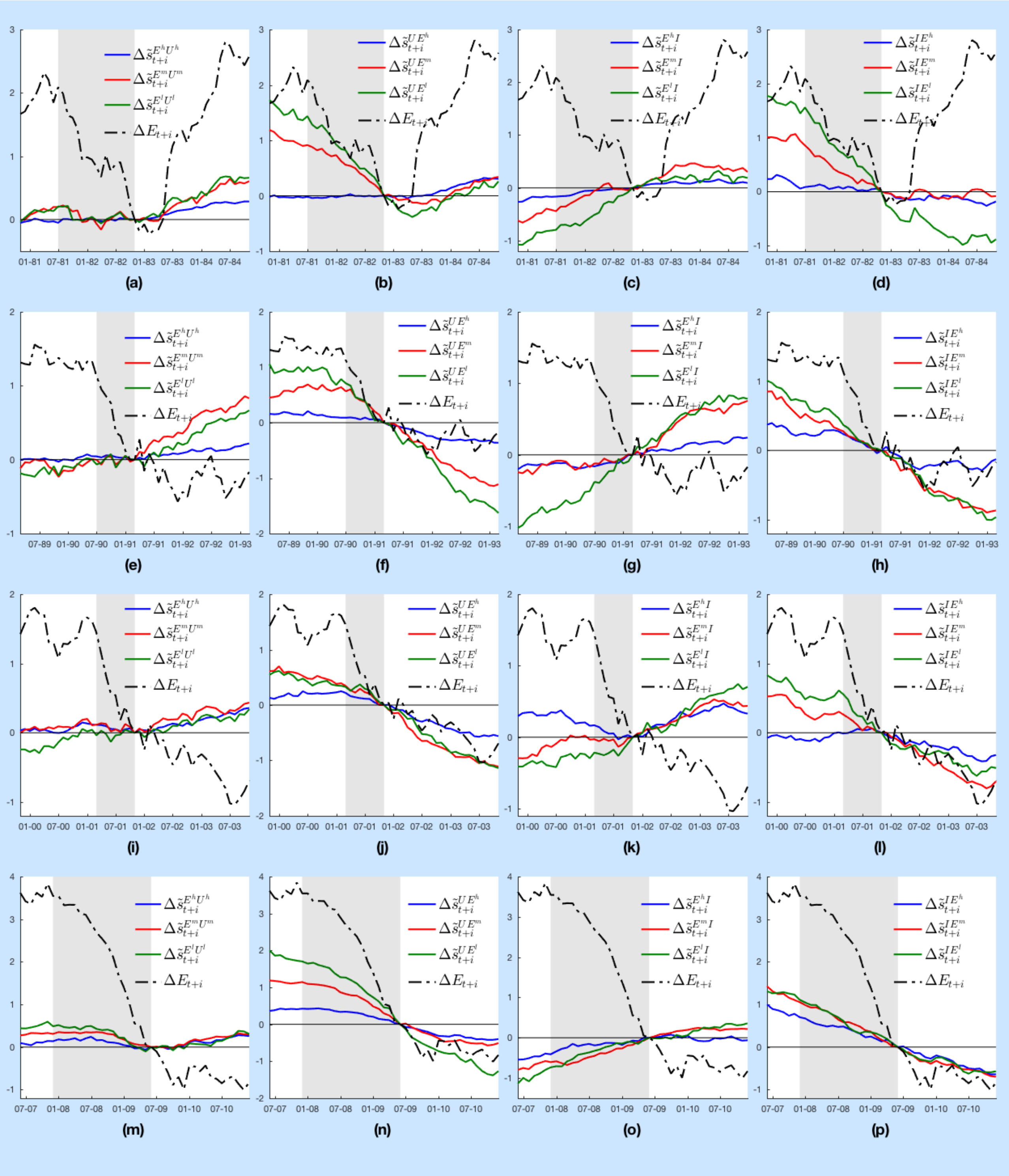

Figure 17: Detailed contributions to aggregate employment fluctuations (1)

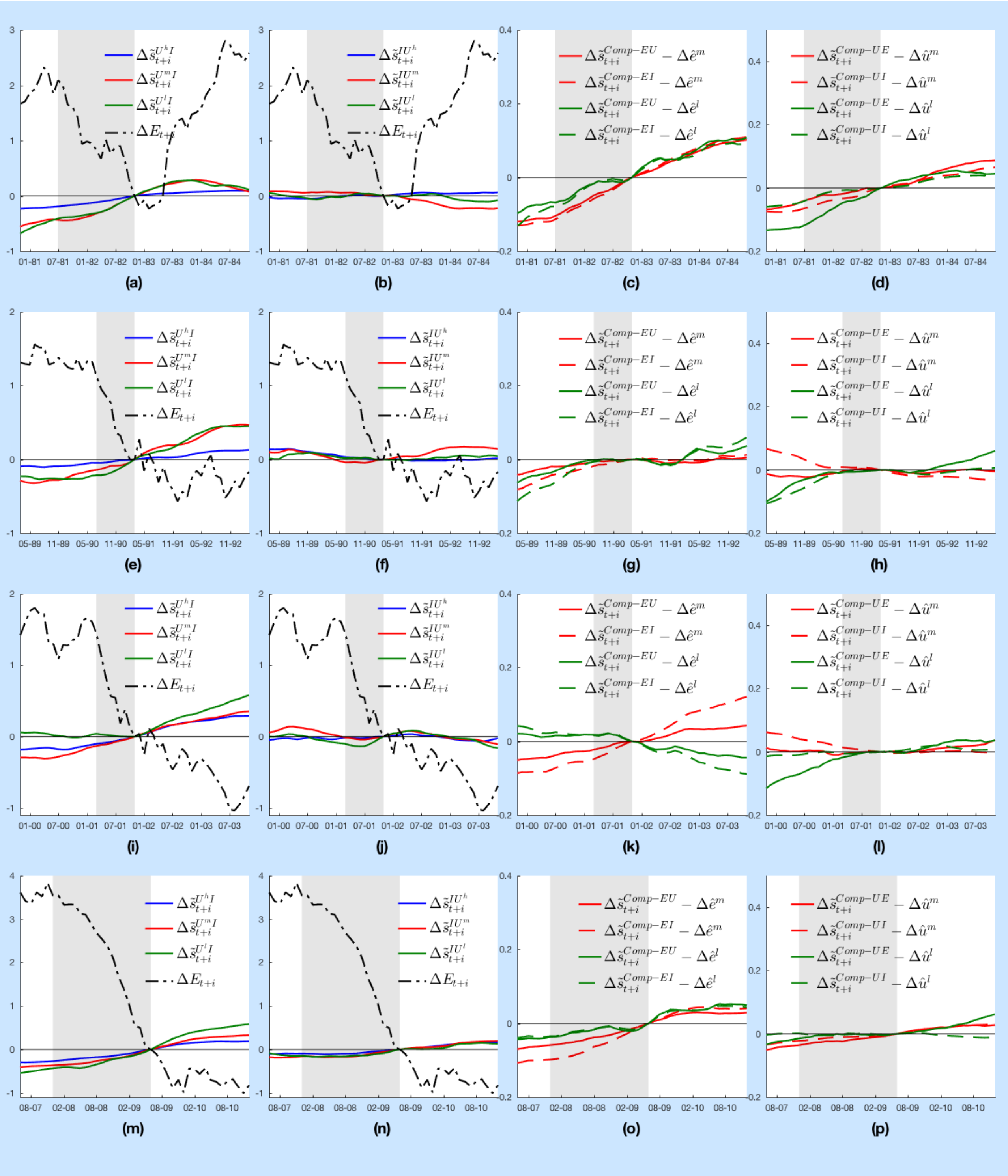

Figure 18: Detailed contributions to aggregate employment fluctuations (2)

A.1.3 Labor force participation

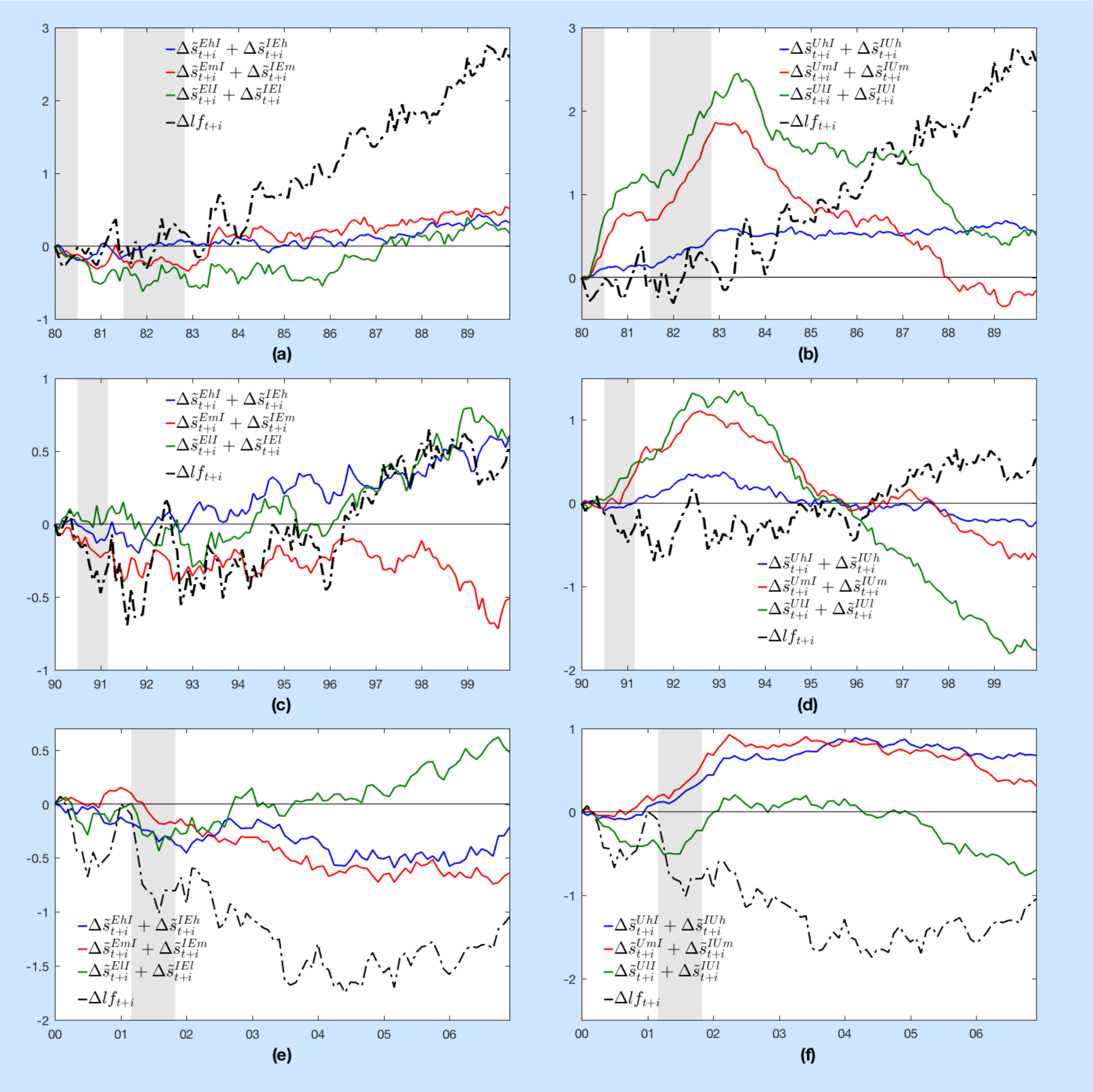

Figure 19: Net contributions of hazard rates to labor force participation fluctuations

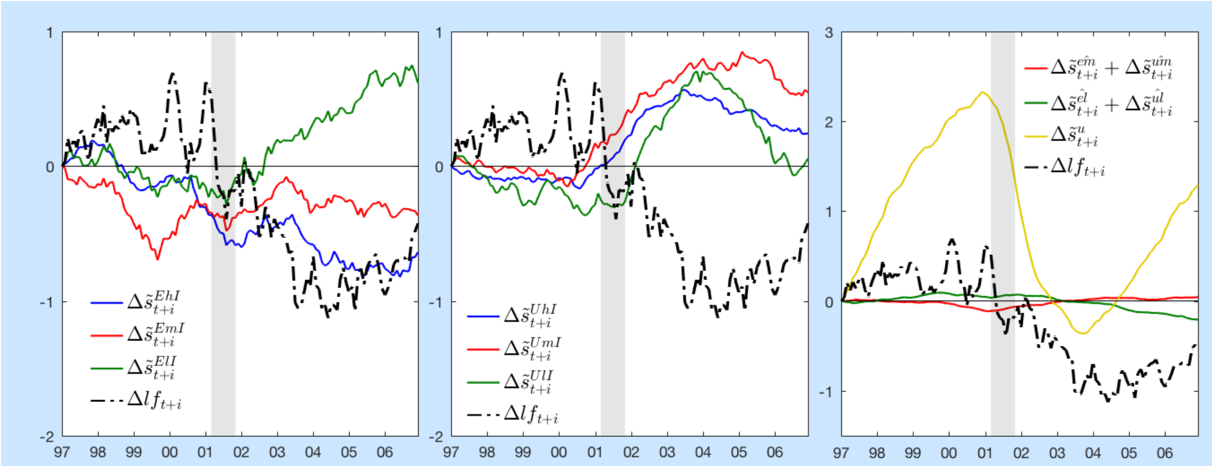

Figure 20: Outflows contributions to labor force participation fluctuations starting in January 1997

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