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ABSTRACT

Extensive and Intensive Margins of Labour Supply: Working Hours in the US, UK and France*

This paper documents the key stylised facts underlying the evolution of labour supply at the extensive and intensive margins in the last forty years in three countries: United-States, United-Kingdom and France. We develop a statistical decomposition that provides bounds on changes at the extensive and intensive margins. This decomposition is also shown to be coherent with the analysis of labour supply elasticities at these margins. We use detailed representative micro-datasets to examine the relative importance of the extensive and intensive margins in explaining the overall changes in total hours worked.

JEL Classification: J21, J22

Keywords: labor supply, employment, hours of work

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1 Introduction

Forty years ago the French and British used to work more than the Americans. They now work less. The aim of this paper is to provide a coherent picture of these changes. To do so we split the overall level of work activity into the number of individuals in work and the intensity of work supplied by those in work. This reflects the distinction between whether to work and how much to work at the individual level and is referred to, respectively, as the extensive and intensive margin of labour supply. At the aggregate level the former is typically measured by the number of individuals in paid employment and the later by the average number of working hours.

The difference between the extensive and intensive margins has been highlighted in recent research attempting to resolve differences between micro and macro responses of labour supply to tax reform. For example, Rogerson & Wallenius (2009), following the work of Prescott (2004), argue that the responsiveness of the extensive margin of labour supply to taxation plays a major role in explaining aggregate differences in total hours worked across countries. They show that an economy with fixed technology costs for firms and an inverted U-shape life-cycle productivity for workers can produce large aggregate extensive labour supply responses driven by movements in employment at either end of the working life. This, they argue, can reconcile the small micro-based elasticities of hours worked with the large responses required if taxes and social security are to explain cross-country differences in total hours of work.

The distinction between the extensive and intensive margins has long been recognised in microeconometric studies of labour supply (Heckman 1993). For example, building on the insights by Gronau (1974) and Heckman (1974, 1979), Cogan (1981) documented the importance of fixed costs of work in separating the link between responses at the employment and hours margin. His study found that earlier estimates of hours of work elasticities at the intensive margin for married women were biased upwards due to the omission of fixed costs. In subsequent empirical analyses the size of the wage elasticities at these two margins has been found to differ significantly by gender, family composition and age (Blundell & Macurdy 1999). Typically the elasticity at the extensive margin has been found to be somewhat larger than the elasticity at the intensive margin. Over time, as labour force participation of women increased, the labour supply elasticities of men and women have, to some extent, converged (Blau & Kahn 2007).

It is not only women with children where the role of the extensive labour supply margin has been found to play a major role in understanding individual and family labour supply

behaviour over the life-cycle. 'Early retirement' behaviour has been found to respond systematically to participation tax rates implicit in social security systems, see for example Gruber and Wise (1999) and papers therein.

The relative size of labour supply responses at the intensive and extensive margin has also been a key parameter in the public economics literature on earnings tax design, see Diamond (1980), Saez (2002) and Laroque (2005). A 'large' extensive elasticity at low earnings can 'turn around' the impact of declining social weights implying a higher transfer to low earning workers than those out of work, in turn providing an argument for lower tax rates at low earnings and a role for earned income tax credits. Participation tax rates (PTR) and effective marginal tax rates (EMTR) at low earnings remain very high in many current tax systems. This is carefully documented in the evidence to the Mirrlees Review, see Brewer et al. (2010) and references therein. In the UK effective marginal tax rates are well over 80% for some low income working families because of phasing-out of means-tested benefits and tax credits.

A related discussion in labour supply elasticities is the time horizon of behavioural responses. Many micro-based studies have focused on weekly hours of work while macro-based analysis look at aggregate measures of annual hours of work. The measure and properties of the extensive (no work at all vs. some positive work during the period) and intensive (average hours supplied by the workers) margins are sensitive to the length of the reference period. Furthermore, the labour elasticities are different when assessed at the steady state or when they incorporate intertemporal substitution effects (Blundell & Macurdy 1999, Chetty et al. 2011).

But what do we know about the importance of these margins for different types of workers? How well does the extensive margin explain changes in total hours over time and across countries? In this paper we provide a detailed decomposition of the evolution of total hours of work into changes at the extensive and intensive margin. We examine three key countries - the US, the UK and France. These three countries stand at the top, middle and bottom, respectively, of Prescott's 2004 table of labour supply flexibility. They are also countries where we can access nationally representative detailed microdata over a long period of time so as to examine the relationship between the extensive and intensive margin across different individual types. We study the forty year period up to 2008. The UK provides an interesting comparison with the polar cases of France and the US. Over this period the UK has adopted many of the same (or similar) tax policies as in the US (Blundell & Hoynes 2004) while, at the same time, it has moved from a dominant position

in the supply of total hours to one lying between the US and France.

This analysis, which complements the results presented in Blundell, Bozio & Laroque (2011*b*), finds that neither margin dominates in explaining changes in total hours worked for these countries, rather the relative importance of the extensive and intensive margin is shown to differ systematically by age, gender and family composition.

Section 2 provides an overview of the changes in aggregate hours worked over the last forty years. Section 3 presents a theoretical framework to decompose the aggregate labour supply elasticity into extensive and intensive sub-elasticities. It applies a statistical framework providing bounds on the empirical measures of the intensive and extensive margins to the case of France, the UK and the US. Section 4 presents detailed description of the labour margins for some specific demographic groups, i.e. the young, the mothers and the older workers. Section 5 concludes.

2 Working Hours in the US, the UK and France

2.1 Definitions and Data

Labour supply is a multi-faceted concept and can cover relatively broad definitions. Our interest is in market work but we shall not equate non-market work with "leisure", as it could include household production and voluntary work. Even if we might like to measure the amount of labour supply accounting for effort and productivity, we concentrate in this paper on a narrower definition of labour, i.e. *time spent in market work*.

There are many different concepts of market work (or hours worked) that have been used in the labour statistics literature: normal hours, hours paid, usual hours or actual hours.[1] Each varies depending whether one includes overtime hours, time traveling to work, meal breaks, holidays, sick leave and many other periods which could be considered paid work or not. In this paper, we use the concept of *actual hours of work*, excluding meal breaks, travel to work, holidays and sick leave, but including short rests at the workplace.

To measure time spent in market work one needs to define a reference period. It is generally the week or the year, but it could equally be a day or a lifetime. The choice of the reference period is important, in particular to define the intensive and extensive margins. In this paper, we use the civil year as the reference period so that we define H_{it} as the total actual hours of market work of individual i in year t. The total actual hours

[1]Most of these concepts have been defined by the October 1962 International Labor Organization (ILO) "Resolution concerning statistics of hours of work". See Fleck (2009) for an overview.

can be decomposed into an extensive and intensive component:

$$H_{it} = p_{it} \times h_{it} \tag{1}$$

We define the *extensive margin* of labour as the fraction p_{it} of the reference period when the individual is employed or self-employed. This definition is different from the more usual one, i.e. whether in or out of the labour market, in two respects. First it relies on the notion of employment, as opposed to positive hours worked, and thus captures the standard notion of the extensive margin as a measure of "participation" to the labour market (Heckman (1974) and Killingsworth (1983)).[2] Second, defining the extensive margin as a fraction of the reference period, as opposed to a dichotomous variable, makes the distinction between extensive and intensive robust to the choice of the reference period.

From (1), it follows that the *intensive margin* of labour, h_{it}, is defined as the total number of hours of work worked in the reference period H_{it} divided by the fraction of the reference period in employment, i.e. by the measure of the extensive margin, p_{it}. This is a measure of the intensity of work when employed. Note that with our definitions periods of employment not worked, like holidays or sick leave, will appear as changes in the intensive margin.

It may be useful to develop a few examples. Consider a worker A who is employed during the entire reference year, working H hours in total during the year. Suppose that she works at a constant rhythm, $H/12$ every month. Her intensive margin is H and her extensive margin is 1. A part-time employee B, who works three quarters of $H/12$ each month, has also 1 as extensive margin but her intensive margin is $3H/4$. Consider now a person C who works at the same rhythm as A between January and June and October-December, while she is unemployed, out of work, not on paid leave, without a work contract in July-September. She works three quarters of the year so her extensive margin is equal to 3/4, while her intensive margin equal H. Thus her total annual hours worked is $3H/4$, equal to that of B, but her intensity of work when employed is similar to A.

The choice of the reference period is nonetheless important to capture movements in the extensive and intensive margins. With the year as reference period, one misses seasonal variations in the intensity of work, for instance in the number of weeks worked per year, or daily variations in the intensity of work, for instance in the number of hours worked per day or in the number of days worked per week. For a given number of hours worked

[2]Note that our measure of the extensive margin of labour does not incorporate the unemployed and should therefore not be equated with standard labour force participation measures.

per year, individuals might have very different timing for these hours. Although we do not focus in this paper on these variations, we provide evidence in appendix B of significant cross-country differences.[3]

The data used in this paper are Labour Force surveys, which are the main source of information for measuring characteristics of labour force participation. More specifically, we use the Enquête Emploi (EE) for France, the Labour Force Survey (LFS) and Family Expenditure Survey (FES) for the UK and the Current Population Survey (CPS) for the US for the period from 1968 to 2008.[4] There are a number of measurement issues but the main attraction of these data is to provide long series of micro-datasets, which provide detailed information, every year, about employment patterns and hours of work, as well as precise demographics like gender, age, education attainment, marital status, number of children etc. No cross-country database is currently available to make these detailed disaggregations.

Questions are comparable across countries as they follow ILO recommendations. We make a very large use of continuous surveys, i.e. surveys which span the entire year and therefore capture seasonal variations in hours worked. Each quarter, we observe individuals from a representative sample in a particular week. We know whether employed and how many hours worked in that week. We average over the year to get the employment and hours of a broad category. For earlier years we have to rely on annual surveys and we make adjustments between the two series.

Before digging deeper into these movements in hours and employment, we should note that whereas the measure of the employment rates across time and countries is considered fairly robust, the measure of annual hours of work is on much less firmer ground, in particular in earlier years. This is largely due to the fact that only annual surveys are available for earlier years which are inadequate to capture seasonal changes in hours worked.

2.2 Trends in Employment and Hours since 1968

Figure 1.A highlights the starting point of our analysis and the key piece of evidence used to motivate the debate on the changing trends in aggregate hours worked across countries. It charts the evolution of the average annual hours of work per individuals aged

[3]On the other hand, the choice of the reference period should not be confused with the choice of units which is inconsequential: a division by 4 (or 52) of a hours/year number mechanically converts it into hours/quarter (or week), and must not be mistaken for a change in the length of the reference period.

[4]Details on measurement issues, on methods used in this paper and comparisons with other sources widely used can be found in our companion paper (Blundell et al. 2011*a*).

16 to 74 from 1968 to 2008.[5] The pattern of total hours per individual shows evidence of a three way split after 1980 in the evolution of total hours across the three countries. However, this simple description of total hours disguises some of the major differences between these three countries.

Changes in total hours represent both the effect of changes at the extensive margin of labour (the employment rate) and at the intensive margin (the actual annual hours of work per person employed or self-employed). Underlying the trends in total hours are two key bifurcations which determine the pattern of employment and hours per worker between France, the UK and the US.

Overall employment rates in the UK and the US have moved somewhat in line with each other showing an increase over this period. Employment rates in France have progressed very differently. Figure 1.B shows a strong decline in employment in France until the mid-1990s with recovery thereafter but leaving a large difference in current employment rates. Note that we are aggregating across all adult men and women aged 16 to 74 in these figures. Later we will document further key differences by gender and age.

Changes in hours per worker tell a different story. Figure 1.C shows the UK and France following each other with strong declines over this period stabilizing somewhat in the 2000s. In contrast, the US has retained a stable pattern of hours per worker over the entire period apart from a dip in the late 1970s and early 1980s.

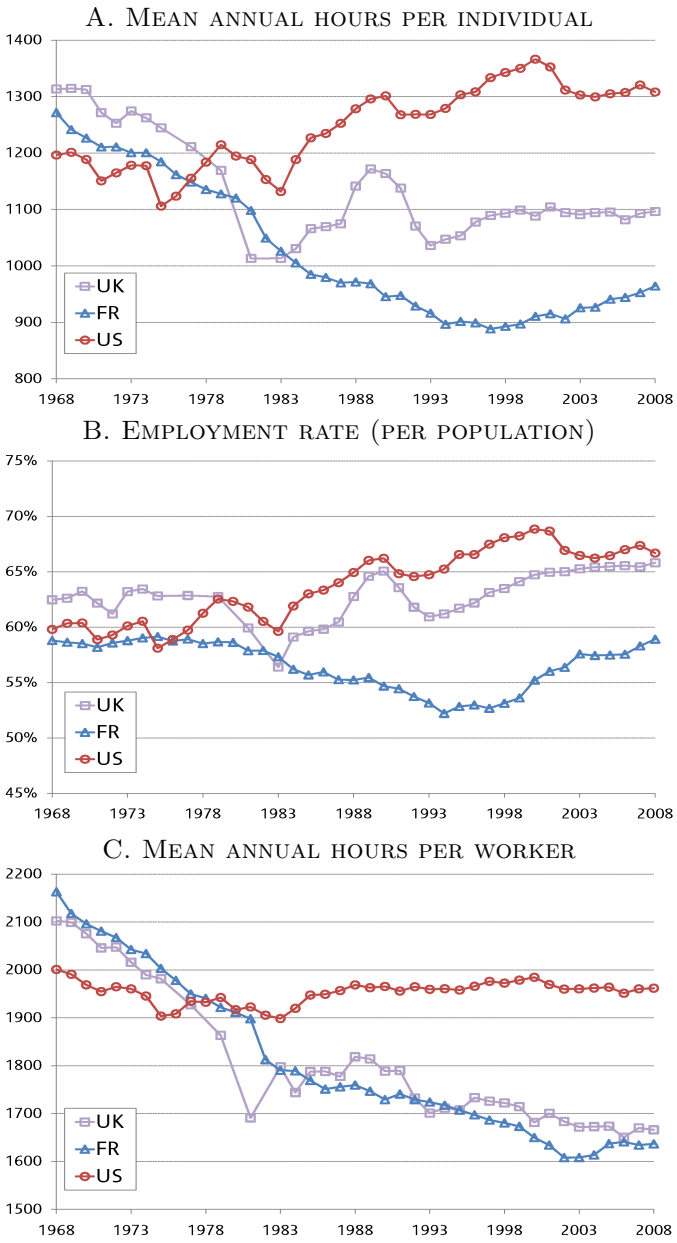
Partly as a reflection of our concerns with the measurement of hours in earlier years and partly due to the major changes occurring after this period, we focus the major part of our remaining analysis on the period since the late 1970s. For this period we are more certain as to the reliability of our data. 1977 is one of the earliest years available for all three labour force surveys and provides a key initial point for our study.

2.3 The Importance of Age and Gender

The trends in hours and employment in Figure 1 tell only part of the story. Much of what is interesting is hidden beneath these aggregate trends. A lot more is learned from the distinction between age and gender. To illustrate these differences we compare two years: 1977 and 2007. The first of these years is before the disjuncture in the series noted in Figure 1 and allows us to use relatively comparable sources across the three countries. The year 2007 is chosen as it is before the impact of the financial crisis was felt in the

[5]Usually the working age population is defined as those aged 16 to 64. We extend this definition to age 74 in order to capture the sizeable increase in the employment rate of 65-74 year old in the US.

Figure 1: Measures of market work for individuals aged 16 to 74 (1968-2008)



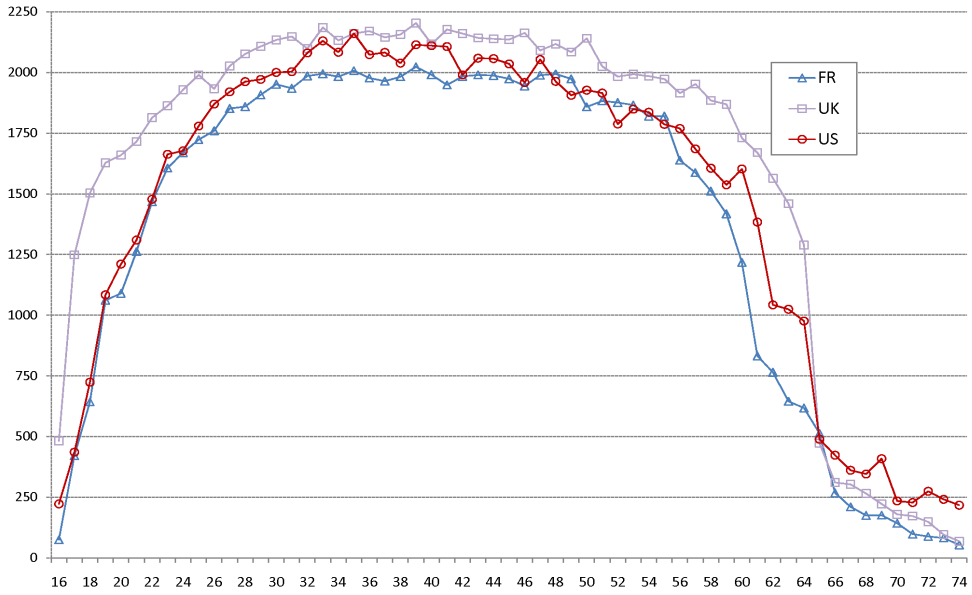
Notes: Annual hours of work are measured using actual weekly hours of work from continuous surveys and averaging over the year. When continuous surveys are not available we use annual surveys making an adjustment to link the series. See Appendix A for details.

Sources: Enquête Emploi, Labour Force Survey, Family Expenditure Survey, Current Population Survey.

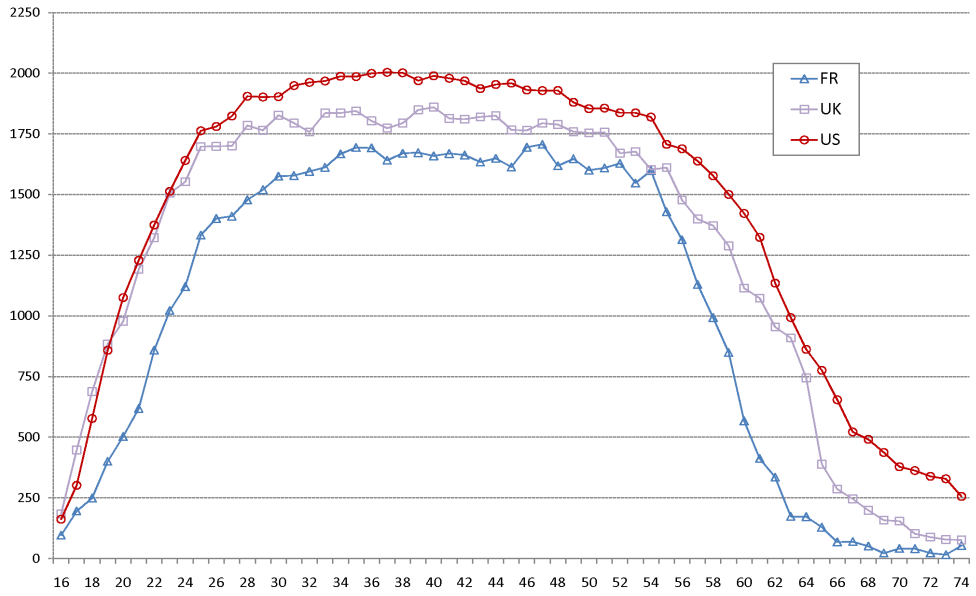
labour market and may reflect labour supply behaviour rather than shorter term business cycle concerns.

Figure 2: Male total hours by age (1977-2007)

A. Male 1977



B. Male 2007

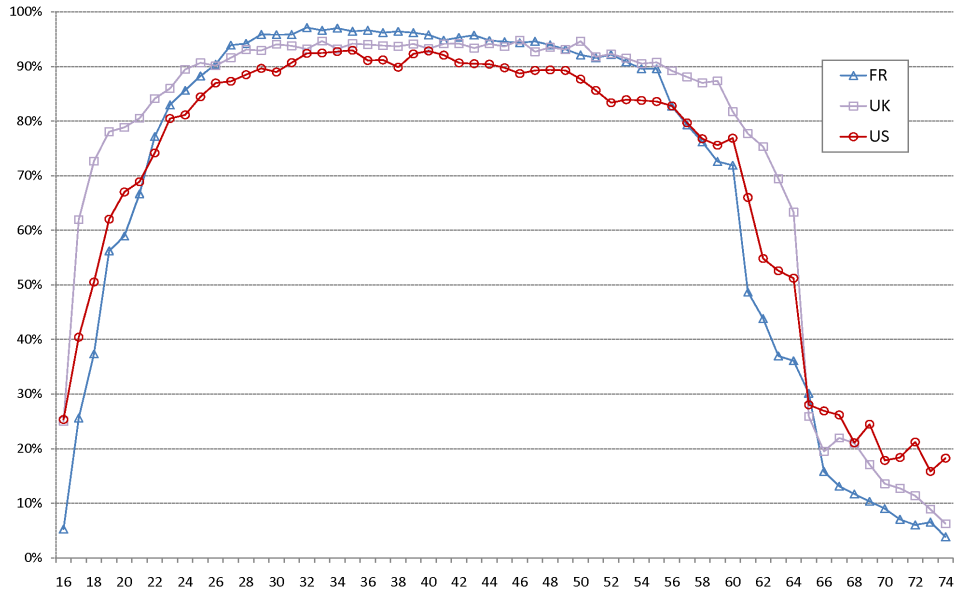


Sources: Enquête Emploi, Labour Force Survey, Current Population Survey.

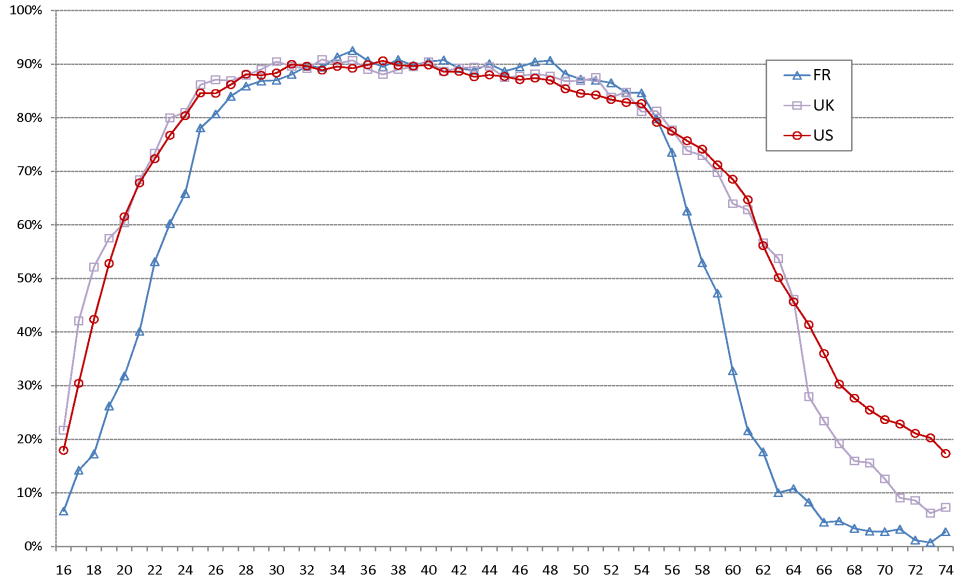
In Figures 2 and 3 we show total hours and the employment rate, respectively, by age for men. The comparison between 1977 and 2007 highlights the interest in decomposing

Figure 3: Male employment rate by age (1977-2007)

A. Male 1977



B. Male 2007



Sources: Enquête Emploi, Labour Force Survey, Current Population Survey.

the changes in labour supply across age groups. In 1977 the employment rates were higher in the two European countries than in the US at most ages (with the exception of France at the very young and older ages), in 2007 the American rate describes the outer envelope. In 1977 the British males distinguish themselves with very higher employment at young

ages (between 16 and 22) and at older age (between 60 and 65). All three countries exhibit strong decline in participation at the age of early eligibility for pensions (60 in France, 65 in the UK and the US).

In 2007, the key differences in average male employment rates between the three countries come exclusively from the young and the old. For males aged 30 to 54, employment rates are almost indistinguishable. Moreover, British and American males have very similar employment rates at all ages up to 65 when the British rate drops markedly. The French drop in employment rate at older age is much earlier with a marked decline as soon as age 55 a further drop before age 60. At age 61 there is a 41-43 points difference in employment rates between French and British or American males. Past age 65, almost no French is working while 20% of American males remain in work at age 73!

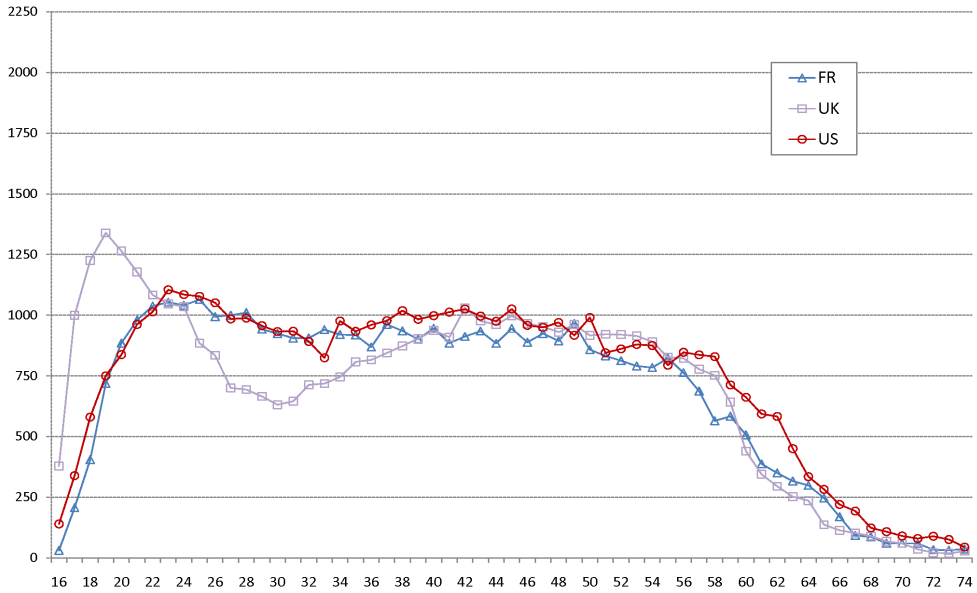
Figures 4 and 5 show the corresponding changes for women. In 1977 women in France and the US hardly differed in their average hours, certainly up to their late 50s. Hours for women in the UK instead showed a distinct 'M' shape, with very high average hours in their late teens and then a strong decline in their early 20s reflecting, as we will see, child birth. By 2007 hours look very different. Women in the US dominate at every age. Women in Britain maintain relatively high hours at younger working ages but the M shape is considerably more smoothed and throughout their 30s, 40s and 50s UK women follow closely the hours of French women.

The employment pattern of females by age has also changed markedly during this period. In 1977, Figure 5.A shows US and French women had similar patterns with UK women again having the strongest M-shape. Employment was high for the very young adult women, then a drop until the early thirties, when women become mothers of young children, then an increase in participation as children age and then the decline in employment at older age, but much earlier than the British males. This M-shape pattern does not appear to be as strong a feature in France or in the US.

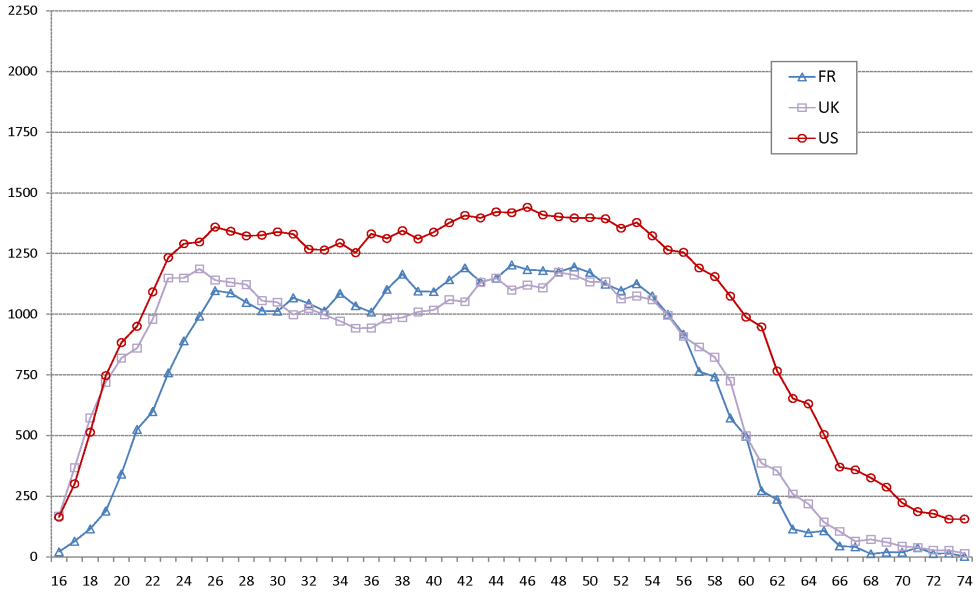
By 2007, female employment rates increased in all three countries. Unlike in the case of total hours, Figure 5.B shows the British 'M' shape has all but disappeared and the age patterns have tended to become closer to the one of males. Employment rates in the three economies are almost identical for women from their late 20s to their mid-50s. At older ages British women show a lower employment rate than those in the US. Note that the state pension age in the UK is 60 for females and 65 for males. In France the lower employment rate of females seems to be almost entirely due to the low participation at young and older ages.

Figure 4: Female total hours per by age groups (1977-2007)

A. Female 1977



B. Female 2007

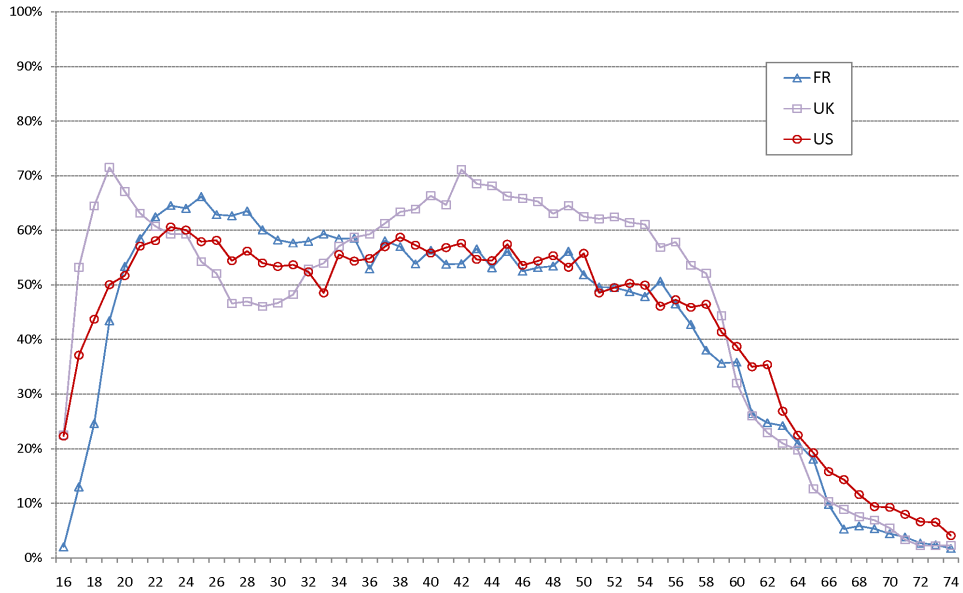


Sources: Enquête Emploi, Labour Force Survey, Current Population Survey.

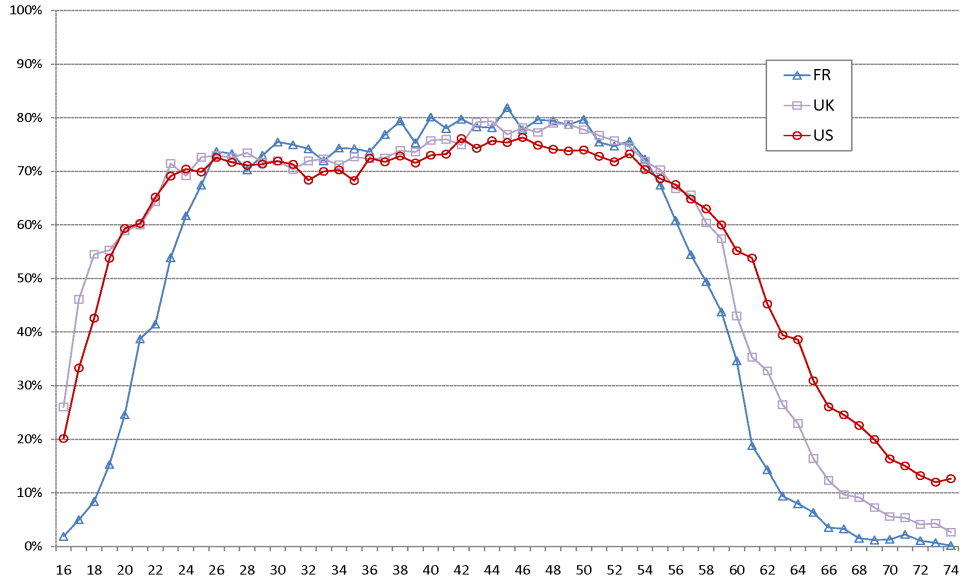
The figures in this section point to important differences at the hours and employment margin by age and gender for each of these countries. But can we be more systematic about these comparisons? In the next section we develop a simple theoretical framework for decomposing responses at the intensive and extensive margin and examining the impact

Figure 5: Female employment rate by age (1977-2007)

A. Female 1977



B. Female 2007



Sources: Enquête Emploi, Labour Force Survey, Current Population Survey.

on the aggregate hours elasticity. We then develop a statistical decomposition that mirrors the theoretical analysis.

3 Elasticities at the Intensive and Extensive Margins

Our aim here is to provide an illustrative theoretical framework to analyze the decomposition of hours responses at the intensive and extensive margins. To do this we consider an economy made of heterogeneous workers choosing between whether to work and how many hours to supply in work. In the application we use more flexible specifications and allow explicitly for observable as well as unobserved heterogeneity.

3.1 Fixed Costs of Work

To capture the main ingredients, different workers face different fixed costs of work and have different tastes for work. The labour supply decision in each period is based on the after-tax wage and the marginal utility of income λ. We assume that the period is short compared with the whole lifetime, so that λ can be considered as given, independent of current labour supply.[6] Preferences are represented as

$$U = \begin{cases} \lambda R(h) + v(T-h,\alpha) - \beta & \text{if } h > 0 \\ \lambda s & \text{if } h = 0, \end{cases}$$

where v is a concave increasing utility index of leisure time, T is total time available, h is labour supply measured in hours, $R(h)$ is the disposable income of someone who works h hours, h positive, s is subsistence income when unemployed and (α, β, λ) are positive parameters. The parameter α describes the marginal (dis)utility of hours worked while β stands for fixed costs of work. The agents also differ according to hourly wages w. It is convenient to describe the distribution of agents' characteristics in the economy through the conditional distribution of fixed costs β given (α, λ, w), $F(\beta|\alpha, \lambda, w)$, and the marginal pdf of (α, λ, w), $g(\alpha, \lambda, w)$.

In this discussion we shall limit ourselves to a fairly simple linear tax and benefit system, $R(h) = r + w(1-\tau)h$. We assume a constant marginal tax rate τ and allow for a possible discontinuity at the origin, subsistence income s possibly being different (larger) than the income r of a worker who supplies little market hours. If an individual works, her preferred number of hours maximizes

$$\lambda w(1-\tau)h + v(T-h,\alpha),$$

[6] This hypothesis is satisfied in a continuous time model, where instantaneous utility is separable in consumption and leisure.

which gives

$$\tilde{h}(\lambda w(1-\tau);\alpha) = T - v'^{-1}(\lambda w(1-\tau),\alpha). \tag{2}$$

She works when the benefit exceeds the fixed cost β, that is when

$$\lambda r + \lambda w(1-\tau)\tilde{h} + v(T-\tilde{h},\alpha) - \beta \geq \lambda s,$$

or

$$\beta \leq \lambda(r-s) + \lambda w(1-\tau)\tilde{h} + v(T-\tilde{h},\alpha),$$

where to lighten notation $\tilde{h}$ stands for $\tilde{h}(\lambda w(1-\tau);\alpha)$ as defined by (2).

From this condition, the employment rate of agents of type (α,λ,w) is

$$\tilde{p}(\lambda, w(1-\tau);\alpha) = F\left(\lambda(r-s) + \lambda w(1-\tau)\tilde{h} + v(T-\tilde{h},\alpha)\right), \tag{3}$$

so that the number of hours worked by type (α,λ,w) agents is

$$\tilde{H}(\lambda w(1-\tau),\alpha) = \tilde{p}(\lambda, w(1-\tau);\alpha)\tilde{h}(\lambda w(1-\tau);\alpha).$$

Hours and employment elasticities follow from standard definitions. From the functional form, the elasticities with respect to wages w or to $(1-\tau)$ are equal, and we shall denote them with the letter ε. We shall use η for the elasticities with respect to subsistence income s. At the intensive margin of labour supply for individuals of type (α,λ,w) the elasticities are :[7]

$$\varepsilon_I(\alpha,\lambda,w) = \frac{\partial \ln(\tilde{h}(\lambda w(1-\tau),\alpha))}{\partial \ln w} = -\frac{1}{\tilde{h}}\frac{v'(T-\tilde{h},\alpha)}{v"(T-\tilde{h},\alpha)},$$

and

$$\eta_I(\alpha,\lambda,w) = \frac{\partial \ln(\tilde{h}(\lambda w(1-\tau),\alpha))}{\partial \ln s} = 0,$$

[7] An often used specification is

$$v(T-h,\alpha) = \frac{(T-h)^{1-1/\alpha}}{1-1/\alpha},$$

for positive α. This yields the intensive elasticity

$$\varepsilon_I(\alpha,\lambda,w) = \frac{T-\tilde{h}}{\tilde{h}}\alpha.$$

whereas at the extensive margin we have:

$$\varepsilon_E(\alpha,\lambda,w)=\frac{\partial\ln(\tilde{p}(\lambda w(1-\tau);\alpha))}{\partial\ln w}=\lambda w\tilde{h}\frac{f(\lambda(r-s)+\lambda w(1-\tau)\tilde{h}+v(T-\tilde{h},\alpha))}{\tilde{p}(\lambda,w(1-\tau);\alpha)},$$

and

$$\eta_E(\alpha,\lambda,w)=\frac{\partial\ln(\tilde{p}(\lambda w(1-\tau);\alpha))}{\partial\ln s}=-\lambda s\frac{f(\lambda(r-s)+\lambda w(1-\tau)\tilde{h}+v(T-\tilde{h},\alpha))}{\tilde{p}(\lambda,w(1-\tau);\alpha)}.$$

3.2 Aggregating Elasticities and the Elasticity of Aggregate Hours

To see how changes in the total hours in the economy relate to these elasticities, first note that the total number $\tilde{H}$ of hours worked is

$$\begin{aligned}H&=\int_w\int_\alpha\int_\lambda\tilde{H}(\lambda w(1-\tau),\alpha)g(\alpha,\lambda,w)\mathrm{d}\alpha\mathrm{d}\lambda\mathrm{d}w\\&=\int_w\int_\alpha\int_\lambda\tilde{p}(\lambda w(1-\tau);\alpha)\tilde{h}(\lambda w(1-\tau);\alpha)g(\alpha,\lambda,w)\mathrm{d}\alpha\mathrm{d}\lambda\mathrm{d}w.\end{aligned}\tag{4}$$

The elasticity of H with respect to $(1-\tau)$ is

$$\begin{aligned}\varepsilon=\frac{\partial\ln H}{\partial\ln(1-\tau)}=\frac{1-\tau}{H}\frac{dH}{d(1-\tau)}=\\\frac{1}{H}\int_w\int_\alpha\int_\lambda\Bigg[\tilde{p}(\lambda w(1-\tau);\alpha)\tilde{h}(\lambda w(1-\tau);\alpha)\frac{1-\tau}{\tilde{h}(\lambda w(1-\tau),\alpha)}\frac{\partial\tilde{h}(\lambda w(1-\tau),\alpha)}{\partial(1-\tau)}\\+\tilde{p}(\lambda w(1-\tau);\alpha)\tilde{h}(\lambda w(1-\tau),\alpha)\frac{1-\tau}{\tilde{p}(\lambda w(1-\tau);\alpha)}\frac{\partial\tilde{p}(\lambda w(1-\tau);\alpha)}{\partial(1-\tau)}\Bigg]g(\alpha,\lambda,w)\mathrm{d}\alpha\mathrm{d}\lambda\mathrm{d}w.\end{aligned}\tag{5}$$

or

$$\varepsilon=\frac{1}{H}\int_w\int_\alpha\int_\lambda\tilde{H}(\lambda w(1-\tau),\alpha)[\varepsilon_I(\alpha,\lambda,w)+\varepsilon_E(\alpha,\lambda,w)]g(\alpha,\lambda,w)\mathrm{d}\alpha\mathrm{d}\lambda\mathrm{d}w.\tag{6}$$

The first term is the contribution of the intensive margin, the second that of the extensive margin, whose elasticities are weighted by the share of type (α,λ,w) labour supply in the aggregate.

A similar computation yields the elasticity of aggregate hours with respect to subsistence income:

$$\eta=\frac{\partial\ln H}{\partial\ln s}=\frac{1}{H}\int_w\int_\alpha\int_\lambda\tilde{H}(\lambda w(1-\tau),\alpha)[\eta_I(\alpha,\lambda,w)+\eta_E(\alpha,\lambda,w)]g(\alpha,\lambda,w)\mathrm{d}\alpha\mathrm{d}\lambda\mathrm{d}w.\tag{7}$$

3.3 Bounds on Changes at the Extensive and Intensive Margins

We are interested in studying how the overall average hours worked H per person varies over time and across countries.[8] Of course, this quantity differs across a person characteristics, age and gender for instance. Suppose there are $j = 1, ..., J$ broad categories. The overall statistic H_t is computed in any year t as an average of the category hours H_{jt} with weights equal to the population shares q_{jt}

$$H_t = \sum_{j=1}^{J} q_{jt} H_{jt}.$$

Evidence from the long history of empirical labour supply studies suggests that measured responses of hours worked at the intensive and extensive margins differ across different categories of workers. Following formula (4) we decompose total hours of work H_{jt} as the product of hours per worker h_{jt} and participation to the labour market p_{j_t}

$$H_{jt} = p_{jt} h_{jt}.$$

When we observe a change in yearly hours worked per person, $H_t - H_{t-1}$, we would like to be able to know how much of the change is due to the intensive or extensive margins. We propose a statistical decomposition: First we define a structural effect S_t due to the change in the composition of the population:

$$S_t = \sum_{j=1}^{J} H_{jt}[q_{jt} - q_{j,t-1}].$$

Then we measure the change due to the behavior of category j, holding the population structure constant as in date $t-1$, as in a Laspeyres index

$$\Delta_{jt} = q_{j,t-1}[H_{jt} - H_{j,t-1}] \tag{8}$$

and the total change across all J categories of workers is simply

$$\Delta_t = \sum_{j=1}^{J} \Delta_{jt} \tag{9}$$

[8] We follow here the decomposition approach outlined in Blundell et al. (2011*b*).

and we have by construction

$$H_t - H_{t-1} = S_t + \Delta_t. \tag{10}$$

There is no obvious way to decompose the change in total hours experienced by category j into the sum of an extensive E_j and an intensive I_j components. It is however natural to suppose that any plausible measure I_j of the intensive margin would have the same sign as the difference of the hours worked per worker[9] at date $t-1$ and t: $\Delta h_j = h_{jt} - h_{j,t-1}$. Assuming linearity, we can then express the change Δ_j as the sum of an intensive component $I_j = p_{Ij}\Delta h_j$ and an extensive component $E_j = h_{Ej}\Delta p_j$. Supposing the fraction p_{Ij} is in the interval $[p_{j,t-1}, p_{jt}]$, we get the intensive bounds

$$I_j \text{ belongs to the interval } [p_{j,t-1}(h_{jt} - h_{j,t-1}), p_{j,t}(h_{jt} - h_{j,t-1})].$$

From the identity $\Delta_{jt} = I_j + E_j$, the extensive bounds are given by

$$E_j \text{ belongs to the interval } [h_{j,t-1}(p_{jt} - p_{j,t-1}), h_{j,t}(p_{jt} - p_{j,t-1})].$$

At the limits, the change in total hours for any category of workers reflecting changes at the intensive margin - hours per worker, and at the extensive margin - employment satisfies two polar exact statistical decompositions:

$$\Delta_{jt} = q_{j,t-1}\left\{[h_{jt} - h_{jt-1}]p_{jt} + [p_{jt} - p_{jt-1}]h_{j_{t-1}}\right\} \tag{11}$$

or

$$\Delta_{jt} = q_{j,t-1}\left\{[h_{jt} - h_{jt-1}]p_{jt-1} + [p_{jt} - p_{jt-1}]h_{jt}\right\} \tag{12}$$

The first term on the right hand side is the intensive margin, weighted in the top formula (11) with the final participation rate (as in a Paasche index) and in the bottom formula (12) with the initial participation rate (as in a Laspeyres index). The second term is the extensive margin (Laspeyres in (11), Paasche in (12)).

In the next section we examine the evolution of h_{jt} and p_{jt} for different age and gender groups. We then use (11) and (12) to provide bounds on the importance of intensive and extensive margins in the evolution of hours worked across these various groups.

Before turning to this we note that the formula in levels relate naturally to the de-

[9]Strictly speaking one might want to treat separately the hours of the workers present at both dates, from those of the workers only working at one of the dates, $t-1$ or t. The computation implicitly assumes that the difference, if any, can be neglected.

composition of the total hours elasticity into its intensive and extensive components as described by (5). Suppose we think of the decomposition (11) for small changes and write

$$\Delta H \simeq \sum_{j=1}^{J} [\Delta h_j p_j + \Delta p_j h_j]$$

This expression can be rewritten in terms of the proportionate changes

$$\frac{\Delta H}{H} \simeq \frac{1}{H} \sum_{j=1}^{J} \left[p_j h_j \frac{\Delta h_j}{h_j} + p_j h_j \frac{\Delta p_j}{p_j} \right]$$

$$= \frac{1}{H} \sum_{j=1}^{J} p_j h_j \left[\frac{\Delta h_j}{h_j} + \frac{\Delta p_j}{p_j} \right]$$

$$= \sum_{j=1}^{J} \frac{H_j}{H} \left[\frac{\Delta h_j}{h_j} + \frac{\Delta p_j}{p_j} \right]$$

corresponding to the terms in the elasticity decomposition formula in (5) and (7) above.

3.4 The Decomposition of Total Hours for the US, UK and France

In our discussion of Figures 2-5 we have seen how an analysis of changes in total hours worked in an economy masks some key variations by age and gender. In this section we apply the approach to the decomposition of total hours for different subgroups of the population developed in the last two sections. We put the decomposition to work to pull together an overall picture of the facts about labour supply changes in the UK, the US and France.

Table 1 decomposes the overall change between 1977 and 2007 by sex and broad age groups. As already mentioned, the three countries have very close number of hours worked per person at the starting year (France: 1148, UK: 1212, US: 1156), but their evolution differs: +165 hours for the US, -118 hours and -195 hours for the UK and France. The lines Δ of Table 1 show the contributions of the categories and the effect of demographic structure, according to equations (8), (9) and (10).

A first remark on these statistics is that the overall country movements, US and France at the extremes with the UK in between, holds for nearly all the categories that we have retained. The contribution to the aggregate of the hours worked by the young and prime

Table 1: Decomposition of the evolution of hours of work between 1977 and 2007 by sex and age groups

	Year	Youth (16-29)		Prime aged (30-54)		Old (55-74)		Residual	All
		Men	Women	Men	Women	Men	Women		(16-74)
FR	1977	1402	871	2010	951	827	367		1148
	2007	858	627	1639	1116	508	344		953
	Δ	-82	-38	-82	36	-36	-3	10	-195
UK	1977	1707	938	2117	873	1107	323		1212
	2007	1219	876	1786	1055	790	385		1094
	Δ	-71	-9	-70	39	-42	10	25	-118
US	1977	1344	835	2018	947	1025	447		1156
	2007	1236	956	1922	1373	1084	754		1321
	Δ	-19	22	-19	90	6	38	46	165

NOTE: Δ are computed following equation (8).
SOURCES: Enquête Emploi, Labour Force Survey, Current Population Survey.

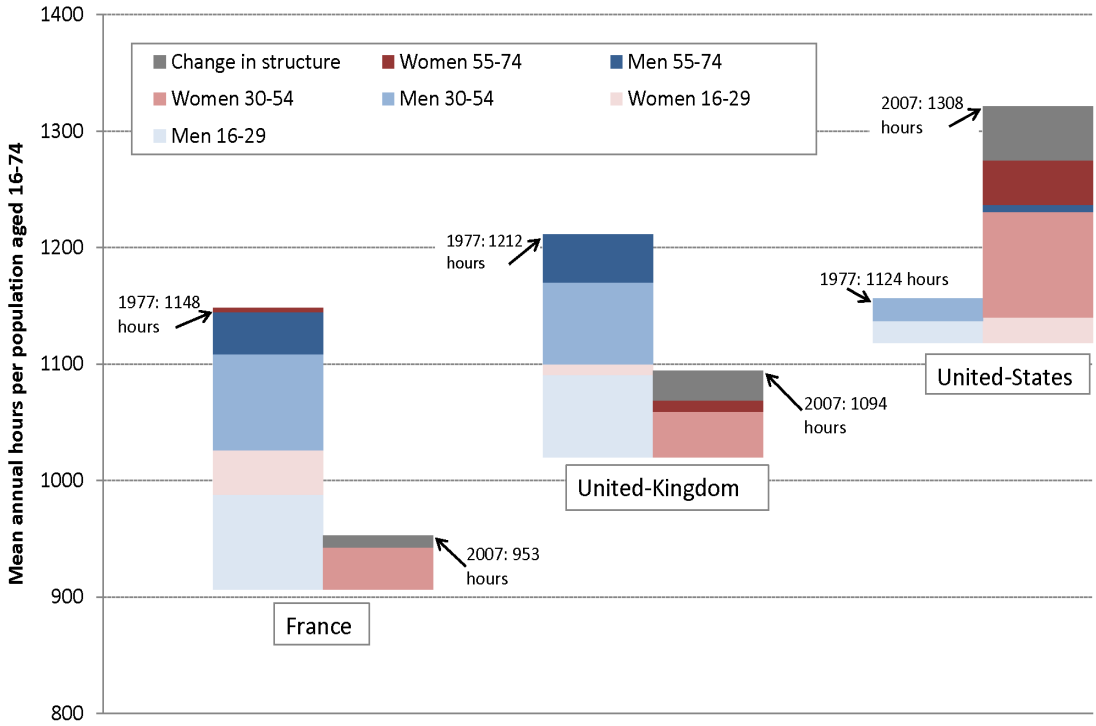
age men is negative in all countries, with a larger decline in France than in the UK than in the US. Table 1 shows a large decline in the number of yearly hours worked by these men in France and the UK: -544 and -488 hours for the French and British young men, -371 and -331 hours for the French and British prime aged men.

A second observation is that the increased participation of women in the labour market works against the general trend. This is particularly obvious for middle aged women who all work more in 2007 than in 1977, but appears also for the old and young women.

The graphical decomposition in Figure 6 serves to illustrate the striking differences across the three economies. The key rise in female hours being so much stronger for all ages in the US, it is sufficient to reverse the correspondingly small declines for men. The change in the structure of the population then plays in the same direction, leaving the US at the top of the figure after a relatively weak start in 1977.

Using the statistical bounds framework developed in the previous section we can go further and examine some key features of these changes at the extensive and intensive margin. This is what we report in Table 2. The indices examine what part of any overall change in hours is attributable to changes at the extensive or intensive margin for any particular subgroup of the population. The row [I-L, I-P] shows the bounds on the intensive margin, L standing for Laspeyres (the change in hours being weighted by the initial participation

Figure 6: Decomposition of the change in total hours per population (1977-2007)



NOTES: Decomposition assumes the population structure unchanged. The residual is attributed to changes in the population structure.

SOURCES: Enquête Emploi, Labour Force Survey, Family Expenditure Survey, Current Population Survey.

rate), P for Paasche (final participation rate). Similarly the Laspeyres index for the extensive margin (E-L) (resp. (E-P)), given by the second term in equation (11) (resp. (12)), is equal to the change in participation multiplied by average hours worked at the initial (resp. final) date. The theoretical discussion in section 3 suggests that the relative importance of these two margins, for any particular subgroup of workers, will depend on the distribution of fixed costs for that group and the proportion of that group in work.

As a concrete example, examine the first entry in the top left of Table 2, French men aged 16-29. The impact on total hours for this group is -82. The I-L index of -37 tells us that the intensive margin does a good bit but not the majority of the work in explaining total hours changes for this group. The E-L estimate of -54 confirms the relative importance of the extensive margin for this group. Again as suggested from our model, and as we might also expect in reality, both margins respond.

Table 2: Decomposition of the evolution of hours of work between 1977 and 2007 by sex and age groups

	Year	Youth (16-29)		Prime aged (30-54)		Old (55-74)		All
		Men	Women	Men	Women	Men	Women	(16-74)
FR	Δ	-82	-38	-82	36	-36	-3	-195
	[I-L, I-P]	[-37,-28]	[-23,-19]	[-59,-56]	[-35,-49]	[-11,-8]	[-9,-10]	[-185,-183]
	[E-L, E-P]	[-54,-45]	[-19,-16]	[-27,-23]	[85,71]	[-28,-25]	[7,6]	[-12,-10]
UK	Δ	-71	-9	-70	39	-42	10	-118
	[I-L, I-P]	[-42,-36]	[-23,-26]	[-48,-45]	[-2,-3]	[-22,-19]	[-6,-8]	[-161,-167]
	[E-L, E-P]	[-35,-29]	[17,14]	[-25,-22]	[41,41]	[-23,-20]	[17,15]	[50,43]
US	Δ	-19	22	-19	90	6	38	165
	[I-L, I-P]	[-6,-6]	[1,1]	[-5,-5]	[14,19]	[3,3]	[3,5]	[15,17]
	[E-L, E-P]	[-13,-13]	[21,21]	[-14,-14]	[72,77]	[3,3]	[33,35]	[148,150]

NOTE: I-P designs the Paasche measure of the intensive margin, I-L the Laspeyre measure, and similarly E-P and E-L designs the Paasche and Laspeyre measure of the extensive margin, as described by equations (11) and (12).
SOURCES: Enquête Emploi, Labour Force Survey, Current Population Survey.

The actual changes for this subgroup, or any other subgroup we examine, will not only have come from changes in taxes, welfare and social security, but from many other changes in the labour market. Nonetheless, the indices in Table 2 give us an indication of where, and for which groups, each of the margins is likely to be important. The theoretical framework also enables us to speculate on what mix of changes to (after-tax) wages, income, fixed costs and benefits in each of the countries could explain the observed changes.

Turning first to prime-age workers, the steep decline at the *intensive* margin for prime aged men in France and the UK relative to the US is striking. For this group the bounds are quite narrow and leave little room for ambiguity. The changes represent an enormous shift in the relative position of these countries. Increases in effective tax rates and/or the regulation of working hours could explain these patterns. However, Britain has seen much less legal hours regulation than France and yet has experienced similar changes.

Income effects could be part of the explanation. There are two potential sources for these. First, as the economy grows individuals may prefer to take some of the gains in real wages in terms of increased leisure, cutting back their hours of work. However, given overall growth has been somewhat similar across all three countries, it would have to

be that Europeans take more leisure in response to rises in income. A second source of income effect for prime age men is the increased participation by women. This is often termed the added-worker effect. Prime-aged women have certainly seen a strong increase in participation. Indeed, the bounds on the extensive margin changes in Table 2 for women aged 30-54 are the largest positive change to be found in any country-age cell and at any margin. But the largest overall increase, when the intensive margin is taken into account, is for US women. Yet the change in hours is the least for US men. Again responses would have to be different in Europe.

Table 2 tells us that the *extensive* margin for prime-age men in Britain and in France also falls more than in the US, although it declines in the US too. Increases in relative employment costs or out of work benefits in France and Britain could be part of the explanation. Also, even at the extensive margin, income effects may play a role as individuals cut back on their overall life-cycle labour supply. However, this seems more likely at either end of the life-cycle rather than during prime-age.

From Table 2, three groups stand apart with respect to their employment patterns: women, the young and the old. As we have noted, for prime age women it is the increase at the extensive margin that is so extraordinary, especially in the US and in France where the bounds in Table 2 suggest a very similar change and one that is nearly twice the size of that experienced in the UK. Intensive margin changes provide somewhat of a puzzle here, falling back strongly in France while growing in the US. Again differences in hours regulation or effective marginal tax rates may explain these changes. However, once again note that the level of hours per worker in France is pretty much identical to that in the UK by 2007. For older men and women there is a large decrease in hours per worker in France, similar in UK, contrasting with an increase in the US. There are falls at the extensive and intensive margins for UK men but increases at the extensive margin for UK women. This surely is linked to the strong increase in participation among younger cohorts of women. This phenomena is replicated to some extent across all countries and offsets the stronger incentives to retire earlier in the UK and in France. The contrast with the US is stark. At all margins and for both genders the bounds point to positive changes for older workers. The changes among the young are sizable and predominantly negative. In France and the UK there are large falls for young men at both the extensive and intensive margin.

In the next section, we delve deeper into the employment and hours patterns of these three key groups: women with children, the young and the older workers.

4 Children, Youth and Older Workers

Here we look successively at the difference in employment and hours for women with children, the employment of the young and finally the participation of the old.

4.1 Women with Children

The dramatic changes in labour market participation by women have been accompanied by major changes to marital status as well as to the age when women have their first child. A detailed discussion of the causes of these trends is outside the scope of this paper. Here we simply point out the relationship between the (extensive and intensive) labour supply of women with children in these three countries. Figure 7 presents the evolution of the extensive and intensive margins for married mothers aged between 20 and 54. Although the rate of increase in female's labour force participation has varied from year to year, the overall trend in employment rates is strikingly similar in all three countries: they have increased from 40% in 1975 to 70% in 2008, with the US leading the way until 2000. The intensive margin, on the other hand, offers a completely different picture. American married women have not only increased their participation, but also their mean annual hours of work, while French women have seen their average hours decline markedly. The UK also stands apart with married women hours of work below those of their French counterpart - 1200 hours versus 1400 hours - but also markedly below the 1800 hours worked on average by American married mothers.

The differences Europe-US could be explained by different factors. The tax and benefit system treats differently earnings from the second earners. In France, the income tax system provides a large incentive to get married, especially when incomes are different between the two spouses, and with joint taxation, discourage additional earnings from the second earner. In the UK, individual taxation was introduced in 1979, and at first view the tax system is more favourable to second earners. However the benefit system is heavily tilted in favour of part-time work - with special rules for jobs less than 16 and 30 hours per week, see Brewer et al. (2010).

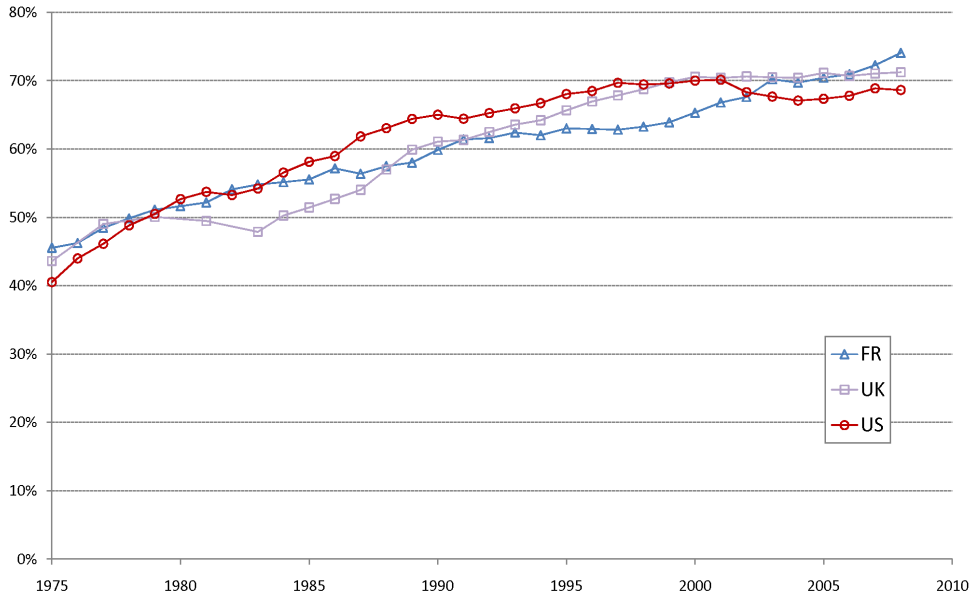
Lone mothers represent another interesting case. Figure 8 presents the extensive and intensive margins of labour supply for 20-54 year-old lone mothers.[10] Contrary to the case of married mothers presented in Figure 7, the employment rate of lone mothers has been markedly different in all three countries. While very similar at the beginning of the period,

[10]Lone mothers are defined as females with children, not married nor cohabiting.

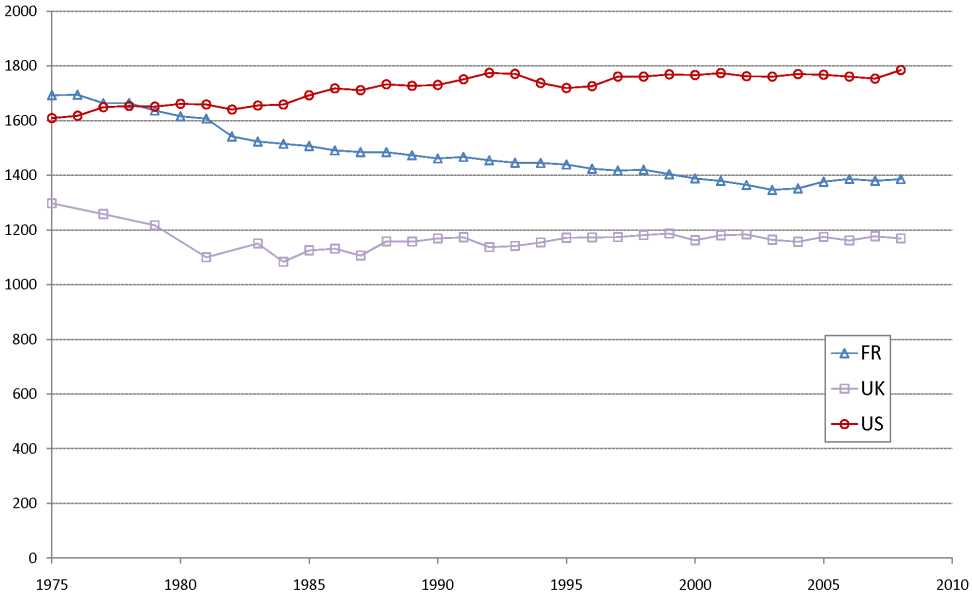
the employment rate of American lone mothers has increased from 60% in the early 1990s to 70% in 2002.

Figure 7: Margins of labour supply for 20-54 year-old married mothers

A. Employment rate



B. Annual hours per worker



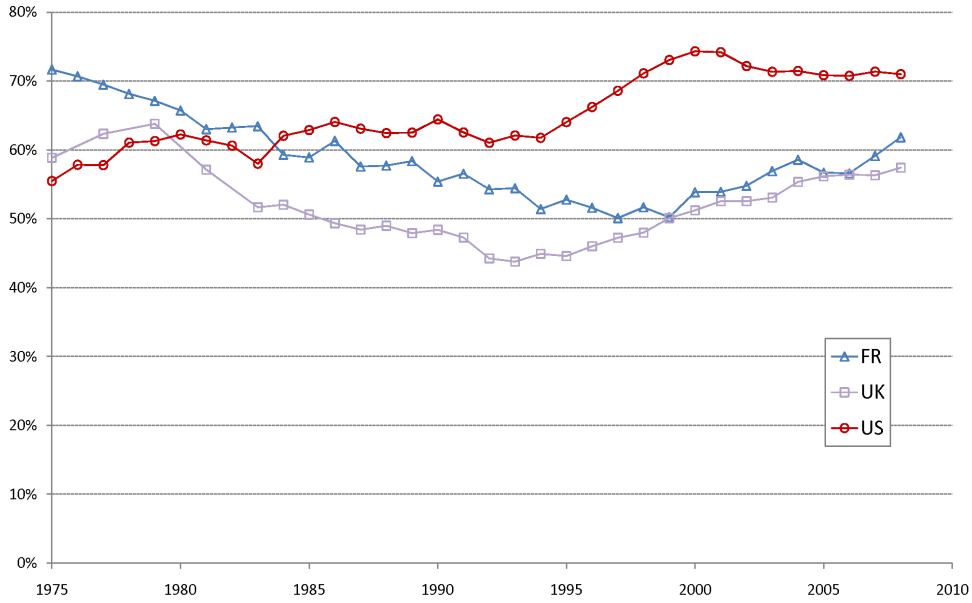
Notes: Lone mothers are defined as females, not married nor cohabiting, with kids.

Sources: Enquête Emploi, Labour Force Survey, Current Population Survey.

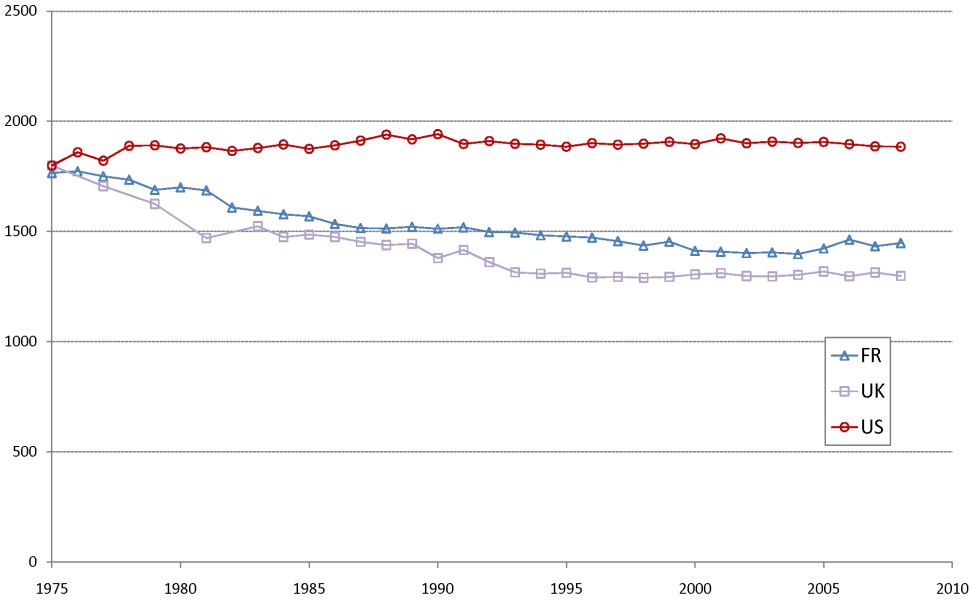
A significant part of this increase has been ascribed in the literature to the develop-

Figure 8: Margins of labour supply for 20-54 year-old lone mothers

A. Employment rate



B. Annual hours per worker



Notes: Lone mothers are defined as females, not married nor cohabiting, with kids.

Sources: Enquête Emploi, Labour Force Survey, Current Population Survey.

ment of the Earned Income Tax Credit (EITC), that became after 1993 the flagship of the workfare policies implemented by the Clinton administration, see Blundell & Hoynes (2004). In the UK, the employment of lone mothers has continued to decline until the late

1990s, when the Working Family Tax Credit (WFTC) similar to the EITC has been put in place by the New Labour government. Comparisons between the UK and the US of these schemes have been carried out carefully and have concluded that at least two third of the increase in participation could be ascribed to these schemes (Blundell & Hoynes (2004)). A scheme similar to the EITC and the WFTC, the Prime pour l'emploi (PPE), was introduced in France in 2001 (Gurgand & Margolis (2008)).

What has been less studied in the literature is the intensive margin of lone mothers. Whereas the large increase in participation in the US has not come along with any change in the intensive margin, mean hours have been regularly falling in France and the UK. No discernable breaks are visible at the time of the introduction of the WFTC or PPE.

4.2 Youth Employment, Unemployment and Education

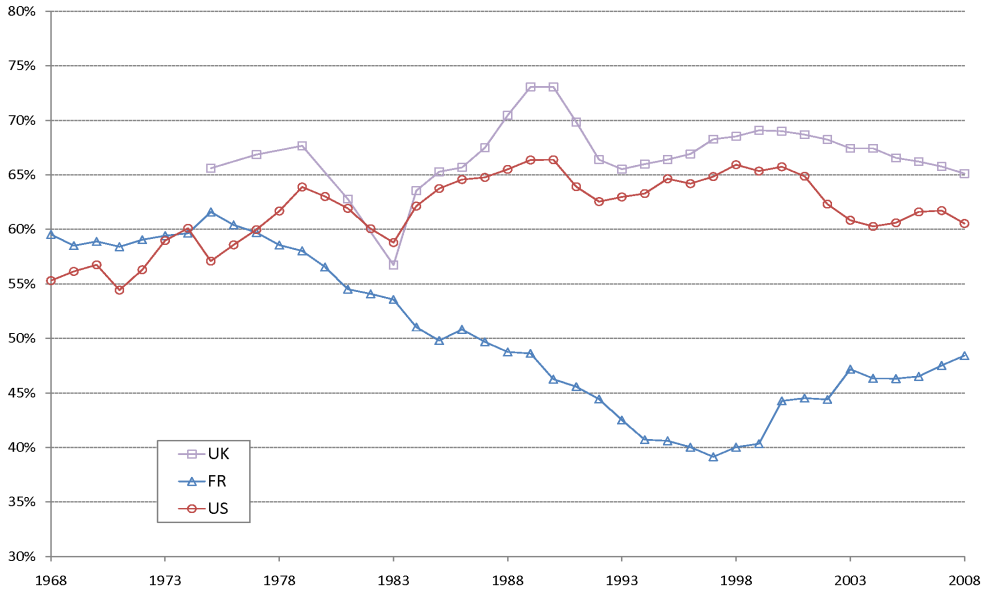
As we saw in Figure 3, one of the striking differences in employment rates between France the UK and the US concerns the youth, aged 16 to 29. Labour force participation at younger ages is complicated by decisions about the amount of market work to provide and the time in education. Depending on tuition costs, outside options in the labour market, returns to human capital investment and other factors, young individuals might decide to join or not in the labour market.

In Figure 9 we present two apparently contradicting pictures, the share of the 16-29 group who is employed and the share who is actively looking for a job. At the end of the period, the employment rate is markedly lower in France than in the US and the UK. Figure 9.B plots a non-employment rate, whose definition differs from ILO unemployment in that we use total instead of active population for the denominator. In all three countries, non-employment increased in the 1970s, peaked between 1983 and 1984, and then decreased more or less slowly. The level remains lower in the US than in both the UK and France, but the difference represents only 2-3% of the entire population.

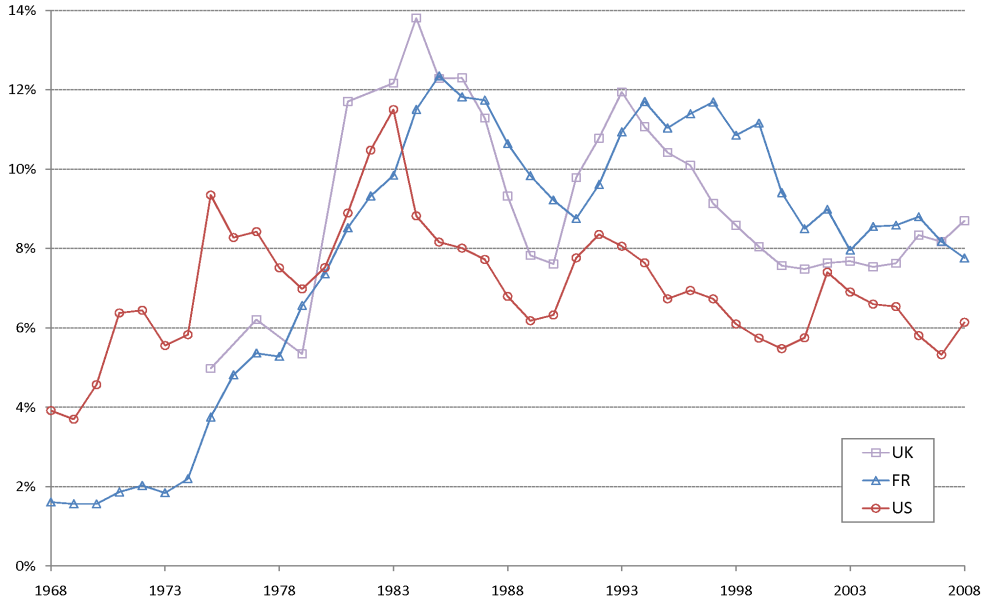
Most of the difference in the non-employment rates comes from the share of 16-29 year-old who are in education and training but not in work. Figure 10 shows the proportion of this age group who is in education or training (panel A) and the proportion in education and training but not in work (panel B). Both figures highlight the large increase in the proportion of young individuals following some form of education. At the end of the period, 45% of young French aged 16 to 29 are in education versus slightly less than 40% in the UK and the US. More strikingly, young French who are studying are generally not working, whereas young Britons and Americans are much more likely to be both working and in

Figure 9: Share of the 16-29 population in work or looking for work

A. In work



B. Looking for work

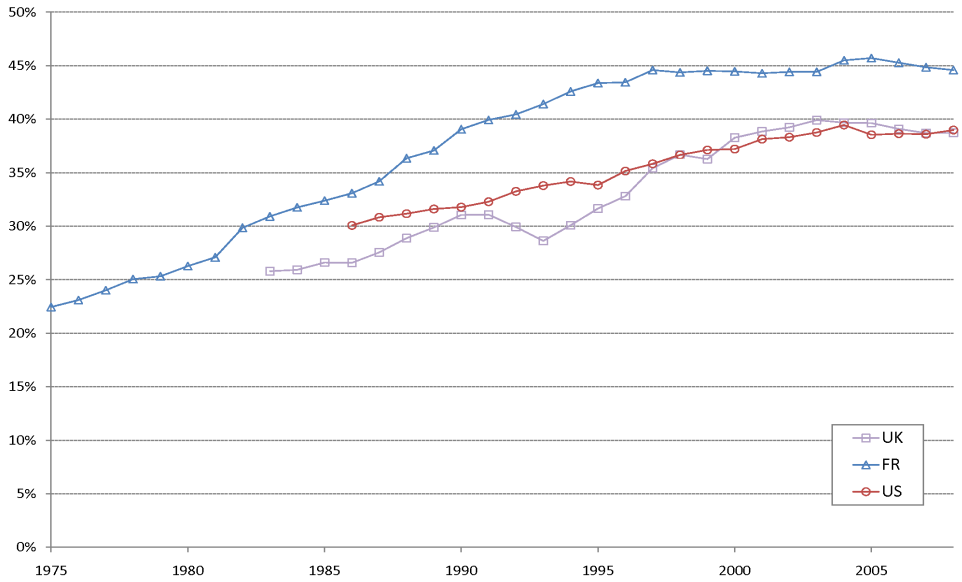


Sources: Enquête Emploi, Labour Force Survey, Current Population Survey.
Note: Individuals looking actively for work are unemployed, in comformity with the ILO unemployment criteria. The difference with the official unemployment rate is the use of total population as denominator and not active population.

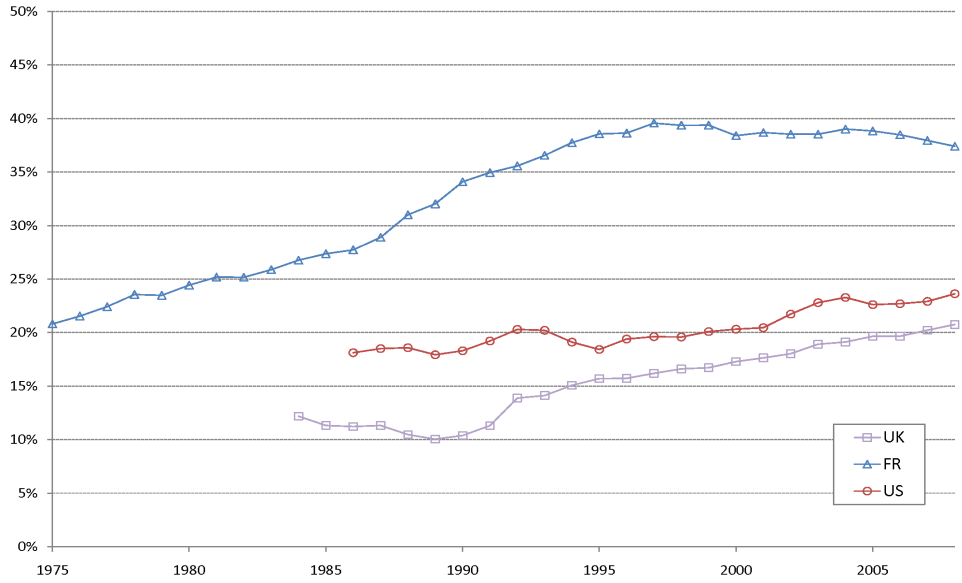
education.

Figure 10: Education and training for the 16-29 years old

A. In education or training



B. In education or training but not in work



Sources: Enquête Emploi, Labour Force Survey, Current Population Survey.

4.3 Older Workers, Pensions and Increasing Life Expectancy

Another group for which the extensive margin differs markedly between the three countries is the older workers. Figure 11 presents the employment rate by age between 50 and 74 at ten years interval. In 1977 the employment rates of older workers in the three countries are not too dissimilar. French workers experienced a drop of employment at age 55, when retirement was first available for certain public sector groups (police, nurses, teachers etc.) and again at age 60 when the rest of the public sector and some private sector workers (women with three children, early retirement schemes) were entitled to a full pension.

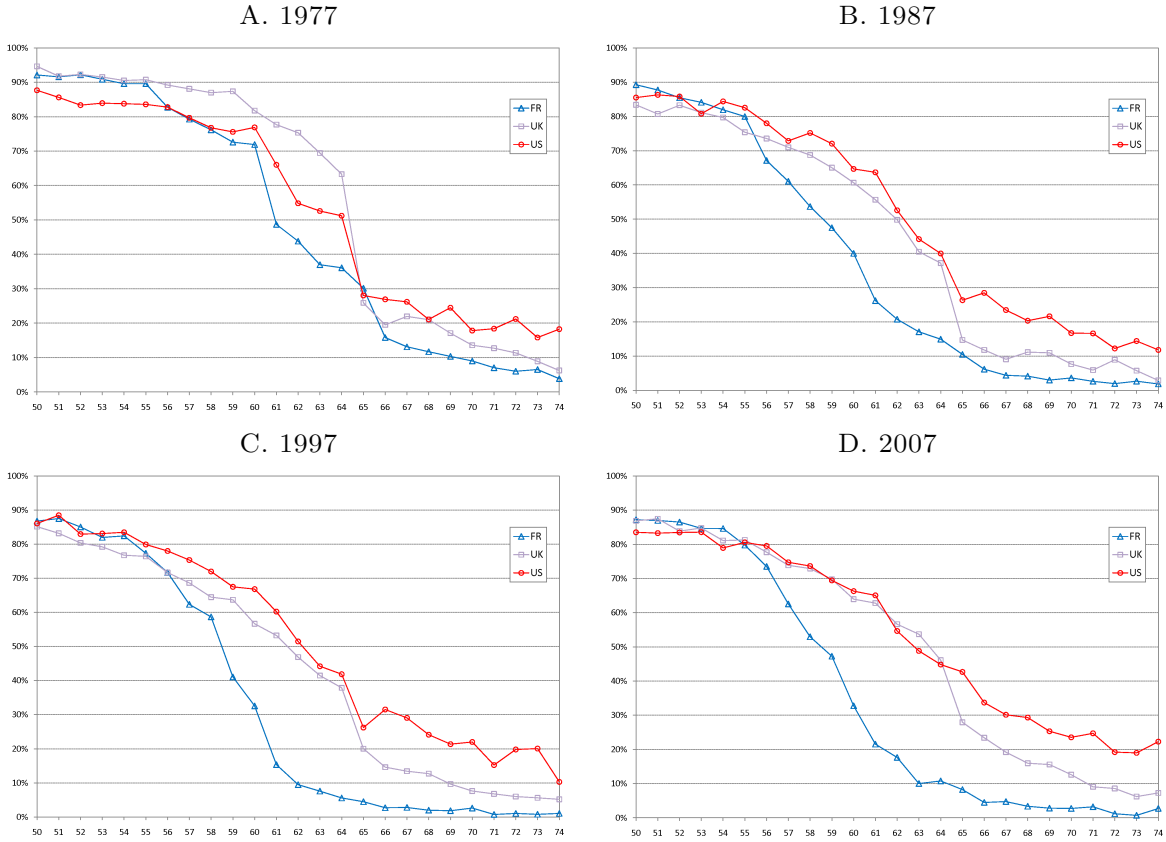
At age 65, both the UK and US experience a large drop corresponding to the eligibility to State pensions and Social Security benefits. After age 65, the American workers stand out with much higher participation compared to their European counterparts. In 1987 all countries have experienced a drop in employment rates at older ages but France stands out with a much more pronounced decrease. In 1979 and 1980, early retirement policies have been expanded in France to a large group of 60-64 year-old. In 1981 these early retirement schemes have been extended to the 54-59 group and in 1983 the main scheme of the private sector has offered a full pension from 60 to those meeting the contribution length requirement. In 1987 French male employment rate at age 61 drops to 30 percentage points below the level of the UK and the US and by 2007 the difference reaches 41 percentage points.

The British and American males have very similar employment rates at older ages up to age 65 when the British experience a more important drop than the Americans. Incentives to retire are largely influenced by pension and social security provisions. In the UK the State Pension age has been fixed for men at 65 and occupational pension plans have often used that age for full entitlement. In the US, Social Security offers since 1961 an early retirement age at 62 while full entitlement is determined by the normal retirement age, at age 65 for those born before 1938. In Figure 11 it is clear that the US curve bends at two points, at age 62 and 65, when the Social Security system provides an incentive to retire.

One interesting element of these comparisons is the difference at very old ages, i.e. between 65 and 74, between Americans on the one hand and British and French on the other hand. While today more than 20% of American males are working at 74, only 7% of British male do and not even 3% of French males are still attached to the labour market.

In Figure 12 we present similar graphs for females. One striking feature is that British females tend to have retirement patterns much closer to their French counterparts than the American ones. Even though the British women have higher participation rates than the

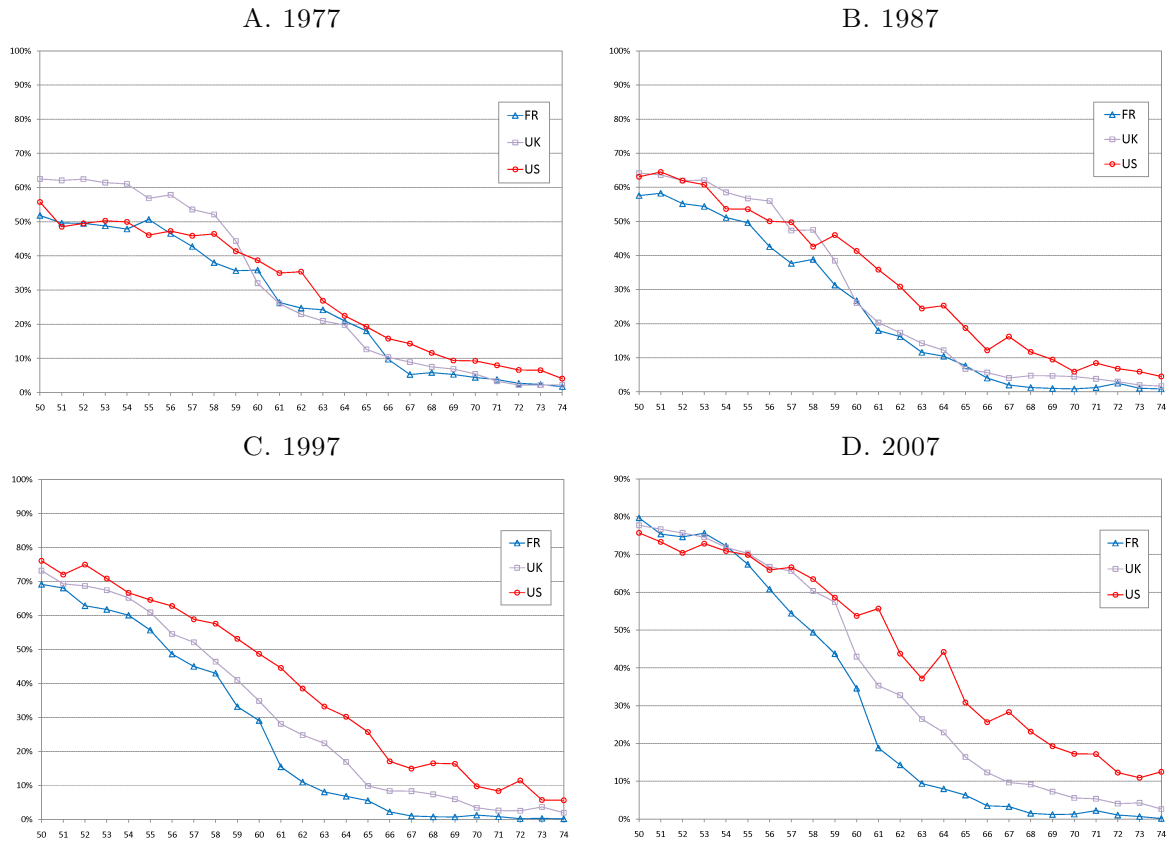
Figure 11: Male employment rate at older age



SOURCES: Enquête Emploi, Labour Force Survey, Current Population Survey.

French in their 50s, they tend to retire significantly at 60, when they can receive the Basic State Pension in full. The picture has slightly evolved in the last 10 years, when British females have experienced increased participation at all ages, while the French females, like their male counterparts, exhibit a significant drop in participation at 55 and 60.

Figure 12: Female employment rate at older age



SOURCES: Enquête Emploi, Labour Force Survey, Current Population Survey.

5 Conclusions

In this paper we have proposed a systematic way of examining the importance of the extensive and the intensive margins of labour supply in explaining the overall movements in total hours of work over time. We have shown how informative bounds can be developed on each of these margins. We have applied this analysis to the evolution of hours of work in the US, the UK and France over the past 40 years. We have shown that the extensive and intensive margins both matter in explaining changes in total hours.

The analysis has highlighted some key differences in behaviour at the intensive and extensive margins. For example, the overall trend in employment rates for women is strikingly similar and has almost doubled in all three countries. The intensive margin, on the other hand, offers a completely different picture. American married women have not only increased their participation, but also their mean annual hours of work, while French women have seen their average hours decline markedly. The UK also stands apart with married women hours of work below those of their French counterpart but also markedly below the hours worked on average by American married mothers.

The contribution to the aggregate of the hours worked by the young and prime age men is negative in all countries, with a larger decline in France than in the UK than in the US. The steep decline at the intensive margin for prime aged men in France and the UK relative to the US is striking. For this group the bounds are quite narrow and leave little room for ambiguity. These changes represent an enormous shift in the relative position of these countries. The extensive margin for prime-age men in Britain and in France also falls more than in the US, although there are declines in the US too.

The changes among the young are sizable and predominantly negative. In France and the UK there are large falls for young men at both the extensive and intensive margins. In France this is associated with a much higher recorded unemployment rate for youth than in the US. When we delve deeper into the employment patterns of the young, this appears to be related to differences in the relationship between education and work across the countries.

For older men and women there is a large decrease in hours per worker in France, similar in UK, contrasting with an increase in the US. There are falls at the extensive and intensive margin for UK men but increases at the extensive margin for UK women. The contrast with the US is stark. At all margins and for both genders the bounds point to positive changes for older workers.

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