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Abstract

Using annual and quarterly labor market data from the US and France, we study the relationship between the extensive and intensive margins of labor adjustment, job polarization and non-standard work along the business cycle. We derive four stylized facts. First, changes in aggregate hours are mainly driven by fluctuations in per-capita employment rather than hours worked per worker. Second, recessionary drops observed in aggregate hours are, to a large extent, due to the disappearance of routine work. In the US, the fall in routine standard employment accounts for most of the decline in aggregate hours, whereas in France, routine jobs losses in both standard and non-standard work matter. Third, the dynamics of routine standard employment are driven by flows from and into unemployment in both countries. Fourth, the dynamics of routine non-standard work differ across countries. In the US, fluctuations in routine non-standard employment is driven by inflows from routine standard work, while, in France, changes in routine non-standard work are accounted for by ins and outs from unemployment. Our findings support the view that within-employment reallocation, through the use of non-standard work, is an alternative margin of adjustment in the US. This is not the case in France and flexibility is achieved by adjusting hiring and separations of standard and non-standard work. In bad times, reduced stepping stones contribute to the fall in routine standard employment.

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1 Introduction

Job polarization is a common feature of developed economies. Over the last 30 years, employment growth has been fast, not only in high-paid jobs (abstract, non-routine, cognitive tasks requiring creativity, problem-solving), but also in low-paid jobs (manual, non-routine job requiring human interaction, service occupation). Employment growth has decreased significantly among middling jobs (routine, repetitive, specific activities accomplished by following well-defined instructions and procedures), and those involving tasks that can be replaced by machines (Autor & Dorn (2013); Goos et al. (2009); Goos & Salomons (2014)). Task-Biased Technological Change (TBTC) is considered as one of the main drivers for job polarization.

While it is now well understood that job polarization has far reaching consequences on the labor market in the long-run, this phenomenon has also a strong cyclical counterpart, as TBTC affects labor market adjustments at business cycle frequency. Namely, in the US, job polarization takes place mainly during downturns: Jaimovich & Siu (2018) document that the bulk of job destructions corresponds to routine job losses which mainly occurred during recessions in the US, and unlike other occupations, routine employment never goes back to its pre-crisis level. Besides, job polarization has accelerated over the last recession: in particular, Autor (2010) and Brynjolfsson & McAfee (2011) highlight that the polarization process has been accelerated by the Great Recession, as many more middle-paying jobs were shred relative to professional jobs and jobs in personal services. In addition, Foote & Ryan (2015) show that job losses during the Great Recession were mainly concentrated among middle-skill workers, the same group that has suffered the most from the disappearance of routine jobs.

In this paper, we focus on the labor market adjustments induced by job polarization in France and the US over the business cycle. Routine jobs are due to disappear in the long-run in both countries, but the date at which this will occur is always uncertain. Likewise, the intensity and duration of expansions and recessions being uncertain, firms hit by productivity shocks may be willing to vary hours of work before creating or destroying a job, as this may be less costly. Thus, firms may use several channels to adjust the total number of hours worked: they can use the extensive margin (the number of workers), but as an alternative to creating or destroying a job, they may vary the intensive margin (hours per worker) as well. In addition, in a European context, firms can also use a short-term rather than a long-term contract. More generally, firms can use different types of non-standard forms of work (part-time or short-term contract) to adjust their labor force: both enable firms to change the total number of hours worked instead of incurring the costs related to hiring and firing workers on "regular" (i.e. long-term) contracts. The comparison between France and the US allows to highlight that different labor market regulations lead to different types of labor market adjustments in a context of job polarization. This dimension has received little attention in the literature, although the OECD (2015) points out that a greater use of ICT and structural changes in employment foster "atypical" forms of work. Growing levels of non-standard work (hereafter "NS"), such as part-time work or work on temporary contracts, raise policy concerns on job safety, job stability, earnings and income inequality. The OECD (2015) suggests a connection between technological changes and the prevalence of NS. Our paper is a first step towards bridging this gap.

We first use yearly data (US CPS data and French Labor Force Survey) since the early 1980s to investigate the behavior of aggregate per-capita hours, defined as the product of the extensive margin (employment-to-working age population ratio) and the intensive margin (weekly hours per worker). The aggregate number of hours in the economy is decomposed into 12 components: 6 per-capita employment levels (3 tasks: abstract, routine and manual jobs, 2 types of form of employment "NS" Non-Standard or "S" Standard, within each tasks) and 6 for hours per worker (weekly hours per worker in each type of task and job). Using counterfactual exercises, we study 4 recessionary episodes in the US and 5 episodes in France. We establish that

Fact 1: In France and the US, over the past four decades, changes in aggregate per-capita hours have been mainly driven by changes in per-capita employment rather than by changes in weekly hours per worker. The main exception is the French 2011 crisis when hours per worker actually played a leading role in accounting for changes in aggregate hours worked in France.

The relative importance of the extensive and intensive margins of adjustment in the US has already been highlighted in the literature (e.g. Elsby et al. (2010)). We extend their work by looking at the French labor market. We also study the relative importance of each labor margin by task group and contractual arrangement in both countries, which leads to Fact 2:

Fact 2: In recession, the fall in routine per-capita employment explains the bulk of the drop in aggregate hours in both countries. The countries differ in the form of employment that is adjusted in bad times:

- In the US, the drop in standard routine employment is striking in recession, while employment in NS tends to increase in recession in all task groups. As a result, in the US, the share of NS spikes in recessions in all task groups.
- In contrast, in France, routine jobs are lost in both S and NS. As a result, the cyclicality of NS does not display any regular pattern in French recessions. The contribution of job losses in routine NS has been sizable in the 1983, 2008 and 2011 recessions.
- In both countries, the main driver for changes in hours per worker lies in routine standard employment.

As routine per-capita employment appears as the major driver of the changes in aggregate hours, we investigate the driving forces behind its dynamics using worker flows. We develop a Markov model linking workers' transitions across labor market status to the evolution of observed per-capita employment stocks. Due to the lack of available data in France, we build quarterly worker flows from 2003Q1 to 2017Q4 and propose a variance decomposition on standard and non-standard routine employment. We then conclude that

Fact 3: In both countries, RS (Routine Standard) per-capita employment is mainly driven by the cyclicality in transitions to/from unemployment (more job losses and fewer job findings in bad times). As for the within transitions (between RS and RNS Routine Non-Standard):

- In recessions, RS falls in the US because more RS workers become RNS (referred to as "downgrading": transitions from RS to RNS)
- In contrast, in bad times, in France, RS falls because less RNS workers become RS workers (less "stepping stone" from RNS to RS)

Fact 4: The countries differ along the behavior of RNS (Routine Non Standard) employment.

- In the US, RNS *increases* in recession. RNS appears to be mainly a short-term transitions to/from standard routine employment. In particular, the cyclicality of inflows from RS to RNS plays a leading role in accounting for RNS fluctuations. In particular, the rise in US RNS observed during the Great Recession is the consequence of an increased downgrading effect.

- In contrast, in France, RNS employment *falls* in recession. RNS is driven by the high cyclicality of job findings (40%) and to a lesser extent job losses and non participation (approx. (20% each).

Our findings support the view that within-employment reallocation, through the use of non-standard work, is an alternative margin of adjustment in the US. In bad times, more standard workers switch to NS. In France, flexibility is achieved by adjusting hiring and separations of standard and non-standard work. Recessions are times when opportunities of stepping stones from S to NS are reduced.

Our paper is potentially relevant to research in macro and labor economics. The data and our stylized facts may be used as an empirical background to discipline theoretical models of labor market adjustment along the extensive and intensive margin across countries. The job polarization process offers an opportunity to revisit how firms proceed to this trade-off when faced with such a strong technological trend. Our study of NS also provides a first look at how firms use this flexibility in a context of technological change.

The paper is organized as follows. We relate to the literature in section 2 and discuss the main theoretical insights related to our findings in section 3. We then present the data in section 4 and decompose the changes in hours worked for France and the US since the early 1980s in section 5. Finally, we study the dynamics of routine employment and NS in both countries in Section 6. Section 7 concludes.

2 Related literature

Our paper investigates the relationship between margins of labor adjustment (extensive and intensive margins), job polarization and non-standard work during cyclical swings. To the best of our knowledge, this is the first paper that investigates all these dimensions. In doing so, our work relates to four strands of the literature.

The paper relates to the literature on the behavior of the extensive and intensive margin in the long-run (Ohanian & Raffo (2012),Van Rens (2012), Blundell et al. (2013), Langot & Pizzo (2019), among others) and along the business cycle (Kudo et al. (2019), Rogerson & Shimer (2011), among others). Facts 1 and 2 of our paper provide insight regarding labor market adjustments along the intensive and extensive margins in a context of polarizing employment, by taking into account NS work. Elsby et al. (2010) find a 70:30 bodies-hours split across the recessions since the early 1970s. Fact 1 in this paper echoes their finding that the decline in total labor input is mainly driven by changes in employment. We extend their finding by looking at French data and by looking at task groups and NS work. Borowczyk-Martins & Lale (2019) propose an interesting methodology of variance decomposition, which we use in section 5. Compared to their paper, there are two main differences : (i) we look at both the extensive and intensive margins, while their focus is on the intensive margin only. (ii) We extend their analysis by looking at job polarization and NS work. As we need to look at per-capita employment, the economic environment becomes non-stationary. We then adapt Borowczyk-Martins & Lale (2019)'s decomposition to look at deviations from trend. Job polarization being induced by technological drift, the removal of the trend is needed before performing a variance analysis in recessionary episodes.

The second strand of the literature studies job polarization. Cortes et al. (2017) match individual-level CPS data to study the decline in middle-wage routine occupations during the last 30 years. They identify workers' transitions contributing the most to the disappearance of routine employment. Their paper is most closely related to section 6 of our work where we study the dynamics of routine employment and its relationship with NS work using data on labor market flows in France and the US. Few papers look at job polarization in a short-run perspective (Jaimovich & Siu (2018), Foote & Ryan (2015), Cortes et al. (2014)). We subscribe to their view that job polarization, driven by long-run technological trends, can actually affect cyclical job losses. We contribute to this line of research by allowing for several margins of adjustment, while previous studies have focused on the changes in per-capita employment across task groups. Our results (Facts 1 and 2) confirm that the extensive margin is the most relevant for the understanding of labor market adjustments in polarizing labor markets, although they also suggest that some attention should be paid to adjustments in hours per worker in routine standard jobs in France, especially in the recent years. Job polarization is a pervasive phenomenon involving various types of labor adjustments, the nature of which may differ across countries endowed with different labor market institutions (LMI). This issue is however discarded when focusing on the US solely. Our paper is one of the first attempts to bridge this gap by looking at NS work in two countries with different LMI and employment practices[1].

[1] See also Albertini et al. (2017), who emphasize the role played by the minimum wage and hiring subsidies for low-skilled workers in France, in a search and matching model. Their theoretical approach is complementary to our empirical analysis.

The third one relates to the papers studying the cyclicality of worker flows in the US (Hall (2005), Shimer (2012), Elsby et al. (2010)) or European countries (Smith (2011), Le Barbanchon et al. (2015)), with non standard work (whether part-time work, as in Borowczyk-Martins & Lale (2019), Fontaine et al. (2018); or temporary contracts, as in Silva & Vazquez-Grenno (2013), Le Barbanchon et al. (2015), Limon (2017)). We extend their work by looking at job polarization in France and in the US. We thereby illustrate how this long-term phenomenon can be related to short-run employment changes in two countries where labor market flows differ substantially.

Finally, our paper also relates to the literature studying the divide between standard and non standard contractual arrangements (such as, among others, Smith (2007), Caggese & Cunat (2008), Cao et al. (2010), Berton & Garibaldi (2012), Macho-Stadler et al. (2014), Cahuc et al. (2016)). Job polarization offers an opportunity to study how firms use NS work to adjust to economic changes in a context of job polarization. This is also highly relevant in the policy debates on labor market reforms, especially in Europe[2]. To the best of our knowledge, such issues have not been investigated yet.

3 Economic intuitions

Our paper highlights that the changes in per-capita employment are of primary importance in accounting for the fluctuations in aggregate hours (see Fact 1). Besides, Fact 2 and the following highlight that the divide between S and NS work plays an important role in the adjustments induced by job polarization, in particular in routine employment. Let us thus provide some theoretical insights regarding the relationship between NS and job polarization. While writing a full-fledged dynamic model lies beyond the scope of this paper, we discuss in this section a few ideas aimed at clarifying the interplay between secular trends and the business cycle involved by job polarization, as well as the relationship between job polarization and NS.

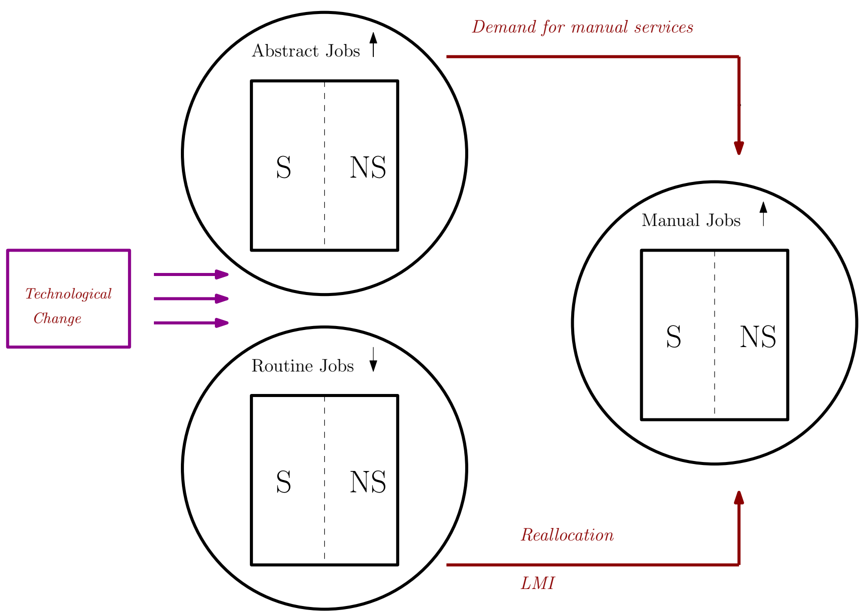
Long-term vs shorter-run labor re-allocation. First, let us recall the long-term labor re-allocation induced by job polarization, as described in the seminal paper by Autor & Dorn (2013). Due to technological progress, machines can replace routine workers, which reduces the demand for routine workers and increases the demand for abstract workers. Manual tasks cannot be replaced by machines as their job requires social inter-

[2]See subsection 6.4 for a discussion on policy related issues

actions and manual dexterity, two dimensions in which humans still outperform machines. Displaced routine workers re-allocate to manual jobs. As abstract employment expands, the demand for manual services increases (for example, the increase in female employment fuels the demand for cleaning services and child care, which are manual jobs). The relative price of manual services increases, which raises the wage in manual jobs and creates the incentive to switch from routine to manual jobs. According to Autor & Dorn (2013), this narrative describes the phenomenon that drives the long-term labor re-allocation inherent to job polarization.

Obviously, this may provide a biased picture in the shorter run, as (i) routine workers can obviously fall into unemployment or inactivity for want of job opportunities, (ii) the real-location process of displaced routine workers is influenced by Labor Market Institutions (LMI), which affect the intensity of job losses during downturns and the re-employment perspectives of the displaced routine workers. More generally, LMI determine the way in which labor re-allocates itself to heterogenous jobs, and determine in particular whether the displaced workers will most likely be re-employed in S or NS. This discussion is summarized by Figure 1 below.

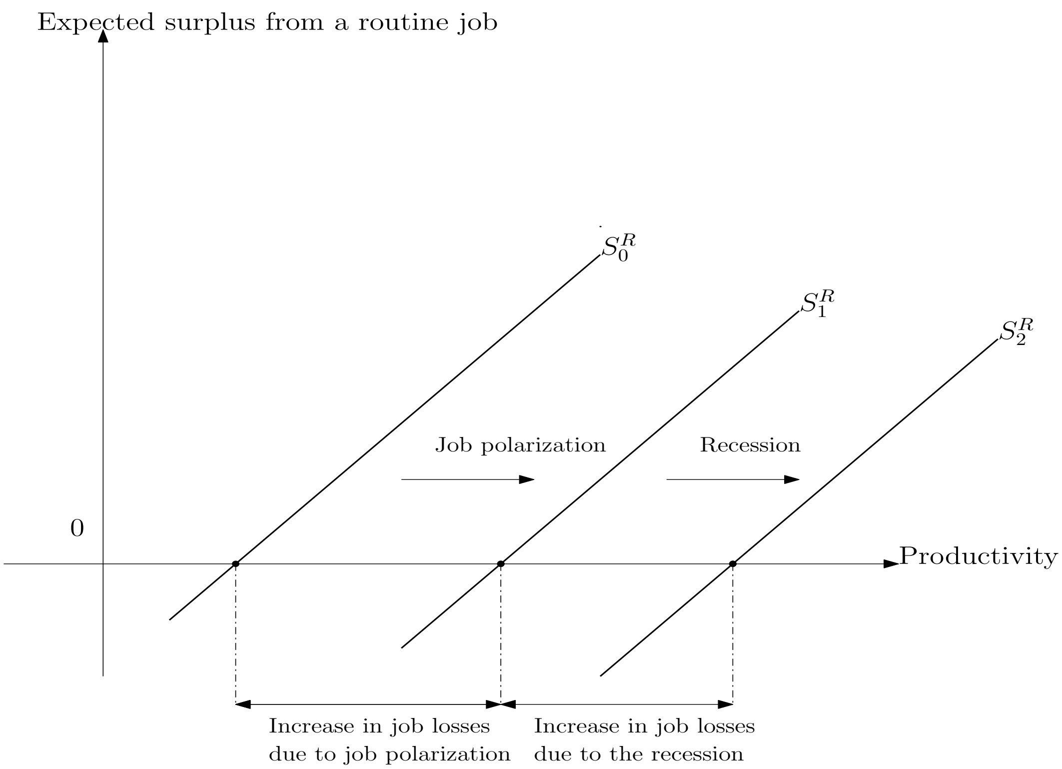
Figure 1: Job polarization: long-term trend and labor reallocation



"S": Standard work. "NS" Non-Standard work. "LMI": Labor Market Institution

Polarization and the Business Cycle. Another reason to focus on the short run stems from the link between polarization and the business cycle, illustrated in Figure 2: in a matching model *à la* Mortensen & Pissarides (1994), jobs are destroyed whenever the expected surplus from a match becomes negative. By reducing the expected value of routine jobs, job polarization implies that job destructions will increase for those jobs. This long-run phenomenon accelerates during recessions: the expected value of all jobs decreases during downturns, but in the case of routine jobs, those jobs were already in a weaker position due to job polarization. Therefore, for routine jobs, the recessionary shock adds to the downward trend stemming from polarization, and job destructions rise massively among this task category during downturns. This intuition is consistent with the large swings in routine jobs during recessions that we find in the data, and the fact that routine employment does not return to its pre-crisis level (See Figure 5 in section 5).

Figure 2: Job polarization accelerates during a recession



"Job polarization": long-term trend that pushes S^R to the right over time. "Recession": Recessionary episode that pushes S^R further to the right.

Job losses also affect abstract and manual jobs during a recession. However, job losses increase by less compared to routine jobs, given that the negative impact of the downturn is partly compensated by the long-term *rise* in their expected value resulting from job polarization.[3] In any case, Figure 2 above implies that it is necessary to separate the

[3]As can be seen from Figure 1, the demand for abstract workers increases because they are more productive so that the expected value of an abstract job increases over time. The same reasoning applies to manual jobs as the demand for manual tasks increases: in Autor & Dorn (2013), the relative price of personal services expands which makes those jobs profitable. In addition, notice that search and matching models being general equilibrium models, job polarization affects labor market stocks and worker flows,

evolutions stemming from the trend and from the business cycle, as we do in section 5.2: some of the jobs disappearing following a recession would have disappeared sooner or later due to job polarization.

Relationship between polarization and NS in the long run. The economic mechanisms discussed previously (see Figure 2) ommit the divide between S and NS which plays an important role to understand the way in which firms adjust labor. This divide depends on firms' decisions to create, maintain or destroy each type of contract, and also by the decision to convert S into NS ("downgrading") or NS into S ("stepping stones"). Let us thus first turn to firms' decisions to use S rather than NS: which type of contract shall be used, in particular when creating routine jobs? Intuitively, the type of contractual arrangement chosen by firms depends on their respective expected values, which is strongly influenced by LMI, in particular employment protection legislation (EPL) [4]. Firms' choices then differ substantially across countries: France creates a higher proportion of jobs in NS than the US, as a result of a more stringent EPL. Besides, given that routine jobs are due to disappear in the long-run, it may be optimal for firms to create such jobs using non standard rather than standard contractual arrangements. This might be particularly the case in a country where it is more costly to adjust the labor force, such as France. In a more flexible, US type of environment, the incentives to create jobs in NS are much lower: routine jobs can thus be created using S as they can be destroyed at a much lower cost. Besides, those who lose their jobs have a very high chance to be offered a job in NS rather than in S in France, given the very high share of NS in job creations[5]. Hence, the former routine workers losing their jobs in S will most likely re-allocate themselves in NS in France vs S in the US.

Relationship between polarization and NS in recession. NS in recession responds to opposite forces. On the one hand, whatever the task, NS jobs are most likely those yielding lower average expected profits compared to standard jobs. NS are thus the first to be displaced in recession. On the other hand, NS being more flexible than S, it can become more profitable to create some jobs in NS than in S: the frontier between both kinds of

the causality running both ways: shifts in labor demand affects worker flows. In turn, worker flows affect the pool of job seekers, which in turn modifies firms' job creation decisions. Restrepo (2015) shows that this may give rise to an amplification mechanism, as displaced workers may lack the skills required for new jobs. Being poorly productive at new jobs, they reduce the expected value of vacancies, thereby further reducing job creations during recessions.

[4]See Cahuc et al. (2016)

[5]Section 6 highlights that about 70 to 80% of job creations are in NS in France

contracts shifts in such a case. This may give rise to a potentially strong substitution between S and NS during downturns.

Figure 3: Total Employment and the Divide Between S and NS: Good vs Bad Times

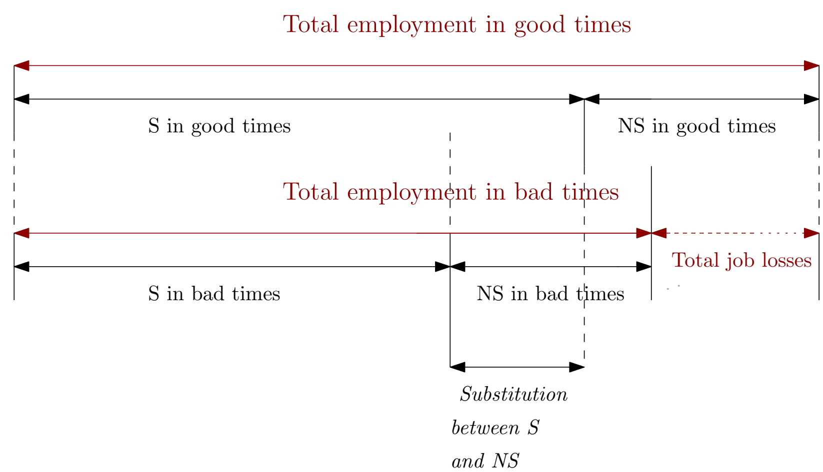


Figure 3 illustrates this mechanism. It depicts the changes in total employment and in the divide between S and NS following a recession. For each task group, firms create jobs either in S or NS, depending on which one is the most profitable contractual arrangement[6]. When a recession hits, the profitability of each type of contract is negatively impacted, leading to net job losses. On top of the net job losses for each task group, the frontier between S and NS is shifted: a substitution between S and NS is also at work, as some of the jobs which would have been created in S before the beginning of the downturn are now created in NS. When this substitution effect outweighs the number of job losses, the recession may thus even lead to a rise in employment in NS.

Notice that the converse mechanism may prevail during recoveries: the creation of each type of contract becomes more profitable and as a result, total employment rises. On top of that, the divide between S and NS shifts towards more S. As a result, when the substitution effect dominates, NS spikes in recession, then declines in the recovery.

Besides, the substitution between S and NS is also impacted by the possibility to change S into NS ("downgrading") or to convert NS into S ("stepping stone"). Firms incentives to convert one type of contract into another varies over the business cycle: they are less likely to use stepping stones, and have higher incentives to use downgrading in bad times. Section 6 studies the way in which both margins of adjustment affect the dynamics of routine employment. It shows the "stepping stone" margin is particularly relevant in

[6] The divide between S and NS varies substantially across task groups: NS is more frequent in activities which are perceived by firms as yielding lower/more unstable/more uncertain expected profits. In any case, NS plays an important role to explain the dynamics of routine employment (see Section 6).

France, whereas "downgrading" plays a more important role in the US (see Fact 3). Then, Fact 4 emphasizes that overall, the substitution effect discussed above is particularly relevant over the business cycle in the US. While this is less clear cut in the French case, it must be kept in mind that the impact of the recession on NS described above is ambiguous in general.

4 Data and definition

In this section, we present the data and definitions used throughout this paper. Subsection 4.1 thus presents the data from the French LFS and the US CPS data, whereas in subsection 4.2, we present our measures of hours of work, non standard work and the classification used to define our three task groups.

4.1 Data

French LFS. We use the French LFS (*Enquête Emploi*) from 1983 to 2017. The survey is designed to be representative of the French population. We use the information on individual labor market status, occupation, hours worked, and labor contract (permanent vs. temporary). The survey was redesigned in 2003. Prior to 2003, the survey was annual, and individuals were surveyed each year for three years in a row. Since 2003, the survey has been quarterly and thus better suited for our purpose, i.e. the measure of flows and transitions into and out of routine employment around the Great Recession. Accordingly, we use the annual LFS from 1983 to 2017 for the analysis of aggregate hours (section 5) and the quarterly LFS from 2003Q1 to 2017Q4 for the analysis of worker flows (section 6).

US CPS data. The Current Population Survey (CPS) Basic Monthly Data provides information on labor market status. The survey is conducted on a monthly basis and collects data on labor status, employment and occupation. A housing unit in the CPS is interviewed for four consecutive months and then dropped out of the sample for the next eight months and is brought back in the following four months. The CPS Montly Outgoing Rotation Group (MORG) focuses on households that are about to rotate out of interviews for eight months or indefinitely. They are asked additional labor questions including respondent's periodicity of pay, hourly wage, usual weeks worked per year at that rate, usual hours worked a week, and overtime pay. In order to have of sense of the long term trends in job polarization, we use CPS MORG data from the NBER website after pooling all months for each year and look at annual hours worked in the US between 1979 and 2017 in section 5.

We then investigate US worker flows in section 6. In order to produce US time-series that are comparable with French quarterly labor market transitions, we consider period between 2003Q1 and 2017Q4 and compute quarterly transitions as in Borowczyk-Martins & Lale (2019) using CPS basic monthly data. We compute quarterly transition probabilities by linking the 1st to the 4th (or 5th to 8th) interview of CPS respondents. We get monthly time series of quarterly transition probabilities. We then obtain quarterly time-series by taking the average of the monthly values. At the end of the process, we get quarterly time series of quarterly workers' transition probabilities, which are comparable to French data.

4.2 Definitions

Hours. The sample consists of individuals aged 16 to 64. The employed population includes all workers in non-farm business sector, excluding unpaid family workers. The data provide two measures of hours: (i) hours worked during the survey's reference week (*actual* hours) and (ii) *usual* hours worked per week, which refers to the usual workers' week schedule, including overtime. Both questions relate to the main job. As in Borowczyk-Martins & Lale (2019), we analyse the changes in actual hours. This is also particularly relevant when looking at business cycles. We then use usual hours to determine workers' employment status. Following the BLS, survey respondents are categorized as full-time workers if they usually work 35 hours a week or more. [7]

Non-standard work (NS). According to the OECD (2015), NS is defined as all employment relationships that do not conform to the "norm" of full-time, regular, open-ended employment over a long time span, with a direct relationship between employer and employee. A job is considered "non-standard" if its features differ from those of standard employment.

In our sample, such a broad definition of non-standard employment includes two partly-

[7] In the US, we use CPS data on hours worked and usual hours from the NBER website. See Borowczyk-Martins & Lale (2019) for further analysis on survey data on hours in the US. We did not modify the data to take into account the 1994 re-design. First, Figure 8 in Appendix B does not display any visible break in 1994. Secondly, our exercise in section 5 focuses on de-trended data during recessionary episodes that occurred well before and well after the break.

overlapping employment types: temporary or fixed-term contracts and part-time work. These forms of employment provide more flexible working conditions. NS could also be viewed as fostering "adjustable" or "flexible" labor allocations. We use the OECD terminology of "non-standard" employment as it is also used by other international organizations (International Labour Organisation, World Bank).

The type of labor contract is not documented in the US survey: the distinction between permanent and temporary contract is not relevant in the US as firing costs are very low and independent of the type of labor contract. As a result, in the US, all part-time workers fall under "non-standard workers" and all full-timers under "standard" employment.

In contrast, in France, the distinction between permanent versus fixed-term contract is crucial in the employment relationship as it determines the level of firing costs, and also labor costs and benefits. In the French survey, we use the survey question on the type of contract ("Contrat à Durée Déterminée" CDD versus "Contrat à Durée Indéterminée" CDI) to determine workers' status. Non-standard employment in France includes all part-timers (whether on a permanent or temporary contract) and full-timers with fixed-term contracts.

Tasks. We follow the literature by using occupational data to categorize workers into task groups (see Appendix A for further details). The occupation codes changed in 2011, when the CPS transitioned between the 2000 and 2010 classification systems. We use Cortes et al. (2017)'s mapping of each occupation code across the five occupation systems into the three task groups. Cortes et al. (2017) consider only individuals aged 16 and more. Occupations in farming, fishing, and forestry are excluded.

We repeat the US procedure on French data in order to ensure comparability across countries. As in Jaimovich & Siu (2012), we consider only individuals aged 16 and more. As for occupations, we apply the procedure used for US data. Occupations in farming, fishing, and forestry are excluded. Occupations are categorized into three groups, each corresponding to the main tasks performed on the job. We base our categorization on the two-digit occupational codes.[8] We aim at matching the same assignment of occupations to tasks as in Jaimovich & Siu (2012).

[8] Harrigan et al. (2016) argue that two-digit codes used in French data are economically meaningful. Each code is the aggregation of 10 to 20 four-digit sub-occupations with stark differences in the susceptibility of jobs to automation. In addition, we checked that our results are not a simple reflection of sectoral changes. As found by Acemoglu & Autor (2011) on US data, we find that job polarisation is a within-sector shift. Results are available upon request.

5 Understanding the behavior of aggregate hours in recessions

In this section, we present the methodology guiding our analysis of changes in hours and employment by task and form of employment in France and the US, using annual data since the early 1980s. Subsection 5.1 describes the evolution of aggregate hours per capita over the sample period for both countries, which leads us to emphasize Fact 1. Subsection 5.2 focuses on the changes occuring during recessions, which leads to Fact 2 already emphasized in the introduction.

5.1 Trends in annual aggregate hours per capita: driven by changes in per-capita employment

5.1.1 Measurement: per-capita employment and hours per worker

Let H_t be the annual per-capita aggregate hours defined as the number of total hours worked divided by the working-age population (to neutralize changes in population size). We have $H_t \equiv \frac{E_t}{P_t} h_t$ where E_t denotes total employment (in thousands), P_t working-age population at period t (in thousands) (16-64 years old), and h_t average number of weekly hours worked per worker. In the sequel, we are interested in the changes in H_t which may stem from (i) changes in the extensive margin in tasks Abstract, Routine and Manual (henceforth, A, R, M) and form of employment (S vs NS) and (ii) changes in the intensive margin as captured by weekly hours worked per worker in each job type. H_t can thus be decomposed by tasks and contractual arrangement as follows:

$$H_t = \omega_t^{A,S} h_t^{A,S} + \omega_t^{R,S} h_t^{R,S} + \omega_t^{M,S} h_t^{M,S} + \omega_t^{A,NS} h_t^{A,NS} + \omega_t^{R,NS} h_t^{R,NS} + \omega_t^{M,NS} h_t^{M,NS} \quad (1)$$

where $\omega_t^{task,job} = \frac{E_t^{task,job}}{P_t}$ captures the number of workers in a specific task and type of employment, divided by working-age population P_t while $h_t^{task,job}$ measures the weekly hours per workers in a specific task and type of contracts. For example, $\omega_t^{R,S}$ measures per capita employment in routine standard job and $h_t^{R,S}$ the average weekly hours on the very same type of job.

5.1.2 Per capita employment drives fluctuations in aggregate hours

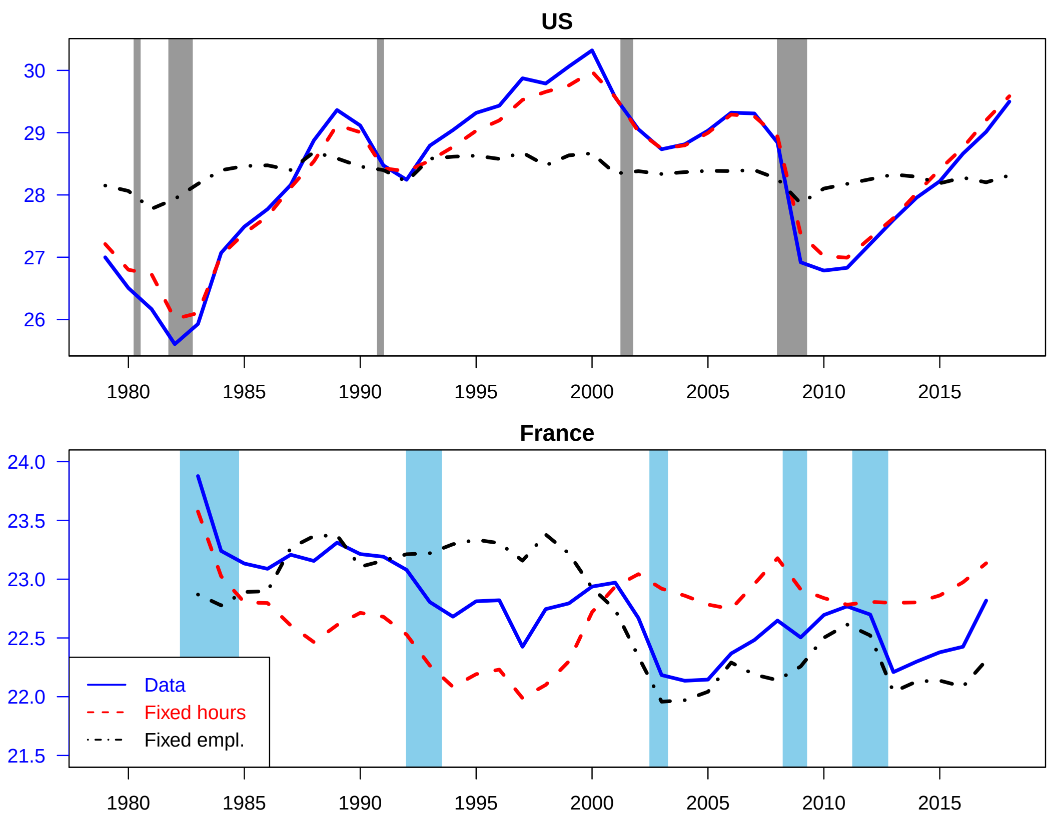
Counterfactuals. We use counterfactual exercises to assess the contribution of the extensive versus intensive margins to changes in aggregate hours. Let us denote $\overline{H}^{x^{task,job}}$ per-capita aggregate hours predicted by time-varying $x^{task,job}$ (with $x = \{\omega, h\}$, $task = \{A, R, M\}$ and $job = \{S, NS\}$), holding other elements in equation (1) fixed to their sample mean. Figure 4 plots aggregate annual hours and counterfactuals predicted by (i) time-varying per-capita employment $\overline{H}^{\omega}$ and (ii) time-varying hours per worker $\overline{H}^{h}$. Let us first have a look at the US data (top panel, solid line). On average, 73 % of the US working-age population is working, each of them is at work 38.9 hours per week, which yields an average H of 28.4 hours. Aggregate hours are pro-cyclical, with a sharp drop observed during recessionary episodes. As for the US counterfactuals (dashed and dashed dotted lines), the time-series based on changes in per-capita employment ω closely tracks observed aggregate hours, which suggests that aggregate hours are mainly driven by changes in the extensive margin.[9] Hours per worker h seem to have played a less significant role in driving changes in aggregate hours.

In France (Figure 4, bottom panel, solid line), observed aggregate hours display a downward sloping trend. This due to two effects: the employment rate $\frac{E}{P}$ declines from 1983 until the late 1990s combined with the fall in weekly hours per worker which accelerates after the late 1990s, in the wake of regulations on weekly working time ("35 heures" launched by Aubry regulations in 1998). As in the US, aggregate hours displays a procyclical behavior with sharp drops in aggregate hours in recession, mainly driven by changes in per-capita employment. Notice that, in the 2011 crisis, the sudden decline in aggregate hours is closely tracked by the counterfactual predicted by changes in hours per worker (dotted line). The last French crisis suggests a larger contribution of hours per worker, rather than per-capita employment. This leads to the following statement:

> **Fact 1:** In France and the US, over the past four decades, changes in aggregate per-capita hours have been mainly driven by changes in per-capita employment rather than by changes in weekly hours per worker. The main exception is the French 2011 crisis when hours per worker actually played a leading role in accounting for changes in aggregate hours worked in France.

[9] One might think that our result is not consistent with Borowczyk-Martins & Lale (2019)'s result. However, their paper focuses on hours per worker (the intensive margin) while our paper looks at aggregate hours (thereby combining the extensive and the intensive margin). As a result, they lay emphasis on changes in the part-time employment *share* while we look at *per-capita* employment.

Figure 4: Aggregate per-capita hours H and counterfactuals



Annual data. US CPS MORG (1979-2018). French LFS (1983-2017). Shaded areas indicate recessionary episodes (US NBER Dates. French ECRI dates). "Data" (solid line): Aggregate per-capita hours. "Fixed hours" (dashed line): Using equation (1), counterfactual aggregate hours predicted by changes in per-capita employment ω only. All hours per worker are set at their respective sample mean. "Fixed empl" (dotted line): Using equation (1), counterfactual aggregate hours predicted by changes in hours per worker h only. All per-capita employment levels are set at their respective sample mean.

Looking at the data on per-capita employment: job polarization at work As per-capita employment appears as a major driver for changes in aggregate employment in both countries (with the exception of the two most recent French recessions), we now focus on employment stock data.[10]

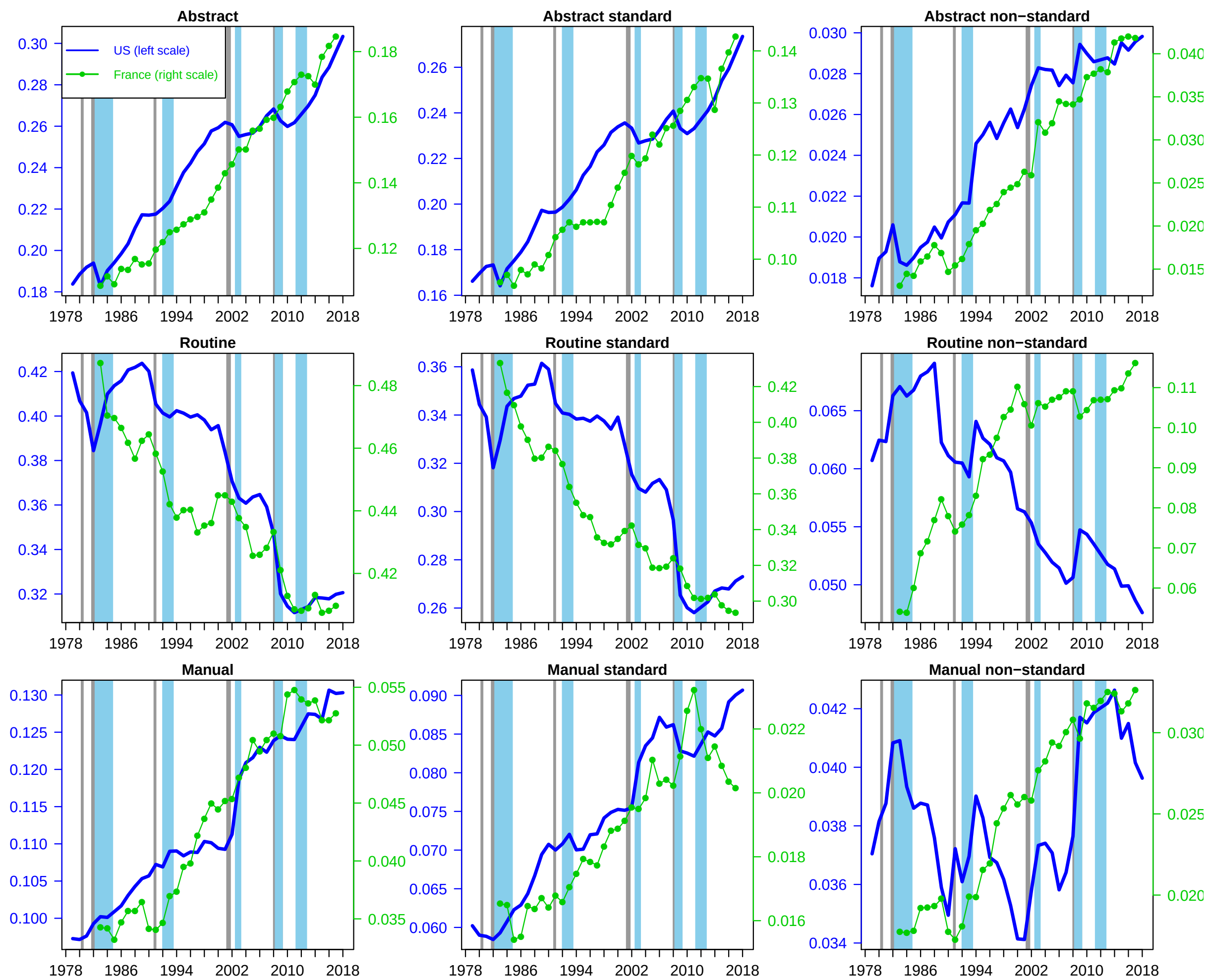
Figure 5 displays the evolution of employment per capita in both countries. Let us first focus on the graphs of the left column (ω^A,ω^R,ω^S). In both countries, job polarization is at work: the number of abstract and manual jobs ω_t^A and ω_t^M are expanding, while the number of routine jobs ω_t^R declines over the period. The extent of the phenomenon is slightly different across countries. In the US, at the beginning of the sample, less than 20% of the working age population is employed in abstract jobs, less than 10% in manual jobs, and more than 40% in routine jobs. Routine jobs offered the vast majority of employment opportunities in the late 1970s. In 2018, routine and abstract jobs employ equal percentage of the working age population (around 30%) while per-capita employment in manual jobs expanded to reach about 13%. In France, in the early 1980s, routine jobs employ nearly half of the working-age population, while 11% are in abstract jobs and 3.5% in manual jobs. In 2017, around 40% of the working age population is in routine employment, versus less than 20% in abstract jobs, and around 5% in manual jobs. In spite of the continuing expansion in abstract jobs, employment in routine jobs in 2017 is still much larger than in abstract jobs, which is not the case in the US in 2018 where routine and abstract jobs equally employ around 30% of the working age population.

In terms of cyclicality, while employment per capita tends to decrease for all types of jobs in hard times, US routine employment tends to display larger employment drops in recessions than abstract and manual jobs. Conclusions are similar in France.

NS Employment. The middle and right panels of Figure 5 display, for each task group, standard and non-standard per-capita employment. In the US, we find that the job polarization trends are similar for each type of contractual arrangement and follows the same evolution as the corresponding employment per capita: the trend is rising for abstract and manual jobs, and falling for routine jobs. Additionally, Figure 6 depicts the share of NS within each task group and provides interesting insights about the interaction between polarization and NS. On average, over the sample period, 34% of manual workers are employed in non-standard work, which is twice larger than their routine counterpart (15%) and more than thrice larger than abstract workers (approximately 10%). While there is no trend in the share of NS in the US for abstract and routine workers, the

[10] For comments on hours per worker, see Appendix B.

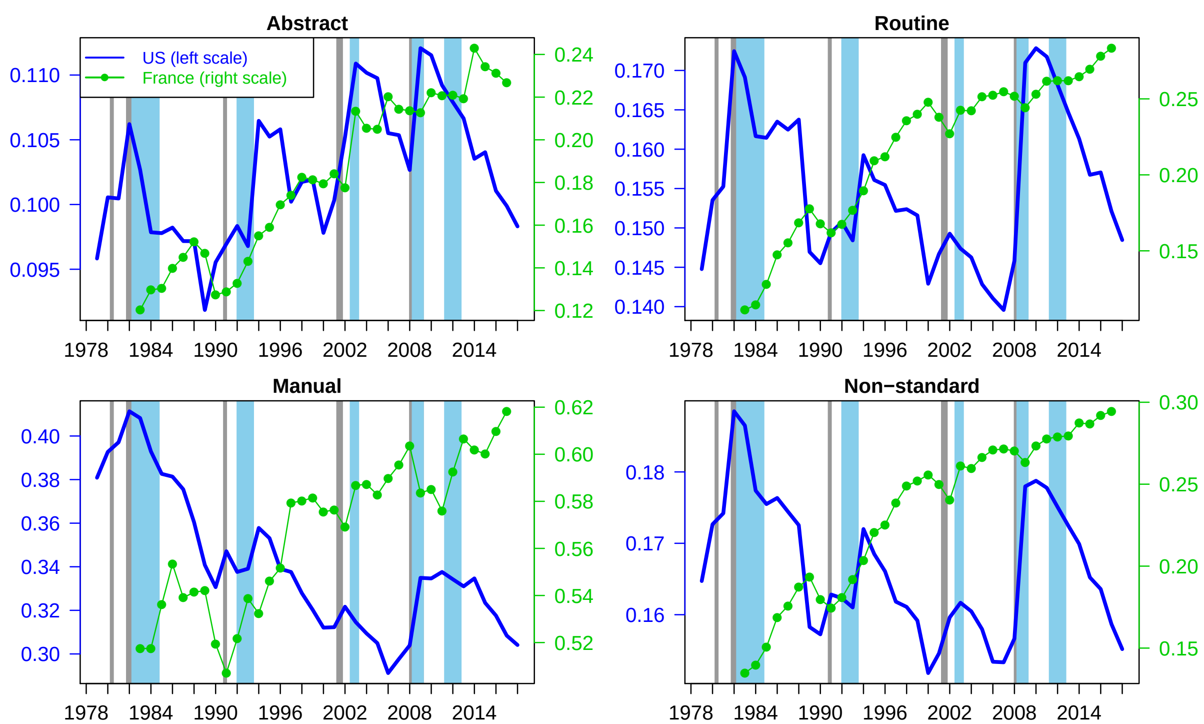
Figure 5: Components of total hours H : ω Employment per capita, by task and job type



Annual data. Solid line: US CPS MORG (1979-2018). Dashed line: French LFS (1983-2017). Shaded areas indicate recessionary episodes (Dark Grey: US NBER dates. Light grey: French ECRI dates. Crisis in both countries in 2008). "Abstract": per-capita employment in abstract jobs $\omega^A = \omega^{A,S} + \omega^{A,NS}$. "Abstract standard" : $\omega^{A,S}$ per capita employment in abstract standard jobs. "Abstract non-standard" : $\omega^{A,NS}$ per capita employment in abstract non-standard jobs.Similar definition applies to Routine and Manual jobs.

prevalence of NS seems downward sloping as the expansion in manual jobs occur mainly through standard employment (bottom panel of Figure 6). This picture is consistent with Autor & Dorn (2013)'s model. With the rise in the demand for manual jobs, the relative price of manual services expands in the economy. Firms hiring manual workers expect steady future profits flows, which leads them to hire workers using standard form of employment. It is also noticeable that, for all task groups, employment per worker in NS tends to move countercyclically, and more particularly, rises markedly following the Great Recession (bottom right panel of Figure 6). In contrast, employment per worker in S moves procyclically and decreases strongly following the Great Recession for all task groups.

Figure 6: Share of non-standard work by task



Annual data. Solid line: US CPS MORG (1979-2018). Dashed line: French LFS (1983-2017). Shaded areas indicate recessionary episodes (Dark Grey: US NBER dates. Light grey: French ECRI dates. Crisis in both countries in 2008). Share of NS within each task defined as $\frac{\omega_t^{task,NS}}{\omega_t^{task,S}+\omega_t^{task,NS}}$.

Figure 6 reveals that NS work in France is not as countercyclical as in the US. In particular, we do not find systematic increases in NS during the French recessionary episodes, and especially during the Great Recession, contrary to the US. Overall, the cyclicality of NS in France is less clear-cut, while in the US non-standard forms of employment exhibit spikes during recessions and decrease during expansions.[11] Another striking difference with the

[11] With respect to section 3, this suggests that a strong substitution effects takes place in the US in

US is the upward trend followed by NS work in France (Figure 5), which may contribute to explain the relative weakness of the substitution effect in the French recessions. Such a secular evolution is common to all task groups, and at the end of our sample period, NS represents 30% of total employment in France versus 13% in the early 1980s. While NS is more frequent in France than in the US, its prevalence in each task group is however similar to the US: the share of NS in manual occupations in France is on average larger (56.7%) than in abstract and routine jobs (18.2% and 21.7% respectively), as was the case in the US.

5.2 Analyzing recessionary episodes since the early 1980s

The analysis of section 5.1.2 highlights that variations in aggregate hours are largely explained by changes in per-capita employment (Fact 1). This subsection provides more insights on this claim by quantifying the contribution of fluctuations in per-capita employment by task and labor contract during recessionary episodes covered by our sample. This lead us to Fact 2.

5.2.1 Methodology

Counterfactuals. We use counterfactual exercises to assess the contribution of the extensive versus intensive margin to changes in aggregate hours in the spirit of Borowczyk-Martins & Lale (2019). As we have 12 time-varying elements in equation (1) (six ω and six h), we compute 12 counterfactual aggregate hours that are the predicted fictitious time-series of aggregate hours when only one element is allowed to vary over-time, holding the other 11 elements fixed to their sample mean. Let us denote $\overline{H}^{x^{task,job}}$ the per-capita aggregate hours driven by element $x^{task,job}$ in equation (1).[12]

Deviation from trends. Job polarization and drifts in labor market institutions (especially in France) generate trends in employment per capita $\omega_t^{task,job}$. The French regulation on working time also affects weekly hours per worker. As we are interested in business cy-

recessions, while it is much weaker in France

[12]For instance, $\overline{H}^{\omega^{R,S}}$ is the counterfactual times series of per-capita aggregate hours predicted by time-varying routine per-capita employment in standard jobs, such that

$$\overline{H}^{\omega^{R,S}} = \omega_m^{A,S} h_m^{A,S} + \omega_t^{R,S} h_m^{R,S} + \omega_m^{M,S} h_m^{M,S} + \omega_m^{A,NS} h_m^{A,NS} + \omega_m^{R,NS} h_m^{R,NS} + \omega_m^{M,NS} h_m^{M,NS}$$

where "m" refers to the sample mean.

cle changes in aggregate hours, we HP-filter H_t (using smoothing parameter 6.25) and the 12 counterfactuals using the recommended smoothing parameter for annual data (6.25). We then focus on cyclical changes, which allows to analyze disproportionate changes in hours per worker and employment per capita, with respect to long-term trends (driven by technological and institutional drifts). [13]

Quantifying the contribution of changes in per-capita employment and hours per worker. In order to decompose changes in per-capita employment, we compute changes in per-capita hours around recessions. The cumulative change is per-capita total hours between period s and t is captured as

$$\Delta H^C_{s,t} = H^C_t - H^C_s$$

where H^C refers to the HP-filtered H_t. We can then write $\Delta H^C_{s,t}$ as driven by the sums of changes in HP-filtered counterfactuals. We quantify the contribution of each element to changes in per-capita total hours between period s and period t as

$$\gamma^{x^{task,job}}_{s,t} = \frac{\overline{H}^{C,x^{task,job}}_t - \overline{H}^{C,x^{task,job}}_s}{\Delta H^C_{s,t}}$$

where $\overline{H}^{C,x^{task,job}}$ denotes the HP-filtered counterfactuals hours predicted by changes in $x^{task,job}$ (with $x = \{\omega, h\}$, $task = \{A, R, M\}$ and $job = \{S, NS\}$). For example, $\overline{H}^{C,\omega^{R,S}}$ denotes the HP-filtered counterfactual aggregate hours predicted by changes in per-capita employment in routine standard employment alone, the other elements are kept at their sample mean.[14]

[13] Notice that we focus on employment per capita such that $\sum\limits_{task}\sum\limits_{jobs} \omega^{task,job}_t = \frac{E_t}{P_t}$. We do not look at employment share (employment for each type of jobs in total employment). In doing so, we differ from job polarization papers such as Autor & Dorn (2013). Indeed, as pointed out by Albertini et al. (2017), focusing on employment share could be misleading, especially when total employment goes down. Employment shares for a given task could increase just because aggregate employment declines. For instance, Albertini et al. (2017) point out that the expansion in manual jobs, measured as employment share, in France in the late 1980s is partly driven by the fall in aggregate employment. A lower change in manual jobs is actually observed when measured as employment per capita. In our view, the analysis of employment per capita, rather than employment share, allows to properly capture changes in the extensive margin for each type of job. Cortes et al. (2014) and Cortes et al. (2017) also focus on changes in employment per capita.

[14] We check that $\sum\limits_{job,task} \gamma^{x^{task,job}}_{s,t} = 1$. In recession, per-capita total hours decline: $\Delta H^C_{s,t} < 0$. If $x^{task,job}$ also drives a fall in per-capita total hours, then, we expect $\overline{H}^{C,x^{task,job}}_t - \overline{H}^{C,x^{task,job}}_s < 0$, such that $\gamma^{x^{task,job}}_{s,t} > 0$, which measures the contribution of $x^{task,job}$ to changes in cyclical per-capita aggregate

5.2.2 Fluctuations in aggregate hours during recessionary episodes

The US. Our US sample covers four recessions. Panel (b) in Table 1 presents the changes in cyclical components of aggregate hours ΔH_t^C, in percentage points as well as % of the sample mean of aggregate hours, over each recessionary episode (whose dates are presented in panel (a))[15]. Panel (c) in Table 1 reports the contributions of the changes in per-capita employment (by task and contract type), while panel (d) corresponds to the contribution of the changes in weekly hours worked per worker to the changes in aggregate hours. Panel (e) summarizes the respective contributions of changes in aggregate employment per capita,γ_ω, changes in the average number of weekly hours worked, γ_h. The last part of the Table splits γ_ω by task group and then by contractual arrangement.

The changes in aggregate hours are negative over the four recessionary episodes, which is consistent with the cyclicality we found in Figure 4. The most severe cyclical swing is the 2008 recession, with a 5.24% drop in aggregate hours, which is twice larger than the fall observed in the 1981 crisis (2.66%).

The comparison between γ_h and γ_ω (panel (e)) shows that, on average, drops in per-capita employment account for more than 70% of the fall in aggregate hours in US recessions, except for the 2001 crisis which is exclusively explained by the extensive margin. Among the changes in per-capita employment, changes in routine employment - and more precisely routine standard employment $\omega^{R,S}$ - is by far the main contributor (panel (c)). Employment in NS plays only a minor role compared to S (panel (e),$\gamma_{\omega^{NS}}$). Specifically, the sign of $\gamma_{\omega^{NS}}$ is always negative. This is consistent with our theoretical insights of section 3, suggesting a strong substitution between NS and S during recessions which can lead to an increase in NS. This is particularly true for manual jobs since all contributions of $\omega^{M,NS}$ are negative (see panel (c) of Table 1.

The falls in hours per worker account for less than 30% of the decline in aggregate hours (γ_h, panel (e)). The contribution of the intensive margin is mainly due to a fall in weekly hours worked in routine standard jobs ($h^{R,S}$, panel (d)).[16] In line with Jaimovich & Siu (2018), our decomposition exercise confirms that fluctuations in routine labor are central

hours. Notice that $\gamma^{x^{task,job}}$ can be negative, thereby showing that changes in $x^{task,job}$ would predict an evolution of H^C opposite to that observed in the recession. As the sum of γ equals 1, when one γ is negative, we might also have some $\gamma > 1$ in absolute value.

[15]For the US, we take the same NBER dates as in Borowczyk-Martins & Lale (2019) and follow their analysis by focusing on a 2 year-window. For France, we consider the dates of recession provided by ECRI. We focus on a 1-year window as the fall in aggregate per-capita hours is the steepest in the first year of the recession. In 2011, for the last French recession, we use a 2-year window as the changes in aggregate hours was actually very small in France in 2012.

[16]We provide the graphical illustration of such results in Appendix C.

Table 1: Decomposition of changes in aggregate hours in recessions

	US				France				
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(a) Recessionary episodes									
s	1980	1990	2001	2007	1983	1992	2002	2008	2011
t	1982	1992	2003	2009	1984	1993	2003	2009	2013
(b) Changes in total hours									
ΔH^C	-0.75	-0.82	-0.43	-1.48	-0.48	-0.16	-0.36	-0.20	-0.42
ΔH^C in %	-2.66	-2.88	-1.52	-5.24	-2.11	-0.72	-1.58	-0.87	-1.84
(c) $\gamma_{s,t}^{\omega^{job,task}}$	Contribution of per-capita employment								
$\omega^{A,S}$	-0.13	0.15	0.76	0.13	-0.09	-0.09	0.37	-0.21	0.03
$\omega^{A,NS}$	-0.03	0.01	-0.05	-0.02	-0.03	-0.12	-0.34	0.03	0.11
$\omega^{R,S}$	**0.94**	**0.56**	**0.78**	**0.65**	**0.47**	**1.34**	**0.90**	**0.50**	**-0.46**
$\omega^{R,NS}$	-0.03	-0.02	0.01	-0.05	**0.30**	**0.00**	**-0.43**	**0.82**	**0.10**
$\omega^{M,S}$	0.04	0.06	-0.22	0.05	-0.01	-0.06	0.04	-0.10	0.17
$\omega^{M,NS}$	-0.04	-0.02	-0.11	-0.04	0.02	-0.16	-0.08	0.18	-0.03
(d) $\gamma_{s,t}^{h^{job,task}}$	Contribution of hours per worker								
$h^{A,S}$	0.05	0.09	-0.16	0.08	**0.03**	**-0.18**	**0.19**	**-0.11**	**0.27**
$h^{A,NS}$	0.01	0.01	0.02	-0.00	0.02	-0.05	-0.11	-0.03	0.01
$h^{R,S}$	**0.18**	**0.13**	**-0.04**	**0.17**	**0.11**	**0.11**	**0.45**	**-0.20**	**0.59**
$h^{R,NS}$	-0.01	0.01	-0.00	0.00	**0.16**	**0.23**	**0.00**	**-0.08**	**0.15**
$h^{M,S}$	0.02	0.01	0.00	0.03	-0.01	-0.01	0.04	0.00	0.01
$h^{M,NS}$	0.01	0.02	0.01	0.00	0.03	-0.04	-0.04	0.06	0.05
(e) Summary									
γ_h	**0.26**	**0.27**	**-0.16**	**0.28**	**0.34**	**0.08**	**0.54**	**-0.21**	**1.08**
γ_ω	**0.74**	**0.73**	**1.16**	**0.72**	**0.66**	**0.92**	**0.46**	**1.21**	**-0.08**
γ_{ω^R}	0.91	0.54	0.79	0.60	0.77	1.35	0.47	1.32	-0.36
γ_{ω^A}	-0.16	0.16	0.70	0.11	-0.12	-0.21	0.03	-0.18	0.14
γ_{ω^M}	-0.00	0.04	-0.33	0.01	0.01	-0.22	-0.04	0.08	0.14
γ_{ω^S}	0.84	0.76	1.32	0.83	0.38	1.20	1.30	0.18	-0.25
$\gamma_{\omega^{NS}}$	**-0.10**	**-0.03**	**-0.16**	**-0.11**	**0.28**	**-0.27**	**-0.84**	**1.03**	**0.17**

US CPS MORG, annual data, 1979-2018. French LFS, annual data, 1983-2017. In panel (a), "ΔH_t^C in %", changes in cyclical aggregate hours as a % of the sample mean of aggregate hours. In panel (e), $\gamma_h = \sum_{task,job} \gamma_{s,t}^{h^{task,job}}$, $\gamma_\omega = \sum_{task,job} \gamma_{s,t}^{\omega^{task,job}}$, $\gamma_{\omega^R} = \sum_{job} \gamma_{s,t}^{\omega^{R,job}}$, $\gamma_{\omega^A} = \sum_{job} \gamma_{s,t}^{\omega^{A,job}}$, $\gamma_{\omega^M} = \sum_{job} \gamma_{s,t}^{\omega^{M,job}}$, $\gamma_{\omega^S} = \sum_{task} \gamma_{s,t}^{\omega^{task,S}}$, $\gamma_{\omega^{NS}} = \sum_{task} \gamma_{s,t}^{\omega^{task,S}}$. Numbers in bold are commented in the text.

in the fall in aggregate hours observed during busts. Our approach however complements theirs as we show that routine employment, and especially routine standard employment, accounts for the largest part of cyclical fluctuations at the extensive and the intensive margins, the former being by far dominant compared to the latter.

France. The right part of Table 1 presents the results of our decomposition exercise based on French data. As in the US, we observe that changes in aggregate hours ΔH^C are negative over the five French recessionary episodes. The most severe recession occurred in the early 1980s with a 2% fall in aggregate hours, closely followed by the recent 2011 crisis (1.84%). In contrast to the US economy, the 2008 crisis, with a -0.87% change in aggregate hours, was not the largest cyclical swing in France.

Table 1 suggests two different types of labor market adjustments in French recessions. The first type is similar to the US labor market adjustments, i.e. they are mainly driven by the extensive margin (in panel (e), $\gamma_\omega > \gamma_h$)). This is observed during the 1983, 1992 and 2008 recessions. As in the US, the fall in per-capita employment is explained by important changes in routine work. A look at the values of $\omega^{R,S}$ and $\omega^{R,NS}$ shows that both types of routine jobs are important, contrary to the US. In particular, the contribution of RS is of first importance during the first two French recessions, while that of RNS dominates during the Great Recession.

In the second type of labor market adjustments observed in France, variations in weekly hours per worker play a predominant role. This is especially the case in the 2011 recessions (panel (e), $\gamma_h > \gamma_\omega$)). In 2002, the contribution of both margins is balanced, with a slightly dominant influence for the intensive margin ($\gamma_h = 0.54$). In 2011, variations in the intensive margin would actually predict a higher decrease in cyclical hours than the one we actually observe ($\gamma_h = 1.08 > 1$), while changes in per-capita employment ($\gamma^\omega = -0.08$) would actually predict a rise in aggregate hours, which is counterfactual. The sizeable contribution of hours per worker in the 2011 French crisis is consistent with Fontaine et al. (2018)'s results. They show that cyclical changes in hours per worker has played a major role in accounting for fluctuations in French aggregate hours since 2003.

The sign of the contribution of NS to the changes in aggregate hours does not display any regularity (panel (e), $\gamma_{\omega^{NS}}$): it is positive for the 1983, 2008 and 2011 recessions, and negative for the other recessionary episodes of 1992 and 2002. Thus, the fall of RNS contributes to the fall in aggregate hours in 1983, 2008 and 2011, but not in 1992 and 2002. This is consistent with Figure 6 which does not show any regularity regarding the behavior of the share of NS during recessions in France. With respect to our discussion in section 3, this suggests that the substitution effect between S and NS does not always dominate during recessions in France, contrary to the US.

A focus on the Great Recession. To fix ideas, we now examine in more details the labor adjustments in the Great Recession (columns (5) and (9) in Table 1). In both countries, the fall observed in aggregate hours was largely explained by job losses in routine per-capita employment.

In the US economy, cyclical changes of job losses in routine standard employment alone accounts for nearly 65% of the fall in aggregate hours while the contribution of routine non-standard is negligible. In contrast, in France, both forms of contractual arrangement matter. The contribution of job losses in routine non-standard employment is even dominant ($\omega^{R,NS} = 0.82 > \omega^{R,S} = 0.50$).

Overall, the fall in NS, whatever the task group considered, is a good proxy for the recessionary decline in aggregate hours observed during the Great Recession in France ($\gamma_{\omega^{NS}} = 1.03$). In contrast, in the US, variations in NS would actually predict an *increase* in aggregate hours during the crisis. With a large drop in standard employment and an increase in non-standard work, the share of NS in the US economy spikes in recession, which is consistent with Figure 6. This leads to Fact 2.

> **Fact 2:** In recession, the fall in per-capita routine employment explains the bulk of the drop in aggregate hours in both countries. The two countries differ in the form of employment that is adjusted in bad times. In the US, the drop in standard routine employment is striking in recessions, while employment in NS tends to increase in recessions in all task groups. As a result, in the US, the share of NS spikes in recessions in all task groups. In contrast, in France, routine jobs are lost in standard and non-standard work. As a result, the cyclicality of NS does not display any regular pattern in French recessions. The contribution of job losses in routine NS has been sizable in the 1983, 2008 and 2011 recessions. In both countries, the main driver for changes in hours per worker lies in routine standard employment.

6 The dynamics of per capita employment

As routine employment appears as the major driver of the changes in aggregate hours, we investigate the driving forces behind the dynamics of per-capita routine employment using worker flows. In this section, we investigate the dynamics of job polarization and non-standard work using data on worker flows. We focus on the recent period 2003Q1-2017Q4 as worker flows are available only after 2003 in the French LFS. Subsection 6.1 presents our methodology, subsection 6.2 provides some descriptive statistics regarding labor market flows by task and contract type. Subsection 6.3 then presents our variance decomposition exercise, which leads us to establish Facts 3 and 4. Finally, we discuss the main implications of our findings, both for economic modelling and from a policy perspective in subsection 6.4.

6.1 Measuring worker flows by task and form of employment

We consider three labor market statuses : employment, unemployment (measured according to the ILO definition) and non-participation. When looking at employed individuals, their occupations are categorized into three groups, each corresponding to the main task performed on the job: abstract, routine or manual. The US data does not record any past occupation for non-participants. As a result, all US individuals categorized as non-participant are not assigned any task. We then treat French inactive individuals in the same way. In addition, for unemployed workers, even though French and US data provide information on their occupation in their most recent job, we decide to consider only one unemployment category, without distinguishing unemployment of workers with past occupation as abstract, routine or manual. We make this choice for 2 reasons: (i) past-occupation is not a 100% predictor of the occupation after re-employment (Sahin et al. (2014)), (ii) this choice reduces the size of the dynamic system which makes the interpretation of results more straightforward. In a nutshell, we classify individuals in each quarter into one of 8 mutually exclusive categories: unemployed (U), not in the labor force (N), and for those employed, we have 3 task groups (A, R, M), which can themselves be split by type of contractual arrangement (S or NS). For instance, Abstract Standard work at time t is denoted as A, S_t, and R, NS_t stands for Routine non standard employment at time t, etc.

We thus rely on a 8-state Markov model of labor market adjustments, where the corresponding stocks are denoted as:

$$X_t = (A, S_t; A, NS_t; R, S_t; R, NS_t; M, S_t; M, NS_t; U_t; N_t), \tag{2}$$

and evolve as follows:

$$X_t = \ell_t X_{t-1}, \quad (3)$$

where ℓ_t denotes a square matrix of size 8, whose elements $\ell_{i,j}$ capture the probability of transition from labor market status i to labor market status j. Using quarter-to-quarter matched data, we compute gross flows across employment states. We then adjust the data along three dimensions. We first seasonally adjust gross flows using x12. As in Elsby et al. (2015), we then compute transition probabilities that are consistent with the observed changes in stocks (A, R, M, U, N) (correction for margin error). Finally, as gross flows provide transition probabilities observed at discrete points of time, in order to correct these measures for possible transitions occurring between consecutive surveys, we correct gross flows for time aggregation bias (Shimer (2012)). We then get instantaneous transition rates.

6.2 Average quarterly transition rates

To get an idea of the respective importance of each type of labor market flows, let us consider Tables 2 and 3 below, where average quarterly transition rates for France and the US are respectively reported.

Table 2: US: Average quarterly transition probabilities

	To: A,S	A,NS	R,S	R,NS	M,S	M,NS	U	N
From:								
A,S	**89.4**	**3.9**	3.1	0.1	0.8	0	1.4	1.4
A,NS	**28.3** (a)	**51.6**	0.5	3.2	0.4	1.9	4.3	10
R,S	2.9	0	**84.9**	**5.2**	1.2	0	3.6	2.1
R,NS	0.5	2	**26**	**49.1**	0.7	2.9	7	11.8
M,S	2.3	0.2	4.2	0.3	**74**	**12.4**	3.1	3.5
M,NS	0.3	1.5	0.6	3.9	**22**	**52.7**	6.6	12.4
U	6.1	3.3	17.4	10.6	5	7.9	**16.2**	33.5
N	1	1.2	1.6	2.8	0.9	2.4	7.4	**82.7**

"A,S" : abstract standard work; "A,NS" : abstract NS; "R,S" routine standard work, "R,NS" : routine NS, ... "U" : unemployed; "N" : non participation. (a): each quarter, 28.3% of non standard workers in abstract jobs become standard workers in the US. To help with the reading of the table, diagonal elements within each task are in bold.

General picture. As found in Elsby et al. (2013), the US labor market is characterized by a higher turnover than its French counterpart. Indeed, comparing the diagonal elements of Tables 2 and 3 above, it turns out that all US numbers are lower than their French counterparts, indicating a lower average probability to remain in the same labor market state. For instance, the average quarterly probability of remaining unemployed

Table 3: France : Average quarterly transition probabilities

	To: AS	A,NS	R,S	R,NS	M,S	M,NS	U	N
From:								
A,S	**97.5**	**0.8**	0.2	0.0	0.0	0.0	0.5	0.9
A,NS	**3.9** (a)	**88.1**	0.1	0.5	0.4	0.1	3.8	3.3
R,S	0.2	0.0	**97.0**	**0.8**	0.0	0.0	0.8	1.2
R,NS	0.1	0.2	**4.6**	**82.0**	0.0	0.2	8.5	4.4
M,S	0.3	0.1	0.3	0.1	**93.9**	**2.3**	1.4	1.5
M,NS	0.1	0.1	0.1	1.1	**2.3**	**86.7**	5.0	4.5
U	0.8	2.3	2.7	15.5	0.4	2.7	**55.9**	19.7
N	0.2	0.4	0.4	1.6	0.1	0.4	6.0	**91.0**

"A,S" : abstract standard work; "A,NS" : abstract NS; "R,S" routine standard work, "R,NS" : routine NS, ... "U" : unemployed; "N" : non participation. (a): each quarter, 3.9% of non standard workers in abstract jobs become standard workers in France. To help with the reading of the table, diagonal elements within each task are in bold.

amounts to 55.9% in France against 16.2% in the US. Likewise, the probability to remain in e.g. Routine Standard work is 84.9% in the US, against 97.0% in France. Let us now focus on the job finding rates which can be found on line "U" in both Tables. As expected, the average duration of unemployment is larger in France than in the US. A job seeker in France faces on average a 24.4% quarterly probability of finding a job[17], and the average length of an unemployment spell is thus above a year[18], versus less than 6 months in the US[19]. Regarding job stability (column "U" in Tables 2 and 3), probabilities of losing a job (whether abstract, routine or manual) are higher in the US than in France. Our findings are consistent with previous evidence on US and French worker flows (Shimer (2012), Elsby et al. (2015), Le Barbanchon et al. (2015) or Fontaine (2016)).

Tasks. Our originality lies in documenting the ins-and-outs of each task group. Routine jobs account for the vast majority of job findings : 75% of job findings are in routine jobs in France[20] and 56% in the US[21]. As regards to mobility across employed workers in France (Table 3), our estimates of transition probabilities suggest that there are virtually no transitions from routine employment to manual employment or to abstract employment. This implies that most career changes (transitions from one task to another) almost always imply an unemployment spell in France. In contrast, in the US, we observe in Table 2 more mobility between abstract and routine employment ($R, S \rightarrow A, S = 2.9\%$, $A, S \rightarrow R, S = 3.1\%$ per quarter), as well as between Manual and routine employment ($R, S \rightarrow M, S = 1.2\%$, $M, S \rightarrow R, S = 4.2\%$ per quarter).

[17] (100-55.9-19.7)

[18] $\frac{1}{0.244}$ quarters

[19] $\frac{1}{1-.162-.335}$

[20] (2.7+15.5)/(0.8+2.3+2.7+15.5+0.4+2.7)

[21] (17.4+10.6)/(6.1+3.3+17.4+10.6+5+7.9)

In both countries, abstract jobs are the most stable ones, with the lowest separation probability and the lowest probability of transition to non-participation. Manual employment lies at the other end of the distribution with the highest probability of exiting manual employment (compared to abstract and routine jobs), higher probability of exit to unemployment or non participation, especially in the US. Therefore, one consequence of job polarization may be that, while employment stability remains globally unchanged at the aggregate level, as the former routine workers reallocate to abstract (more stable) or manual (less stable) jobs, job stability may decrease at the individual level for the former routine workers reallocating to manual/less stable jobs.

NS work. We investigate further this topic by looking at the relationship between job polarization and non standard forms of work. When examining the diagonal elements in Tables 2 and 3, in all task groups, NS is characterized by less stability than S, especially in the US. All non-standard workers are more likely to switch labor market status next quarter than their counterparts with standard contract.

In France (Table 3), non-standard workers are three to ten times more likely than standard workers to lose their job within the next three months. Non standard workers in routine jobs are characterized by the highest job finding and job separations rates. Column "N" in each Table suggest that holding a non-standard contractual arrangement increases substantially the risk of dropping out of the labor market: for instance, the average probability of dropping out from an abstract job is 7 times larger with a non-standard than with a standard contractual arrangement in the US, and more than 4 times larger in France.

As for the so-called *stepping stone effect*, we actually observe few transformations from non-standard to standard work in France: each quarter, only 3.9% of non standard workers in abstract job become standard workers (4.6% in Routine jobs ; 2.3% in Manual jobs). In each task group, in France, 70% to 80% of job findings are in NS. "Downgrading" from standard to non-standard work is rare within each task group: transitions from A, S to A, NS, R, S to R, NS are marginal each quarter. The only exception is the manual segment of employment: workers transitions equally go both ways (M, S to M, NS and vice versa) at a rate of 2.3% per quarter. Furthermore, manual workers face a lower stepping stone probability (from M, NS to M, S) and a higher likelihood of downgrading (from M, S to M, NS). This suggests that manual jobs in France are of lower quality and/or less stable than abstract and routine jobs. Overall, Table 3 suggests that French workers with standard forms of employment enjoy a more favorable economic environment, which contributes to the dualism of the French labor market.

In the US (Table 2), the job finding rate (transition from U to employment) is actually larger in standard than in non-standard work for abstract and routine jobs. In contrast, for manual jobs, workers find a non standard job more easily than a standard job (with a quarterly probability of, respectively, 7.9% for non-standard jobs against 5% for standard ones). Stepping stones are more frequent in the US than in France: each quarter, on average, 25% of part-timers get a full-time job within their occupational group. For each task group, this gives a probability of transformation from non-standard work to standard work of 28.3% in abstract jobs, 26% in US routine jobs, 22% in manual jobs each quarter. In any case, this is way above the values found in France, and could be expected given the higher flexibility of the labor market in the US. "Downgrading" from standard to non-standard work is also much more frequent in the US than in France. Each quarter, 3.9% of full-time abstract workers switch to part-time. This goes up to 5.2% for standard routine workers and 12.4% for standard manual workers.

Summary statistics of Tables 2 and 3 provide a first piece of evidence indicating that within-employment reallocations, namely transitions involving standard and non-standard work at the same task group, are much more important in the US than they are in France.[22]

6.3 β Variance decomposition of employment

6.3.1 Computing β

With knowledge of the various transition rates in hand, our goal is now to decompose cyclical fluctuations in employment rate into contributions attributable to each of the flow hazards. To do so, we adapt the dynamic decomposition of Elsby et al. (2015) to our empirical model. The main advantage of this method relies on the fact that it is not

[22]We compute transitions across employment categories without controlling for a change in employer. When we look at the change in employer, using CPS monthly data after 1994, we find a change in employer occurs with a probability lying between 3.13% and 4.87% for occupational stayers (no career change, the worker remains in her task group) who switch between S and NS. This is consistent with Borowczyk-Martins & Lale (2019)'s view that the switch between S and NS (whatever the direction of the change) is primarily done at the same employer. We show that this is true within each task group. When looking at occupational moves (change in task group), the change in employer is more likely. The likelihood of change of employer in case of a change in task group, without change in form of employment (whether S or NS), rises to approximately 35% to 55%, which echoes Moscarini & Thomson (2007)'s findings that 60% of occupational movers in the US change employer. If the change in task group is also combined with a change in form of employment (S, NS), the probability of change in employer rises to approximately 70%. The results for French data are qualitatively consistent with these findings. Results are available upon request. The study of job-to-job mobility lies beyond the scope of the paper and is left for future research.

based on a steady-state approximation. Given the relatively low level of worker flows on the French labor market, a non-steady state decomposition becomes even more relevant.

We obtain the following β statistics indicating the share of employment per capita variance that is accounted for by the hazard rate from state i to state j:

$$\beta^{ij} = \frac{\text{Cov}\left(\Delta\omega_{t-1,t}, \Delta\tilde{\omega}^{ij}_{t-1,t}\right)}{\text{Var}(\Delta\omega_{t-1,t})} \tag{4}$$

where ω stands for per capita employment[23], Δ is the first difference operator and $\tilde{\omega}^{i-j}_{t-1,t}$ the counterfactual employment per capita obtained when only one worker transition (from i to j) fluctuates. In order to compute $\tilde{\omega}^{i-j}_{t-1,t}$, we proceed as follows. First, we compute labor market stock changes that are driven by contemporaneous but also *past* changes in transition rates. This recursive formulation of stock variations is at the heart of the non-steady state decomposition. Second, we express the variance of any given labor market stock as the sum of its covariance with any counterfactual obtained in the previous step.

6.3.2 Results

Table 4: β decomposition of R, S and R, NS - 2003Q1-2017Q4

	US		France	
	R, S	R, NS	R, S	R, NS
	(1)	(2)	(3)	(4)
(a) Job separation from employment to unemployment				
$\beta^{R,S-U}$	**34.5**	2.3	**21.6**	1.6
$\beta^{R,NS-U}$	1.6	-8.4	0.8	**24.4**
Total job separation to U	36.1	-6.1	22.4	26.0
(b) Job finding from unemployment				
$\beta^{U-R,S}$	**35.9**	4.3	**17.6**	0.3
$\beta^{U-R,NS}$	3.2	**-44.4**	0.5	**41.4**
Total job finding from U	39.1	-40.1	18.1	41.7
(c) Within: to/from NS				
$\beta^{R,S-R,NS}$	**20.3** (a)	**91.3**	2.3	-0.2
$\beta^{R,NS-R,S}$	2.6	4.7	**26.2**	1.5
Total within	22.9	96.0	28.5	1.3
(d) to/from Non-participation				
β^{N}	-3	**18.2**	**13.8**	**22.3**

US CPS basic monthly. French LFS. 20013Q1-2017Q4 in both countries. (a): 20.3% of the variance in changes in per capita routine standard employment in the US is explained by transition from routine standard ro routine non-standard work. β^N sum of all βs involving non-participation. Numbers in bold are commented in the text.

For each employment stock, we can compute a β decomposition driven by 56 non-diagonal

[23] we ommit the task and job indices here for notational simplicity

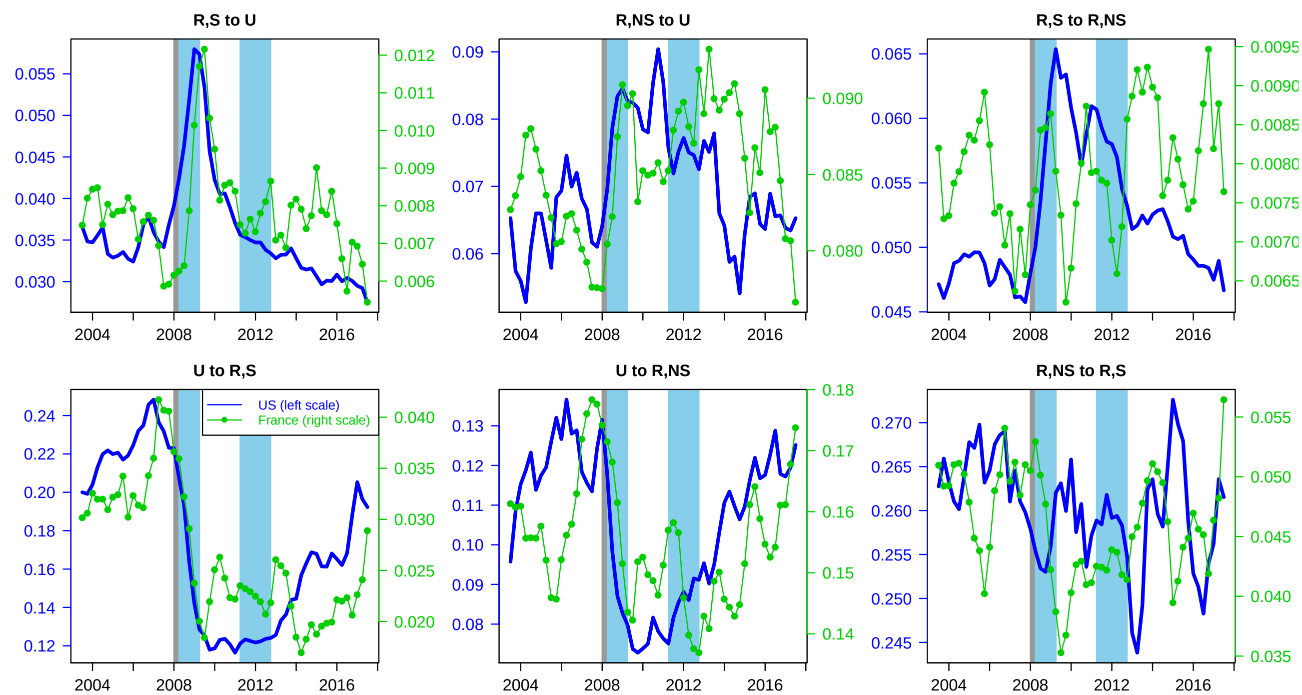
elements in the (8×8) Markov matrix in equation (3). Table 4 shows the quantitative contribution of selected transition probabilities to the variance of routine standard and routine non-standard per-capita employment for the US and France. For the sake of brevity, we report complete decomposition results along with unemployment variance decomposition in Appendix D. For comparison purpose, we restrict our analysis to a period for which data on worker flows are available in both countries, namely the 2003Q1-2017Q4 period.

Fluctuations in R, S employment Let us first have a look at the fluctuations in routine standard employment in both countries (columns (1) and (3)). The main drivers of RS changes are the transitions involving unemployment (panels (a) and (b)). In the US, job separations and job findings to routine standard jobs account for 70.4% of the observed variation in routine standard employment per capita. This corresponds to a balanced relative contribution of each transition rate (about 35% for routine job losses and job findings respectively). The pattern is qualitatively similar in France, even if the figures are of a lower order of magnitude ($\beta^{R,S-U} + \beta^{U-R,S} = 39.2\%$). This can partly be explained by a higher influence of transitions involving non-participation (13.8% in France, versus -3% in the US).

Panel (c) of Table 4 looks at the "within" reallocations, i.e. transitions between standard and non-standard work in the routine task group. In the two countries, transitions between standard and non-standard work explain approximately 25% of the variance of RS. However, a look at the respective contribution of each type of transition shows a striking difference across countries: in the US, changes in "downgrading" from R, S to R, NS matters the most while in France, it is the cyclicality of the "stepping stone" effect from R, NS to R, S which makes up the largest part of the contribution to RS fluctuations. Thus, the transitions from RS to RNS alone account for 20.3% of the variance of RS work in the US versus only 2.3% in France. In France, the changes in the transitions from RNS to RS explain the vast majority of RS fluctuations ($\beta^{R,NS-R,S} = 26.2\%$).

Fluctuations in R, NS employment. Columns (2) and (4) in Table 4 display the decomposition results of the variations in routine non-standard work for the US and France respectively. Again, there are important differences between both labor markets. In the US, over the 2003Q1-2017Q4 period, variations in RNS are overwhelmingly explained by within-employment reallocations. They explain 96% of the variance of routine non-standard employment. The transformation of routine standard jobs to non-standard jobs, namely the "downgrading" effect, is by far the main driver for RNS variance ($\beta^{R,S-R,NS} =$ 91.3%). In France, the picture is thus quite different along several dimensions. First, within transition probabilities have a negligible influence in accounting for the variance of RNS. Second, most of the variability in RNS, about 65%, is due to transitions involving unemployment. In particular, routine non-standard job separations explain 24.4% of the changes in RNS while the contribution of the job finding rate is of 41.4%. A look at the same figures for the US points to another striking difference with France: in the US, unemployment exit to routine non-standard have a negative contribution of -44.4% to R, NS variance. This indicates that the cyclical behavior or the $U - R, NS$ transition rate is very different from what we observe in France, and plays in an opposite direction compared to the cyclical fluctuations in R, NS.

Figure 7: Selected transition probabilities.



Skyblue shaded areas indicate French recessionary episodes (French ECRI dates). Grey shaded areas indicate US recessionary episodes (NBER dates).

Illustration: the 2008 crisis. To illustrate our results, we display in Figure 7 the evolution of worker transition probabilities. At the early stage of the Great Recession, in both countries, R, S employment falls (Figure 5) as R, S workers face a steeper probability of job losses ($R, S \rightarrow U$) while job finding to routine standard employment falls ($U \rightarrow R, S$).

In the US, the probability for routine standard workers to switch to routine non-standard work increased by about 2 percentage points. This increased "downgrading" effect contributed to the fall in R, S employment. This finding complements Borowczyk-Martins & Lale (2019)'s results on the spikes of part-time employment in recessions. US firms use within-employment reallocation to adjust labor in bad times.

In France, during the 2008 crisis, French RNS worker faced a lower probability to get a RS job. The steep drop in the $R, NS \rightarrow R, S$ transition (lower stepping stone effect) contributed to the fall in RS jobs. More specifically, for a RNS worker the probability of "upgrading" to routine standard work fell by 2 percentage points, from 5.5% to 3.5%.

> **Fact 3:** In both countries, RS (Routine Standard) per-capita employment is mainly driven by the cyclicality in transitions to/from unemployment (job losses and job findings). As for the within transitions, in recessions, RS falls in the US because more RS workers become RNS (increased "downgrading"); while, in France, RS falls because less RNS workers become RS workers (fewer "stepping stones").

As for R, NS jobs, R, NS *increases* in the US in the Great Recession (Figure 5), boosted by increased inflows from R, S workers (increased "downgrading" in recession). Notice that US unemployed workers have a harder time finding a R, NS job, which would tend to *lower* R, NS employment. However, as R, NS employment actually *increased* in the data, the drop in the R, NS job finding rate does not appear as a driver for R, NS employment. This explains $\beta^{U-R,NS} < 0$ in Table 4.

In contrast, in France, R, NS *fell* in the 2008 crisis (Figure 5), due to spikes in job losses ($RN, S \rightarrow U$) and steep fall in job finding ($U \rightarrow R, NS$).

Fact 4: The countries differ along the behavior of R, NS (Routine Non Standard) employment. In the US, R, NS *increases* in recession. R, NS appears to be mainly a short-term transition to/from standard routine employment. In particular, the cyclicality of inflows from R, S to R, NS (namely the increased "downgrading"), plays a leading role in accounting for R, NS fluctuations, especially during the Great Recession. In contrast, in France, the *fall* observed during recessions is driven by the high cyclicality of job finding (40%) and, to a lesser extent, job losses and entries/exits implying non-participation (approx. (20% each).

Our findings support the view that within-employment reallocation, through the use of non-standard work, is an alternative margin of adjustment in the US. In bad times, more standard workers switch to NS. In France, flexibility is achieved by adjusting hiring and separations of standard and non-standard work. Recessions are times when opportunities of steeping stones from S to NS are reduced.

6.4 Policy implications and lessons for economic modelling

We discuss here implications of our findings in terms of policy and economic modelling.

Economic modelling First, when modelling labor market adjustments, labor economists face the standard question of whether hours per worker should be endogenized or not. We show that the focus on the extensive margin in the job polarization literature is relevant when one looks at US data. However, on French data, the understanding of both margins of labor may be relevant, especially in the recent recession.

Secondly, our results help understand the career changes and labor market mobility in both countries. In France, task changes mainly involve an unemployment spell (Table 3). Direct mobility without any unemployment spell is marginal. In addition, in terms of modelling, the simple model of occupational choice in Autor & Dorn (2013), with direct occupational switch, without unemployment, would not be relevant in France. In the US (Table 2), in contrast, 3 to 4% of employed workers operate a change in task group from one quarter to the next. This fraction is significant but remains quite low compared to the massive job losses in routine employment over the last decades. Labor reallocation in the US does not go through only employment-to-employment task reallocation, as in Autor & Dorn (2013)'s model. Our result is consistent with Cortes et al. (2014)'s findings that inflows into routine employment from unemployed and non-participants drive the disappearance of routine jobs. Modelling job polarization also requires in the US the understanding of worker flows in and out of non-employment.

Finally, our findings support the view that within-employment reallocation, through the use of non-standard work, is an alternative margin of adjustment in the US. In bad times, more standard workers switch to NS. The substitution effect of NS discussed in section 3 prevails such that NS spikes in recession. Our result suggest that a proper modelling of NS along the business cycle would require the understanding of variable labor utilization, with lumpy adjustment in hours at the same employer, as suggested by Borowczyk-Martins & Lale (2019). We show how this adjustment unfolds in a job-polarization context, with a substitution effect affecting all task groups, especially routine workers.

In France, flexibility is achieved by adjusting hirings and separations of both standard and non-standard work. NS appears as a labor status "at the margin" of labor: a gateway to employment for unemployed workers and non-participants, but to unstable jobs. Recessions are times when hiring in NS goes down, implying both lower hirings from non-employment and reduced opportunities of steeping stones from S to NS. In France, a modelling of adjustments with NS, from a macroeconomic perspective, would require the understanding of non-employment dynamics.

Policy implications Job polarization refers to the growth of "lousy" (manual) and "lovely" (abstract) jobs as Goos et al. (2009). Our result adds NS to this analysis by stressing that, in the US, standard as well as non-standard routine work have been lost over the past decades (See Figure 5). In the US, mainly standard jobs have contributed to an increase in the numbers of "lovely" and "lousy" jobs, so that the US does not display any upward trend in the share of NS in the economy (Figure 6). In particular, US manual jobs expansion mainly occurs using S rather than NS. The share on NS in manual jobs is actually falling over time in the US. In contrast, in France, while standard routine jobs have been lost over the past decades, non-standard forms of employment expanded in all task segments of the labor market. In particular, over the past decades in France, manual jobs expansion has mainly occurred using NS rather than S, which is unlike the US. The OECD (2015) voiced concerns about the growth of NS work as these jobs tend to pay lower wages than standard jobs, especially at the bottom of the earnings distribution, thereby raising earnings inequality. Our analysis suggests that this concern may be particularly relevant for the French labor market.

Finally, our paper has also policy implications related to the welfare costs of the business cycles. Lucas (1987) argues that the welfare costs of business cycles are negligible. In contrast, Krebs (2007) argues that business cycle costs are sizeable when displaced workers face income losses that persist even after the displaced worker is re-employed. This may be particularly relevant in the context of job polarization, where many routine jobs are lost in recession: policies aimed at improving the reallocation of former routine workers to new jobs and retraining schemes aimed at increasing their chance of finding abstract rather than manual jobs may prove beneficial. In this perspective, the French labor market exhibits two main features compared to the US: (i) occupational mobility is much lower: routine workers seldom change occupations in France, as we have shown in section 6 (Tables 2 and 3). (ii) NS work is wide spread and has followed an upward trend: in France, the highest job finding rate lies in non-standard employment. Besides, NS is not often a stepping stone toward S, and the conversion rate of NS into S gets even lower during recessions. These features have important consequences for welfare losses born by displaced routine workers: (i) implies that policies aimed at increasing French workers' general human capital are needed to improve their occupational mobility. In addition, improving job search assistance for former routine workers may also be helpful. (ii) implies that many former routine workers previously holding standard jobs will end up in NS work. This type of work providing lower job stability and lower wages compared to standard employment, the former routine standard workers incur sizeable income losses. In such a context, policies aimed at reducing the impact of the business cycle, in a job polarization context, should primarily focus on reducing the share of NS work in job creations. Such policies may also improve growth prospects, as it is generally argued that NS work may negatively affect human capital investments[24]. In any case, while the trend towards job polarization seems inevitable given the development of new technologies, the US example shows that the trend towards higher NS can be avoided.

7 Conclusion

Using annual and quarterly labor market data from the US and France, we study the relationship between the extensive and intensive margins of labor adjustment, job polarization and non-standard work along the business cycle and derive four stylized facts. First, changes in aggregate hours are mainly driven by fluctuations in per-capita employment rather than hours worked per worker. Second, recessionary drops observed in

[24]See e.g. Krebs (2003) where labor income risks are related to human and physical capital investments as to the cost of the business cycle. However, the divide between S and NS is not taken into account in this paper.

aggregate hours are, to a large extent, due to the disappearance of routine work. In the US, the fall in routine standard employment accounts for most of the decline in aggregate hours, whereas in France, routine jobs losses in both standard and non-standard work matter. Third, the dynamics of routine standard employment are driven by flows from and into unemployment in both countries. Fourth, the dynamics of routine non-standard work differ across countries. In the US, fluctuations in routine non-standard employment is driven by inflows from routine standard work, while, in France, changes in routine non-standard work are accounted for by ins and outs from unemployment. Our findings support the view that within-employment reallocation, through the use of non-standard work, is an alternative margin of adjustment in the US. This is not the case in France and flexibility is achieved by adjusting hiring and separations of standard and non-standard work. In bad times, reduced stepping stones contribute to the fall in routine standard employment.

Our paper is potentially relevant to research in macro and labor economics. The data and our stylized facts may be used as an empirical background to discipline theoretical models of labor market adjustment along the extensive and intensive margin across countries. The job polarization process offers an opportunity to revisit how firms proceed to this trade-off when faced with this strong technological trend. Our study of NS also provides a first look at how firms use of this flexibility in a context of technological change. Developing a dynamic labor market model including these dimensions is left for future research.

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Online Appendix

A Definition of tasks

US. Abstract jobs (creative, problem-solving, and coordination tasks) include non-routine cognitive workers (Management, business, and financial operations occupations. Professional and related occupations).

Routine employment (repetitive, codifiable job tasks) include sales and related occupations, office and administrative support occupations, production occupations, transportation and material moving occupations, construction and extraction occupations, and installation, maintenance, and repair occupations.

Manual jobs (assisting or taking care of others requiring physical dexterity and flexible interpersonal communication) are service occupations such as Ushers, Lobby Attendants, and Ticket Takers, Amusement and Recreation Attendants, Embalmers, Funeral Attendants, Morticians, Undertakers, and Funeral Directors, Barbers, Hairdressers, Hairstylists, and Cosmetologists, Makeup Artists, Theatrical and Performance, Manicurists and Pedicurists, Shampooers, Skincare Specialists, Baggage Porters and Bellhops, Concierges, Travel Guides, Child-care Workers, Personal Care Aides, Fitness Trainers and Aerobics Instructors, Recreation Workers, Residential Advisors, Personal Care and Service Workers, All Other.

France. Abstract jobs are management, business, science, and arts occupations; this includes occupation codes 23 large business heads, 31 licensed professionals, 33 civil servant, executives, 34 scientific professional, 35 creative professional, 37 top managers and professionals, 38 technical manager, engineers, 42 teacher, and 43 health workers.[25]

Routine jobs are sales and office occupations; construction and maintenance occupations, and production, transportation, and material moving occupations; this includes occupation codes 45 mid-level professionals in the public sector, office worker, 46 mid-level professionals in the corporate sector, office workers, 47 technician, 48 foremen, supervisors, 52 civil servants, office workers, mid-level and low level, 53 security workers, 54 office

[25] One could argue that occupation 43 could also be considered to be part of manual non-routine jobs. We choose to consider them in the abstract group, as Charnoz & Orand (2015). These authors consider the same group of occupations in the abstract group and checked that these jobs are indeed characterized by abstract-intensive tasks. In addition, Jaimovich & Siu (2012) also consider medical occupations as part of non-routine cognitive jobs.

workers in the corporate sector, 55 retail worker, 62 skilled industrial workers, 63 skilled manual laborers, 64 drivers, 65 skilled distribution worker (dispatch, dockers, warehousemen, ...), 67 low skill workers, in manufacturing, food industries, press, ... 68 low skill laborers, craftsmen.

Manual jobs are service occupations. This includes occupation codes 56 Personal service workers and 22 heads of small businesses (selling food, tobacco, services, and other items).

B Looking at the data: hours per worker

B.1 US

Let us look at the evolution of weekly hours per worker, the other component of aggregate hours. Figure 8 shows that each abstract worker is at work on average 41.4 hours a week, which is larger than routine workers (38.8 hours a week) and manual workers (34.2 hours a week). The low average hours per week in manual occupations is due to (i) the larger share of part-timers in manual work (Figure 6) and (ii) to the difference in hours per worker in non-standard work: part-timers in manual jobs work 20.4 hours a week versus approximately 21.3 hours in abstract and routine part-time jobs.

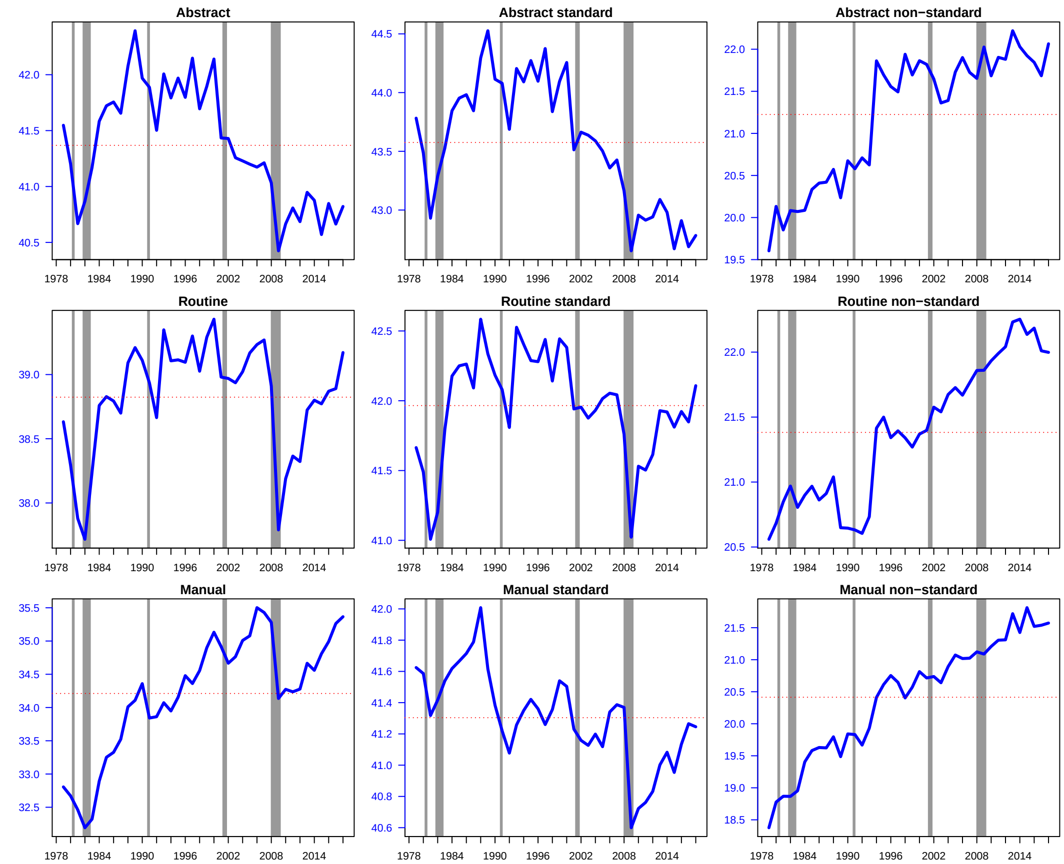
Figure 8 suggests that there is no strong trend in hours per worker in standard employment for abstract and routine jobs, while, in all tasks, the number of hours per worker in NS steadily increases over the period. Notice that weekly hours on manual jobs with full-time contracts also tend to decline.

Notice that for each task group, hours are procyclical for standard work $h^{A,S}, h^{R,S}, h^{M,S}$ with a particularly sharp drop following the Great Recession, whereas NS hours per worker do not seem to respond to the recessions.

B.2 France

Let us turn to weekly hours of work depicted in Figure 9. On average, abstract workers work 38 hours a week, versus 36.5 hours for routine workers and 31 hours for manual workers. As in the US, manual workers work less because the share of NS is dominant in this task group (Figure 6) and weekly hours per worker in NS is lower in this task group (22 hours per week on average versus 27 hours for abstract workers and 29 hours for routine workers).

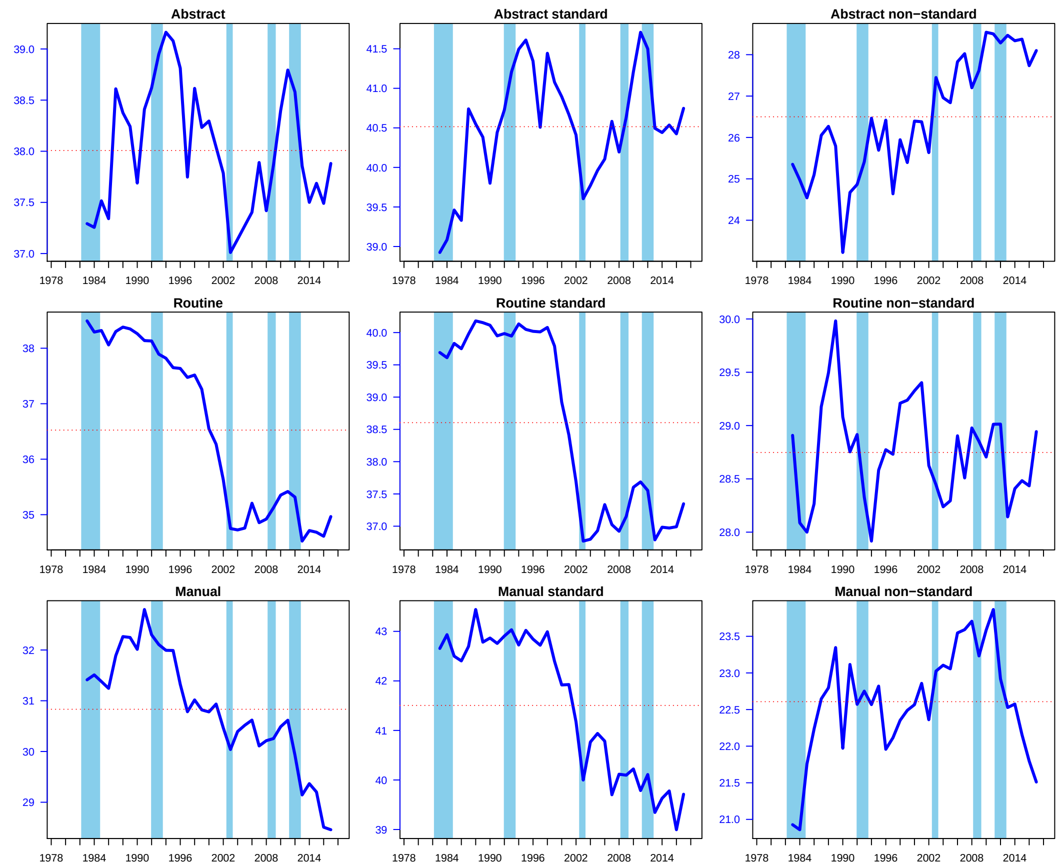
Figure 8: US: Components of total hours H : h weekly hours per worker, by task and job type



US CPS MORG, annual data, 1979-2018. Shaded areas indicate NBER recessionary episodes. h^A average weekly hours in abstract jobs. Similar definition applies to Routine and Manual jobs. Horizontal line "average" is average value over the sample period.

Globally, the trend in hours of work is decreasing for Routine and Manual jobs, and rather increasing for Abstract jobs. One also sees that the evolutions are different when decomposing by contract type : while weekly hours have decreased sharply at the end of the 1990s for all task groups, they increased in NS during the same period. Weekly hours did not necessarily decrease (and not by much) following the beginning of the Great Recession in 2008, but they decreased substantially in Abstract Standard, Routine and Manual NS following the recessionary episode in 2011. Thus, weekly hours are not necessarily procyclical, depending on the type of contract and task, and which recession is considered.

Figure 9: France: Components of total hours H : h weekly hours per worker, by task and job type



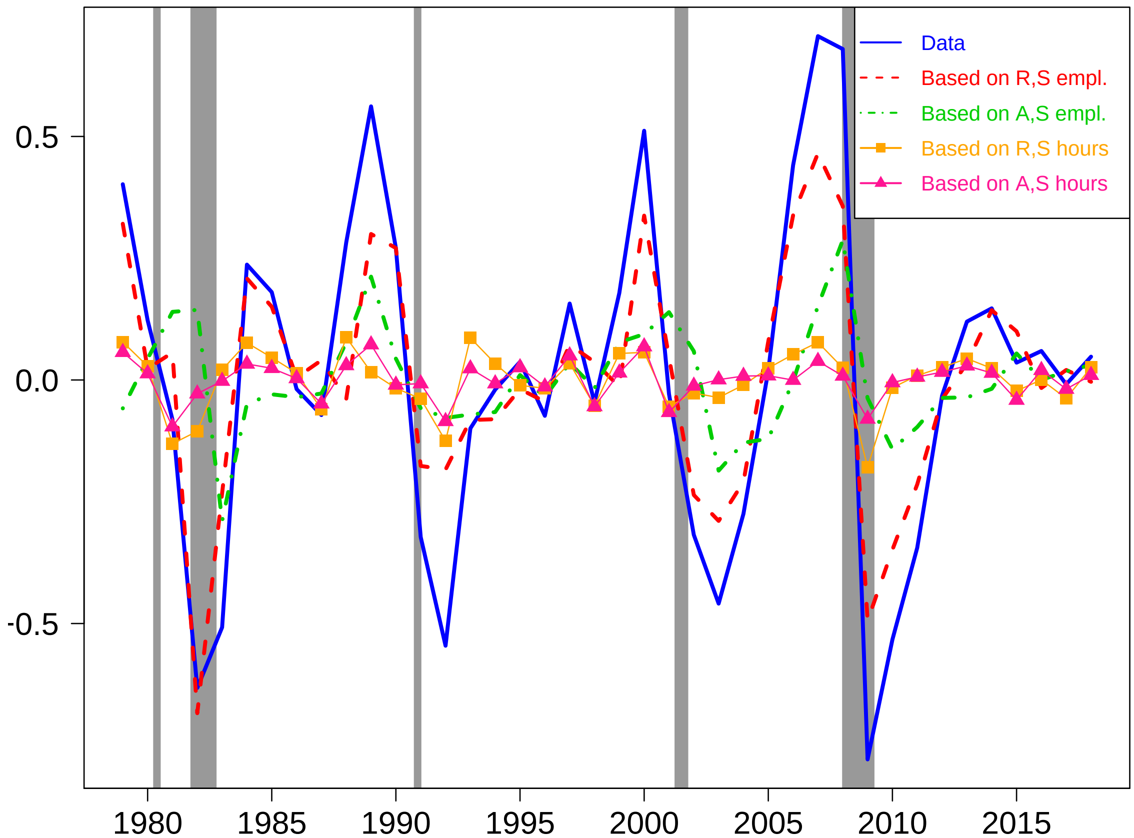
French LFS, annual data, 1983-2017. Shaded areas indicate ECRI recessionary episodes. h^A average weekly hours in abstract jobs. Similar definition applies to Routine and Manual jobs. Horizontal red line “average” is average value over the sample period.

C Total hours H by task/job type and counterfactuals over the business cycle

Figure 10 illustrates the main properties discussed in section 5.2.2. It represents the total variation of aggregate hours over the business cycle (continuous dark line - Data), and the variations implied by the main contributors to such changes, i.e. routine standard employment, abstract standard employment, hours worked on routine standard and abstract standard jobs respectively. Overall, the visual impression provided by this picture is consistent with Table 1 regarding the respective contribution of the extensive and intensive margins : variations in employment per capita contribute much more to the variation in aggregate hours than changes in hours per worker.

Figure 11 presents the same type of exercise for France: the variations observed in the data can then be compared to those stemming from the main contributors: routine standard

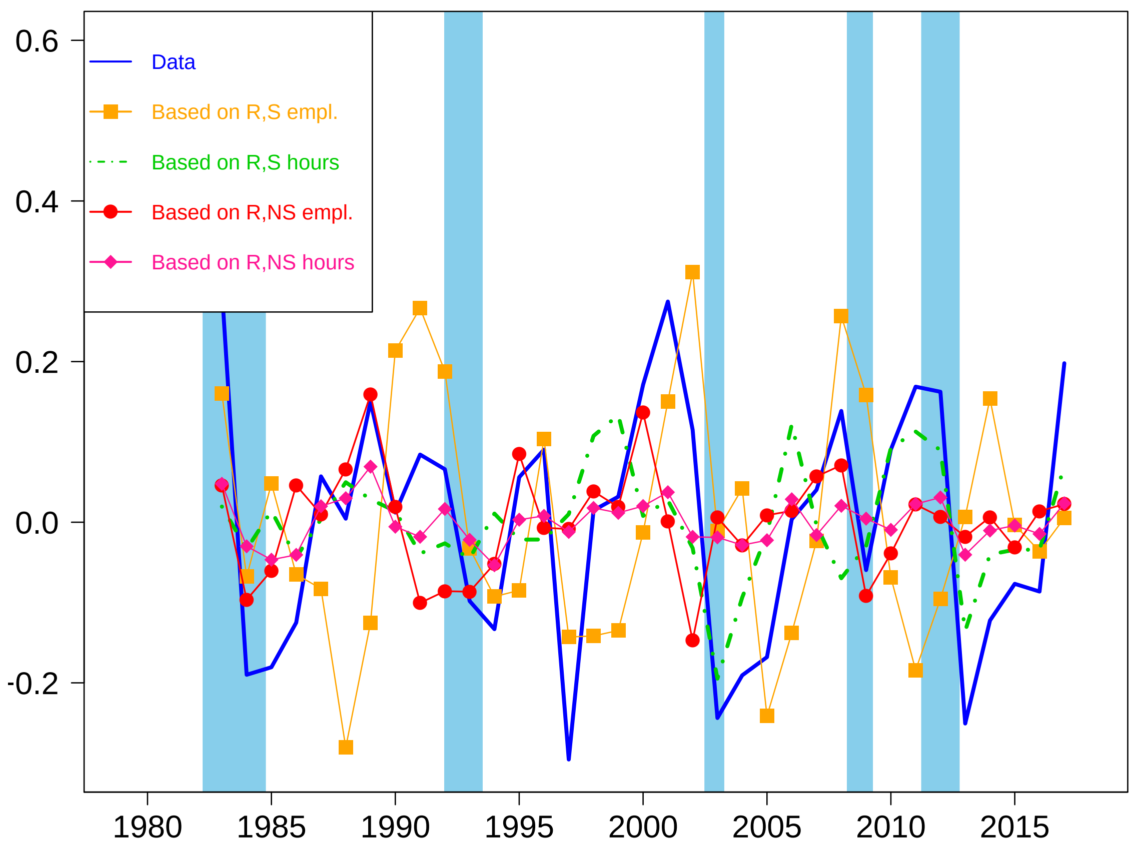
Figure 10: US: Total hours H by task/job type and counterfactuals: cyclical component



US CPS MORG, annual data, 1979-2018. HP filtering with smoothing parameter of 6.25. "Data": HP-filtered per-capita aggregate hours H^C. "Based on R,S empl" : counterfactual HP-filtered per-capita aggregate hours predicted only by changes in routine standard per-capita employment ω^{RS}. Similar definition applies to the other lines.

employment, routine standard hours and abstract standard hours. As in the US, it turns out that the biggest contribution comes from the extensive margin, and routine standard employment in particular. However, the intensive margin plays a bigger role than in the US.

Figure 11: France: Total hours H by task/job type and counterfactuals: cyclical component



French LFS, annual data, 1979-2018. HP filtering with smoothing parameter of 6.25. "Data": HP-filtered per-capita aggregate hours H^C. "Based on R,S empl" : counterfactual HP-filtered per-capita aggregate hours predicted only by changes in routine standard per-capita employment ω^{RS}. Similar definition applies to the other lines.

D Complete tables for variance decomposition

Columns (1),(2),(4) and (5) in Table 5 report the full variance decomposition summarized in Table 4.

Columns (3) and (6) of Table 5 report the variance decomposition of unemployment fluctuations in the US and France respectively. The major forces behind French unemployment changes lie in changes in the job finding rate of routine NS that account for more than 20% of unemployment variance. The second biggest contribution lies in routine job losses in routine standard employment ($\beta^{R,S-U} = 12\%$). Job losses and findings in routine non standard work alone account for nearly a third of fluctuations in French unemployment. These results clearly suggests that fluctuations in NS play a key role in short run changes in French unemployment. Interestingly, the contribution of routine employment losses in standard work ($\beta^{R,S-U} = 12\%$) is larger than that of job finding in this type of job ($\beta^{U-R,S} = 9.2\%$), thereby suggesting that, along the business cycle, job losses are sharp in routine standard jobs, while job finding does not respond as much, especially during expansions.

In each occupational group, regarding job losses in France , the contribution of employment exits from standard jobs ($\beta^{A,S-U}, \beta^{R,S-U}, \beta^{M,S-U}$) is larger than job losses in non standard work ($\beta^{A,NS-U}, \beta^{R,NS-U}, \beta^{M,NS-U}$). This may relate to the legal constraints on temporary work contract in France. As long as the term of the contract is not reached, separations from temporary contracts are not common (Cahuc et al., 2016). They occur without any penalty at the term of the contract. There are also legal constraints in the renewal procedure: temporary contracts can only be renewed once and the maximum duration of a temporary job spell cannot exceed two years. The increased prevalence of temporary contracts can then reduce the fluctuations in the separation rate through a standard compositional effect, as the cyclicality of the separation rate is very heterogenous across temporary and permanent contracts. In addition, NS also includes part-timers with permanent contracts.

The picture that emerges from the decomposition of the US unemployment variance is different from the French one. First, the total contribution of NS to unemployment fluctuations is of a lower order of magnitude. Indeed, when NS accounts for 24% of US unemployment rate changes, the same statistic is around 38% in France. Second, the two countries differ with respect to the contribution of the job finding. Unemployment exits to standard employment generate around 30% ($\beta^{U-A,S} + \beta^{U-R,S} + \beta^{U-M,S}$) of US unemployment changes while, in France, they account for barely 12%. Unambiguously,

Table 5: β decomposition of R,S, R,NS and u - 2003-2017

	US			France		
	(1)	(2)	(3)	(4)	(5)	(6)
	R,S	R,NS	u	R,S	R,NS	u
$\beta^{A,S-A,NS}$	0.1	0.6	0.2	0.2	0.2	0.2
$\beta^{A,S-R,S}$	3.2	-1.4	-0.1	3.1	-0.6	-0.3
$\beta^{A,S-R,NS}$	0.2	-3.2	0	0.2	3.3	0.2
$\beta^{A,S-M,S}$	0	-0.1	-0.1	0.2	0.4	0.2
$\beta^{A,S-M,NS}$	0	-0.2	0	1	1	1.1
$\beta^{A,S-U}$	-2.3	4.1	**3.7**	-0.6	-0.3	**2.3**
$\beta^{A,S-N}$	0.3	-0.6	-0.3	-0.4	-0.6	-0.2
$\beta^{A,NS-A,S}$	0.2	0.6	0	-0.2	-0.3	-0.2
$\beta^{A,NS-R,S}$	0.4	-0.1	0	0.1	0	0
$\beta^{A,NS-R,NS}$	0.2	1.7	0	0.1	-0.1	-0.2
$\beta^{A,NS-M,S}$	0	0	0	0.2	0.2	0.3
$\beta^{A,NS-M,NS}$	-0.1	0.1	0	-0.1	0	0
$\beta^{A,NS-U}$	-0.4	0.3	**1**	0.1	-0.1	**0.7**
$\beta^{A,NS-N}$	0	-0.2	0.1	0.3	0.4	0
$\beta^{R,S-A,S}$	2.7	1.7	0.3	5.8	0.2	0.3
$\beta^{R,S-A,NS}$	-0.1	0	0	1.1	-0.1	0.1
$\beta^{R,S-R,NS}$	20.3	91.3	0.8	2.3	-0.2	0.5
$\beta^{R,S-M,S}$	0	0.4	0	1.1	0.1	0.1
$\beta^{R,S-M,NS}$	-0.2	0	0	2.8	0.1	0
$\beta^{R,S-U}$	34.5	2.3	**12.5**	21.6	1.6	**12**
$\beta^{R,S-N}$	-3.2	0.5	-0.4	9.9	-0.3	-0.7
$\beta^{R,NS-A,S}$	-0.3	7.5	0.1	0.6	1.7	0.4
$\beta^{R,NS-A,NS}$	0.2	4.1	0	0.2	3.5	0.2
$\beta^{R,NS-R,S}$	2.6	4.7	0.1	26.2	1.5	0.7
$\beta^{R,NS-M,S}$	-0.3	3.5	0	0.1	0.7	0
$\beta^{R,NS-M,NS}$	0.2	6.9	0	0.1	0.9	0.2
$\beta^{R,NS-U}$	1.6	-8.4	**2.7**	0.8	24.4	**8.5**
$\beta^{R,NS-N}$	-3.3	26.3	-0.7	0	3.1	-0.4
$\beta^{M,S-A,S}$	0	0.2	0.1	-0.7	-0.6	-0.8
$\beta^{M,S-A,NS}$	0	0	0	0	-0.1	-0.1
$\beta^{M,S-R,S}$	6.3	-1.2	0	0.7	0.1	0.1
$\beta^{M,S-R,NS}$	0	1.6	0	0	0.6	0
$\beta^{M,S-M,NS}$	0.4	1.6	0.4	0	0.5	0.2
$\beta^{M,S-U}$	-0.9	1.2	-0.1	0.2	0.4	1.5
$\beta^{M,S-N}$	0	-0.4	-0.3	0.1	-0.6	-0.1
$\beta^{M,NS-A,S}$	0	0.2	0	-0.1	-0.3	-0.1
$\beta^{M,NS-A,NS}$	0	0.1	0	0.1	0.1	0
$\beta^{M,NS-R,S}$	1	-0.1	0.1	0.8	0.1	0.1
$\beta^{M,NS-R,NS}$	1.4	-10.4	0	-0.1	-2.2	-0.1
$\beta^{M,NS-M,S}$	0.2	0.7	0.2	0	-0.1	0
$\beta^{M,NS-U}$	-0.7	0.9	**2.8**	0	0.4	**-1.4**
$\beta^{M,NS-N}$	0.1	-0.1	-0.6	0.1	-0.3	-0.1

Table 6: β decomposition of R,S, R,NS and u - 2003-2017 (cont.)

	US			France		
	(1)	(2)	(3)	(4)	(5)	(6)
	R,S	R,NS	u	R,S	R,NS	u
$\beta^{U-A,S}$	-2.2	4.4	**4.8**	-0.1	-0.1	**2.3**
$\beta^{U-A,NS}$	-0.4	0.6	1.4	0.3	0	3.1
$\beta^{U-R,S}$	35.9	4.3	**19.6**	17.6	0.3	**9.2**
$\beta^{U-R,NS}$	3.2	-44.4	**8.2**	0.5	41.4	**21.8**
$\beta^{U-M,S}$	-1.2	2.9	**4.2**	0.1	-0.2	**0**
$\beta^{U-M,NS}$	-2.5	2.7	7.1	-0.2	-0.7	4.6
β^{U-N}	-7.6	7.6	18.1	-1.1	-8.5	17.1
$\beta^{N-A,S}$	0.3	1.3	0.5	-0.5	-0.5	-0.6
$\beta^{N-A,NS}$	-0.2	0.5	0.2	0.2	-0.2	-0.1
$\beta^{N-R,S}$	10.3	-0.6	0.7	2.2	0.8	0
$\beta^{N-R,NS}$	4.1	-21.5	0.6	0.6	14.6	0.6
$\beta^{N-M,S}$	0.1	0.5	0.3	0	0.1	0
$\beta^{N-M,NS}$	-0.1	0.1	0.5	0	0.3	0.4
β^{N-U}	-3.8	4.8	11.3	2.4	14	16.3

such patterns suggest that NS is not a primary driver shaping US unemployment whereas it is in the French case. In both countries, entries and exits from routine jobs explain more than 40% of unemployment dynamics. The novelty of our approach is to underline that the cyclicality of the job polarization process does not involve the same forms of employment on both sides of the Atlantic, especially as the job finding rate is concerned.

Third, with respect to job separations, the overall contribution of job losses is the same in both countries (around 24%), particularly with respect to employment exits from routine standard work (around $\beta^{R,S-U} = 13\%$ in both countries).

Finally, in Table 5, the total contribution of changes in workers' transitions involving manual jobs to unemployment variance is far larger in the US than in France. Table 5 suggests that this is due to US job finding of manual standard jobs ($\beta^{U-M,S}$) and separation from manual non standard employment ($\beta^{M,NS-U}$), that are more responsive to the business cycle than in France.