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ABSTRACT

The Evolution of Hours Worked and the Gender Wage Gap: Theory and Evidence from Four Countries

We consider the contribution of the intensive margin of labor supply (hours worked above zero) to the gender wage gap across four economies (Germany, France, US, UK) over a long time-horizon. We first build a model in which firms offer two wage contracts – one that pays a fixed wage but allows workers to choose their preferred number of hours up to "full time", and a second in which wages are relative to imperfectly observable productivity but hours can be limitless. The former includes part- and full-time work, while the latter represents a class of workers who often must supply very long hours but who can then earn potentially unlimited remuneration. We then apply a Oaxaca decomposition for part-, full-, and over-time workers to observe the relative contribution of sorting and remuneration across these hours "regimes" over time and across countries. Through this, we show that while female employment in over-time work increased and the gender wage decreased, this was not driven by increasing selection but rather by a decrease in the unexplained portion of the wage gap over time. We conclude by considering the contribution of unions and labor market flexibility to these cross-country differences.

JEL Classification: J01, J16, J31

Keywords: labor supply, gender wage gap, over-time work, Oaxaca decomposition

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1 Introduction

In the broad literature on gender gaps in the economy, the contribution of hours worked at the intensive margin has often been in the background, in favor of a focus on the extensive margin of women's labor supply, residual gender wage gaps among workers, or a combination of the two (see Blau and Kahn, 2017, for an overview). However, recent work has begun to consider the implications of labor supply at the intensive margin on both the shape of the overall earnings distribution and on gender disparities in wages and earnings (e.g. Cortes and Pan, 2017; Bick et al., 2022; Erosa et al., 2022).

A key feature of this work is the non-linear relationship between hours worked and hourly wages, in particular above the standard benchmark for full-time work (e.g. 40 hours per week in the US). In the following, we extend this line of inquiry in a cross-country framework over nearly 30 years covering four Western economies – the US, UK, France and Germany – that are characterized by different labour market institutions and different labour market participation rates over time.[1] To do so, we begin by developing a model of labor supply in an economy where employers offer dual wage contracts. One contract is a "fixed" hourly wage for part- or full-time work, where workers can choose their preferred number of hours up to the standard full-time hours regime. The second requires workers to commit to working above the standard number of hours, what we call the "reference point," a feature employers use to elicit workers' "type." Consider for example the many professional occupations (finance, law, consulting) in which workers are often expected to supply a high number of hours; for women, who bear a disproportionate share of domestic work, this results in a much sharper tradeoff, as in Cortés and Pan (2019).

To illustrate, in Figure 1 we depict the distribution of hours and wages across these four countries pooled over all years. These figures provide three pieces of information. First, the blue bars plot the share of all workers working each number of hours. From this we observe differences across countries in the existence of a reference point in hours. France (which undertook a policy change in the definition of full-time work from 39 to 36 hours in 1999) and the US exhibit a strong "reference point" at 39 and 40 hours per week, respectively. Germany and the UK lack this feature, with far more dispersed distributions of hours worked.[2]

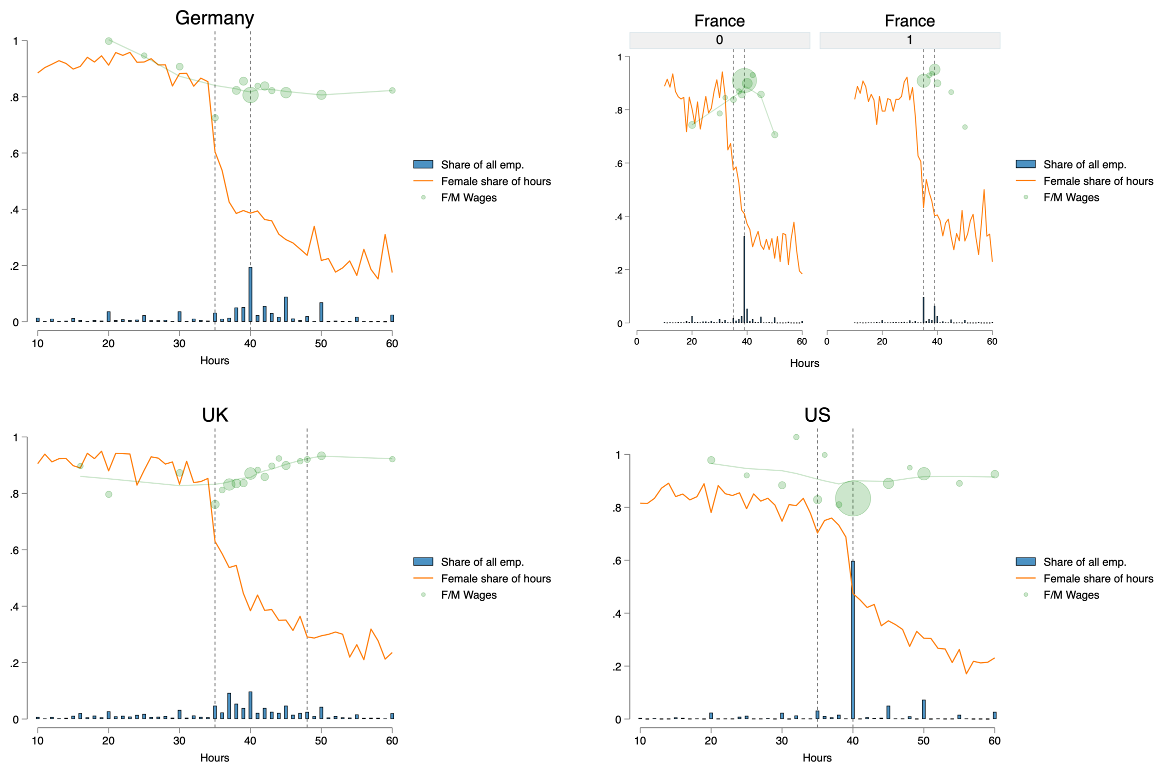
The second piece of information is the orange line overlaying each figure, which plots the share of workers at each set of hours who are female. This is the most, if not only, consistent pattern across all locations – part-time work is dominated by female workers, while over-time work is male dominated. In the US, at the reference point (40 hours) roughly half of workers are female. In the remaining three countries that share is only slightly lower.

The third piece of information is depicted by the green circles that plot the female/male wage gap where the size of the circle is proportional to the share of all workers who supply that number of hours (equivalent to the blue bars). Here is where patterns diverge considerably. In the US, the wage gap is *largest* among workers at the reference point – women's wages are more comparable to men's, in raw means, among part-time and over-time workers. In France, the other economy featuring a strong reference point, precisely the opposite pattern emerges – female/male wage parity is closest to 1 among full-time workers and is farther from parity as one moves away from the reference region

[1] In the following we often refer to four "countries" for parsimony, though we recognize that the UK features more than one country.

[2] The strong concentration of hours in US using CPS data has already been noticed by Bick et al. (2022), in contrast to other countries. While self-reported hours contribute to mass-points, they do not fully account for the fact that in the US, and to a lesser degree France, a large share of workers are concentrated at the modal number of hours. In the US, nearly 60% of workers work 40 hours, before France's policy change the share was about 50%. In the UK and Germany, about 15 and 20 percent of workers are at the mode.

Figure 1: Hours worked and wage gap, by gender and country



Notes: Each sub-figure plots three pieces of information. (1) The blue bars show the share of all workers supplying each number of hours, where 60 is 60 or more hours; these sum to 1. (2) The orange line plots the share of workers at each number of hours who are female. And (3), the green circles and fitted line (lowess) plots the gender hourly wage gap (female wages ÷ male wages) at each number of hours, limited to hours in which 1 percent or more of workers were in that bin; circle sizes represent the relative share of workers at that number of hours corresponding to the blue bars. Vertical dotted gray lines indicate statutory "full-time" work ranges in each country

in either direction (part-time or over-time work). In Germany, the wage gap is increasing in hours worked, while in the UK the reverse is true. In the following we consider what factors contribute to these seemingly divergent relationships over a long time horizon.

One potential explanation for cross-country differences is changes in the correlation between hours and wages. Checchi et al. (2022) show that the covariance between hours and wages changed dramatically over time in these countries, especially in Germany and France where elasticities for women (and for men in the case of Germany) change from negative to positive, while in the US and to a lesser degree the UK the relationship remained relatively stable over time. A positive elasticity reinforces the dispersion of hours, since it positively contributes to earnings inequality: better-paid workers tend to work longer hours.

In the following we construct a model where employers offer wage contracts meant to induce sorting among workers with heterogeneity in productivity and preferences of leisure. In countries with a strong "reference point," potentially employers can use that feature to their advantage. Given prior work has demonstrated higher elasticities for women than for men (e.g. Checchi et al. (2022)) one might expect that sorting will have differential patterns for male and female workers. To that end, our empirical exercises decompose the gender wage gap across these four economies over time, paying particular attention to the share of the gender wage gap that is due to observable characteristics in order to understand sorting, both across countries and over time. The key innovation here is that we do this separately for workers working part-, full-, and more than full-time, as elasticities may change over the distribution of hours, as noted by Bick et al. (2022)).

We show that the share of more than full-time workers who are female has steadily increased in all economies other than Germany, while the wage gap for more than full-time workers has declined over the same period, in particular in Germany. Possibly surprisingly, this was largely due to decreases in the unexplained wage gap (i.e. assuming men and women had the same observable characteristics), rather than due to changes in composition. The share of full-time workers who are female did not increase over the same period, with some exception for France. Yet the wage gap declined here as well, again dominated by a decrease in the unexplained component of the wage gap. Together these suggest that selection is a contributing, though not driving, force of the declining wage gap over this long time horizon. We conclude by considering labor market institutions, in particular the role unions might play.

While one of our contributions is a cross-country perspective over many years, this comes with limitations. First, we are limited by creating harmonized measures across countries, as more detailed or additional measures in one country would bias cross-country Oaxaca decompositions by providing more information in one case and not another. This is particularly salient for occupation and industry of employment. Second, we are limited in what we can say about labor market institutions, which certainly play a role, as we lack measures of individual union membership or the availability of parental leave. We do discuss their potential contribution though. Finally, we focus on the intensive margin and the decision to work more than the standard number of hours in particular, which has received less attention in the literature until recently.

The paper is organized as follows. The next section reviews the recent literature on hours and gender gap. Section 3 proposes a model to study the distribution of hours supplied with heterogeneous workers. Section 4 describes the data, our empirical framework and results. Section 5 concludes.

2 Background

Since the gender gap represents one of the driver of earning inequality, in the present paper we focus on the relationship between wages and hours over the distribution of worked hours, in order to understand whether working longer hours may be detrimental or beneficial to the observed wage gap. In order to include adequate variety of institutional settings, we benchmark the US experience against three European countries for which individual data on earnings and hours exist for a sufficiently long time span. While UK exhibits a flexible labour market with similarities with the US pattern, France and Germany are characterized by a more regulated environment and lower female participation. It is therefore interesting to explore similarities and differences across countries and years, to identify potential drivers to gender equality.

Bick et al. (2018) provide a cross-country review of the distribution of hours and wages in which they show that in most countries hours worked per worker decrease with wages, though in the richest countries hours worked are flat or increasing in the wage. They argue that both at the country level (macro-elasticities) and at the individual level (micro-elasticities) the change from a negative to a positive covariance between hours and wages may be a fundamental feature of the development process.[3] Bick et al. (2022) abandon the comparative perspective and focus on hours worked among US males exploring the relationship between hours and wages at different points in the distribution. Apart from acknowledging the concentration of a large mass of probability around 40 (usual) hours

[3]The magnitude difference between country-level elasticity (extensive margin) and within-country across individual elasticities (intensive margin) is discussed in Chetty et al. (2011).

a week, they argue that mean hourly wages are non-monotonic across the distribution, with a peak at 50 hours. They argue that the concentration at 40 hours is likely created by decreasing marginal productivity of worked hours combined with coordination needs in production.

In their overview of the US gender wage gap, Blau and Kahn (2017) highlight that hours worked is a potential explanation for the gender gap. While Bick et al. (2022) ignore the female component, Cortés and Pan address females' supply of hours across several papers. In Cortés and Pan (2016), they examine the relationship between demand for long hours (which they term "overwork", proxied by the share of men working 50 or more hours per week) and skilled women's occupational choice. Using data from the US, they find that the prevalence of long hours in an occupation significantly lowers the share of young, married, college-educated women with children working in that occupation, suggesting that long hours reduce the desirability of the work for women who bear a disproportionate share of family responsibilities. Cortes and Pan (2017) extends the analysis to a cross-section of 17 countries observed in 2010. Again they find that young, married women's labor force participation falls relative to non-married women's as male overwork increases. They frame this in terms of a "time bind" created by high demands both at home and on the job. In their analysis, cross-country norms and institutions can play a role, for example in high-income countries where some occupations *de facto* require long hours, yet the presence of institutions such as paid parental leave fail to meaningfully limit the relationship. In Cortés and Pan (2019) those authors provide evidence that a reluctance of skilled women to enter occupations that disproportionately reward overwork is associated to the intra-household division of labor since the availability of low-skilled migrant women is correlated with the female share in those occupations. However, Erosa et al. (2022) question the empirical claim that the gender wage gap is largest in those occupations with the highest return to working longer hours, raising doubts that equalizing the distribution of hours between genders would cancel the wage gender gap.

In a previous paper, Checchi et al. (2022), we demonstrate that differences in worked hours meaningfully contribute to earnings inequality, in particular among women. Using the same data we use here (US, UK, France, and Germany over the period 1991-2016) we find that, other than in the US, intensive hours inequality is an important contributor to inequality, and that it has increased over the period under analysis (see Appendix A2 for plots of hors elasticity by gender). In fact, the elasticity of hours with respect to wages plays a key role, shifting from negative to positive in in the two continental economies. We also examine potential factors behind the change in elasticity, in particular the role of trade and labour market institutions, the latter of which we explore here as well.

Several relevant papers focus on the German case, for instance Biewen and Plötze (2019) and Beckmannshagen and Schröder (2022), both of whom apply a variance decomposition on different datasets, each showing that the primary driver of increasing earnings inequality over the past decades is the change in working hours. The first paper, based on German Structure of Earning Survey (SES), focuses on compositional effects by considering person and firm characteristics. The second uses data on desired working time from the German Socio-Economic Panel (GSOEP), documenting that much of the change has been driven by the underemployment of low-wage workers (mainly women and young people) who are in involuntary part-time work and unable to realize their preferred volume of working hours.[4]

[4]Both papers rely on the assumption that workers have some bargaining power in choosing their desired number of hours. In a different perspective and using administrative data, Bossler and Schank (2023) argue that the minimum wage was introduced in Germany in 2015 to balance the impossibility of low-wage workers to increase their worked hours: "We argue that monthly income (combining hourly wages and hours worked) is the more relevant outcome from an individual's perspective because workers do not freely choose their hours of work (because of constraints in labor demand or restrictions in the family context)." (p.3)

Concerning the US, Fernández-Val et al. (2024) propose a model where hours and wages are simultaneously determined, yielding a decomposition of earnings inequality attributable to compositional changes, structural changes, and hours effects. Using the Current Population Survey for the survey years 1976–2019, they find that changes in the female distribution of annual hours of work are important in explaining movements in inequality in female annual earnings. Movements in the male hours' distribution only affect the lower part of their earnings distribution and reflect seasonal fluctuations. Yet, we also note that Denning et al. (2022) argue that hours differences explain little of the gender wage gap in the US, even though men work more hours than women on average. However, when controlling for differences across occupations (in terms of average desired hours and/or task accomplished), results change and show that, for American women, working longer hours reduces the gender gap.[5] Over almost 40 years (from 1980 to 2016), they show that the gender gap in hours fell by 7 percentage points, while the same gap in hourly wages declined by 25 percentage points.

Taken together, the existing literature is largely inconclusive on the relationship between hours worked, in particular long hours, wages, and the wage or earnings gap between men and women. Across countries the picture becomes even murkier. Our paper draws on these results, offering a cross-country perspective over a long horizon. We add to this, and to earlier work, a model that incorporates the notion of *de facto* long hours requirements for singalling the ambition to career advancement, which can have a strong effect on female workers who face the "time bind" generated by an expectation of long hours at home as well. Hence our data and model are designed to bridge and extend the literatures described here.

3 Theoretical Framework

In order to obtain theoretical expectations of the relationship between worked hours and hourly wages, we provide a simple model of the labour market where heterogeneous workers supply variable amounts of hours to a given number of firms producing commodities in a competitive market. A linear production technology allows for full employment at all available hours, while imperfect observability of individual productivity allows for alternative interplay of wages and hours.

3.1 Supply

We start by introducing individual heterogeneity in preferences, where α captures preference for leisure and/or disutility of effort, and σ measures individual hourly productivity. Following Bick et al. (2022), workers' preferences depend on consumption and leisure, with decreasing marginal utility of consumption and increasing marginal disutility of worked hours, corresponding to $0 < \beta < 1$, where concavity with respect to consumption and convexity with respect to labour ensure that the worker will supply a limited amount of hours, for preferences defined by:

$$U(c_i, h_i) = \frac{(w_i h_i)^\beta}{\beta} - \alpha_i \frac{h_i^{(1+\beta)}}{(1+\beta)} \quad \text{s.t.} \;\; c_i = w_i h_i \tag{1}$$

The budget constraint, $c_i = w_i h_i$, includes individual consumption, c_i , hours worked, h_i, compensated at individual-specific wage w_i, with prices normalized to one. From this we obtain the optimal

[5] "Our analysis establishes two key facts: 1) The relationship between hours worked and wages at the individual level is consistently small; and 2) the relationship between hours worked and wages at the occupation level is substantively larger." (Denning et al., 2022) p. 1324).

supply of hours, h_i^*, from first order condition:

$$\frac{dU}{dh_i} = w_i^{\beta} h_i^{\beta-1} - \alpha_i h_i^{\beta} = 0 \tag{2}$$
$$h_i^* = \frac{w_i^{\beta}}{\alpha_i}$$

Hours worked decline with increasing disutility of work (α) and increase with individual wage rate, w_i. If the individual wage rate is positively correlated with individual productivity, then individuals spontaneously working longer hours are those with lower cost for effort and/or higher productivity. Likewise, holding α and σ constant, worked hours are increasing with hourly wage elasticity, β.[6]

3.2 Production technology

3.2.1 Full observability of worker productivity

On the firm side, we assume linear production technology. y_j indicates the output of firm j employing a total of n_j workers. σ_i is the hourly productivity of worker i as above, and h_i is his or her hours worked. From this, we describe technology as:

$$y_j = \sum_{i=1}^{n_j} A\sigma_i h_i \tag{3}$$

where A is a scale factor. Under full observability of individual productivity and perfect competition in wage and output prices, the market for labor clears and employers earn zero profits. In such a case the hourly wage rate corresponds to individual hourly productivity:

$$w_i = A\sigma_i \tag{4}$$

In case of imperfect competition in the output market, we can assume workers receive a share of profits, either via collective bargaining and/or employee profit sharing, and we can write:

$$w_i = (1-\gamma)A\sigma_i \tag{5}$$

where γ is the is the profit share in total revenues. Firm profits are then given by:

$$\pi_j = y_j - \sum_{i=1}^{n_j} w_i h_i = \sum_{i=1}^{n_j} A\sigma_i h_i - \sum_{i=1}^{n_j}(1-\gamma)A\sigma_i h_i = \sum_{i=1}^{n_j} \gamma A\sigma_i h_i \tag{6}$$

which is increasing in individual productivity, σ_i, and in hours worked, h_i, which are offered in greater amount by individuals with lower cost of effort. Thus employers prefer hiring workers with high σ and low α. Under perfect observability they are clearly identified, and they are sequentially hired.[7] However, given perfect competition, all workers in the labor market are hired, and anyone willing to work finds employment opportunities and can work their preferred amount of hours. As a

[6] One could consider a third dimension of heterogeneity, in terms of the wage elasticity β_i, that governs the slope of the indifference curves: $\frac{\partial c}{\partial h} = \frac{\frac{\partial U}{\partial h}}{\frac{\partial U}{\partial c}} = \frac{\alpha h^{\beta}}{c^{\beta-1}} = \alpha c(\frac{h}{c})^{\beta}$. But this renders the model excessively complicated when considering the case of imperfect information to follow.

[7] We abstract here from coordination in production, which is discussed in Denning et al. (2022). If there were present, we should add a cost from deviating from reference hours, yielding as a result that the employers would demand fixed amount of hours irrespective of the preferred amount by the workers.

consequence, the volume of worked hours is supply determined.[8]

Replacing equation 5 (wages) into equation 2 (hours) we obtain:

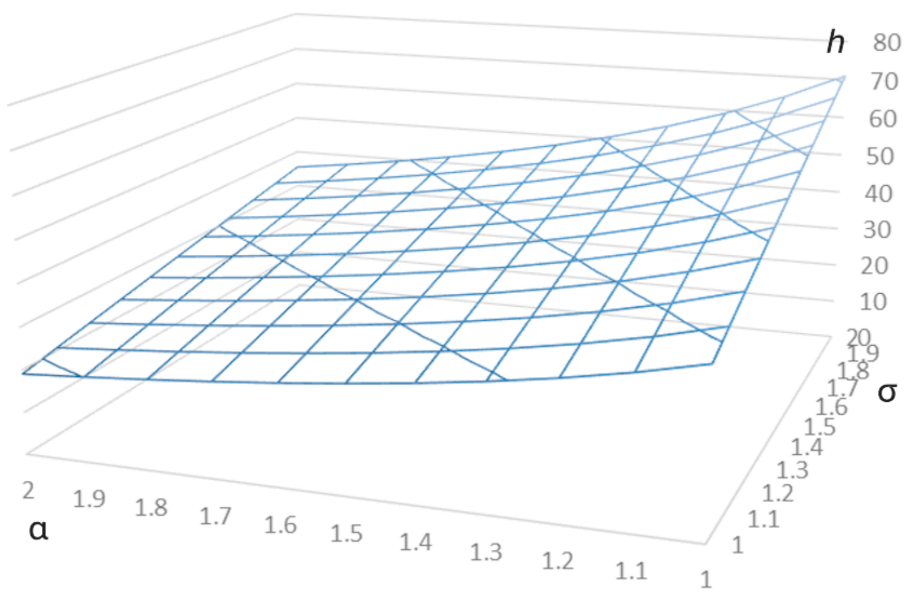
$$h_i^* = \frac{w_i^\beta}{\alpha_i} = \frac{[(1-\gamma)A\sigma_i]^\beta}{\alpha_i} \tag{7}$$

It is important to note that the potential to choose to work longer hours in this formulation does not help employers reveal individual preferences or productivity since the two pieces of information are combined into the optimal supply. Thus employers cannot detect whether a worker willing to work longer hours is more productive, dislikes leisure, or some combination of the two. The desired amount of worked hours negatively affects all individual utilities (as it is easily seen from Equation 2) but does not provide additional information. To see this, we can define iso-hours as a combination of (α, σ) yielding a constant level of desired hours $\bar{h}$, we obtain concave profiles defined by:

$$\alpha_i = \frac{[(1-\gamma)A\sigma_i]^\beta}{\bar{h}} \tag{8}$$

which implies that we may observe two individuals optimally supplying the same amount of hours where one is highly productive with a high distaste for work (for example a woman) while the other is less productivity but has a lower distaste for work (for example a man). This combination corresponds to the level curves in the surface depicted in Figure 2.

Figure 2: Optimal supply of hours



Notes: Figure plots simulated supply of hours (vertical axis) assuming parameters β (elasticity) = 0.8 and common productivity scalar A=80.

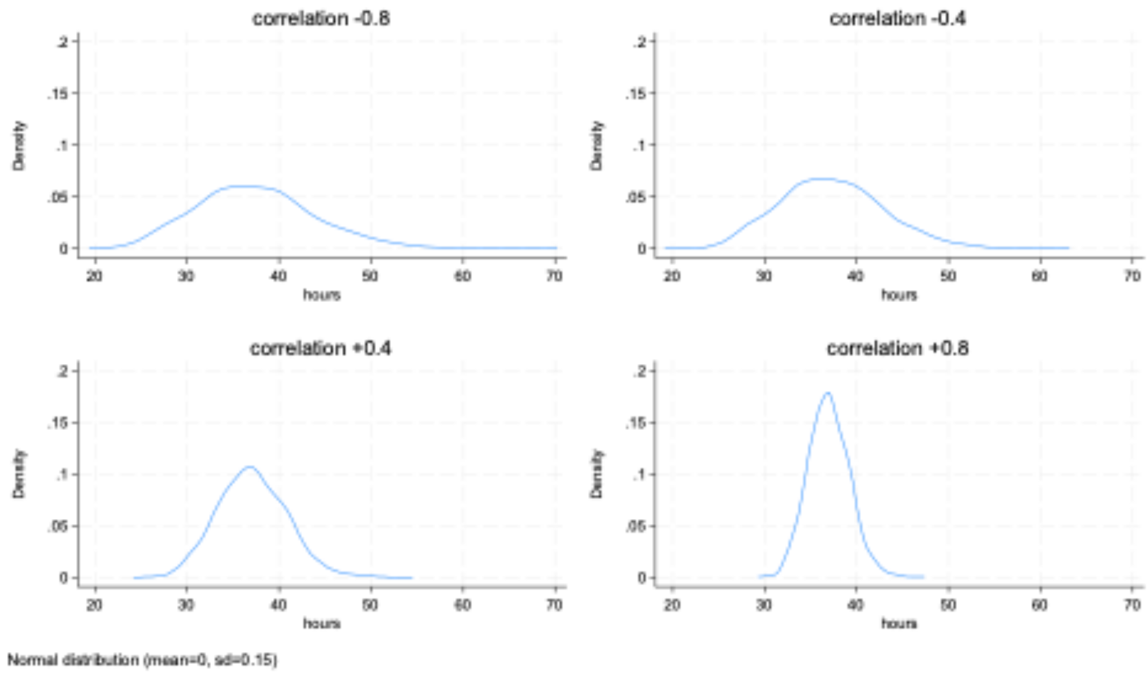
Under perfect observability, the observed distribution of hours depends on both the distribution of (α, σ) in the population *and* on the covariance between the two. If they are negatively correlated (where more productive individuals have a weaker distaste for work), the distribution of hours is more dispersed.[9] On the contrary, if they are positively correlated the distribution of hours is more

[8]In this framework extensive and intensive margins cannot be separated, since everyone will supply a minimum amount of hours.

[9]Bick et al. (2022) estimate a correlation between the two parameters equal to –0.33, which in the present case

concentrated. By simulating 1000 individuals with α and σ distributed on the interval $[1, 2]$, and varying the extent of correlation between α and σ, we obtain Figure 3 which shows the relationship between the described parameters.[10]

Figure 3: Simulated population supply of hours and the covariance between α and σ



Notes: Figure plots simulated supply of hours depending on the correlation (sign and magnitude) between individual productivity (σ) and preference for leisure/distaste for labor (α).

If one removes the assumption of perfect observability of worker taste and productivity, then more productive workers have an incentive to signal their productivity. However, this signal is confounded by heterogeneous preferences for work and leisure. We next consider two cases where (partial) information revelation on the part of workers is possible.

3.2.2 Eliciting worker types via a reference point with prior beliefs

In the first case employers offer a constant hourly wage corresponding to the average productivity of all workers. This case is observationally equivalent to the case of a union setting a single wage.

$$\bar{w} = (1-\gamma)A\bar{\sigma}, \quad \bar{\sigma} = E[\sigma] \tag{9}$$

would produce a rather dispersed distribution of hours. However they impose a non-linear earning function, where the number of workable hours is determined by technology.

[10]We have also explored the sensitivity of the distribution to changes in other parameters, and in particular the hours elasticity to wages β, finding that lower values of β are associated to more concentrated distribution. This is consistent with the transition of Germany from a more dispersed distribution to a more concentrated one, since the hour elasticity has been rising, especially for the female component. It is also consistent with France exhibiting a more concentrated distribution than Germany; and similarly when comparing US with UK (see Checchi et al. 2022). In addition, changing the shape of the distribution matters: assuming normal rather than uniform distribution leads to amore concentrated dispersion of intended hours.

Now firms' (expected) profits depend only on hours worked from an average worker hired in the market:

$$\bar{\pi}_j = E\left[y_j - \sum_{i=1}^{n_j} \bar{w} h_i\right] = E\left[\sum_{i=1}^{n_j} A(\gamma\bar{\sigma} + (\sigma_i - \bar{\sigma}))h_i\right] = n_j \gamma A \bar{\sigma} \bar{h} \tag{10}$$

Employers now have an incentive to hire more productive and/or low preference for leisure workers as they increase profits. Without information available, it is impossible to identify them in the market. Given a constant hourly wage, the worker's optimal choice will only reflect the preference for leisure and the wage elasticity parameter β in supply equation $h_i^* = \frac{\bar{w}^\beta}{\alpha_i}$.

In case of uniform distribution of $\alpha \sim U[\underline{\alpha}, \overline{\alpha}]$, then

$$E[h^*] = E\left[\frac{\bar{w}^\beta}{\alpha}\right] = \bar{w}^\beta \frac{\ln(\overline{\alpha}) - \ln(\underline{\alpha})}{\overline{\alpha} - \underline{\alpha}}. \tag{11}$$

In the extreme case of elasticity β close to zero (observationally typical for males, especially in recent years), the distribution of hours will only reflect the distribution of cost of effort, α. In general, men would work longer hours than women due to their lower preference for leisure resulting from unequal non-market work; in addition, the distribution of women's hours would be more dispersed than the distribution of men's as the elasticity of the former is empirically higher than the elasticity of the latter. Since profits are increasing in worked hours, employers will prefer hiring men rather than women exploiting the inequality.

Workers do not have incentives to artificially vary their supply of hours from their preferred supply as they would deviate without any gain in terms of a higher hourly wage. However, employers may possess *a priori* information about the covariance between preferences and productivity. For instance, if employers believe the correlation between α and σ is negative, as a consequence the availability of working longer hours would act as a joint signal of higher productivity and/or lower cost of effort.[11] Employers can then offer two wage contracts: (1) a constant hourly wage (as in Equation 9), or (2) an hourly wage that increases with worked hours supplied above some threshold $\bar{h}$:

$$w = \bar{w}\left(\frac{h}{\bar{h}}\right)^\delta \tag{12}$$

The threshold, $\bar{h}$, is a reference point, for example corresponding to the average hours offered by the average worker at the average level of productivity:

$$\bar{h} = \frac{((1-\gamma)A\bar{\sigma})^\beta}{\bar{\alpha}}. \tag{13}$$

The best response function of the worker would then be obtained from her indirect utility under the two alternative wage offers. Under the constant hourly wage one obtains,

$$h_i^* = \frac{\bar{w}^\beta}{\alpha_i} \;\rightarrow\; V(\alpha_i) = \frac{(\bar{w}h_i^*)^\beta}{\beta} - \alpha_i \frac{(h_i^*)^{1+\beta}}{1+\beta} = \frac{\bar{w}^{(1+\beta)\beta}}{\alpha_i^\beta \beta} - \frac{\bar{w}^{(1+\beta)\beta}}{\alpha_i^\beta(1+\beta)} = \frac{\bar{w}^{(1+\beta)\beta}}{\alpha_i^\beta(1+\beta)\beta} = \frac{M}{\alpha_i^\beta} \tag{14}$$

[11] In principle one could also consider the case of positive correlation between α and σ. In such a case workers with greater preference for leisure would also be more productive, and therefore to attract them one should offer a hourly wage declining with worked hours, which is contrary to most of the empirical evidence on overpay.

while under a variable hourly wage one obtains,

$$h_i^* = \left[\frac{\left(\frac{\bar{w}(1+\delta)}{\bar{h}^\delta}\right)^\beta}{\alpha_i}\right]^{\frac{1}{1-\delta\beta}} = \left[\frac{\bar{\bar{w}}^\beta}{\alpha_i}\right]^{\frac{1}{1-\delta\beta}}, \quad \bar{\bar{w}} = \left(\frac{\bar{w}(1+\delta)}{\bar{h}^\delta}\right) \tag{15}$$

Here hours supplied under the variable hourly wage contract is more elastic and more responsive to work distaste. Replacing equation 15 into the utility function yields,

$$\begin{aligned} V'(\alpha_i) &= \frac{\left(\frac{\bar{\bar{w}}}{1+\delta} h_i^{*\delta} h_i^*\right)^\beta}{\beta} - \alpha_i \frac{h_i^{*1+\beta}}{1+\beta} \\ &= \left(\frac{\bar{\bar{w}}}{1+\delta}\right)^\beta h_i^{*(1+\delta)\beta} \left[\frac{1}{\beta} - \alpha_i \frac{h_i^{*1-\delta\beta}}{(1+\beta)} \left(\frac{1+\delta}{\bar{\bar{w}}}\right)^\beta\right] \\ &= \frac{\bar{\bar{w}}^{\frac{(1+\beta)\beta}{1-\delta\beta}}}{\alpha_i^{\frac{(1+\delta)\beta}{1-\delta\beta}}(1+\delta)^\beta} \left[\frac{1+\beta-\delta\beta}{(1+\beta)\beta}\right] \\ &= \frac{M'}{\alpha_i^{\frac{(1+\delta)\beta}{1-\delta\beta}}} \end{aligned} \tag{16}$$

We can therefore identify an individual who is indifferent between a constant and a variable hourly wage, i.e. $V(\alpha^*) = V'(\alpha^*)$:

$$\alpha^* = \left(\frac{M'}{M}\right)^{\frac{1-\delta\beta}{(1-\beta)(1+\delta\beta)}} = \alpha(\underset{+}{\bar{w}}, \underset{-}{\bar{h}}) \tag{17}$$

All workers with $\alpha_i < \alpha^*$ will choose a variable wage and will work beyond the standard hours $\bar{h}$, while workers with $\alpha_i > \alpha^*$ will work their preferred amount of hours, with indifference at equality. Notice that the partitioning of the worker population varies according to the proposed wage and the reference hours.

3.2.3 Eliciting worker types via a reference point without prior beliefs

We now move to a second case, where employers do not have *a priori* information but rather observe a noisy signal of true hourly productivity:

$$y_i = A\sigma_i + \varepsilon_i, \quad \varepsilon \sim (0, \zeta) \tag{18}$$

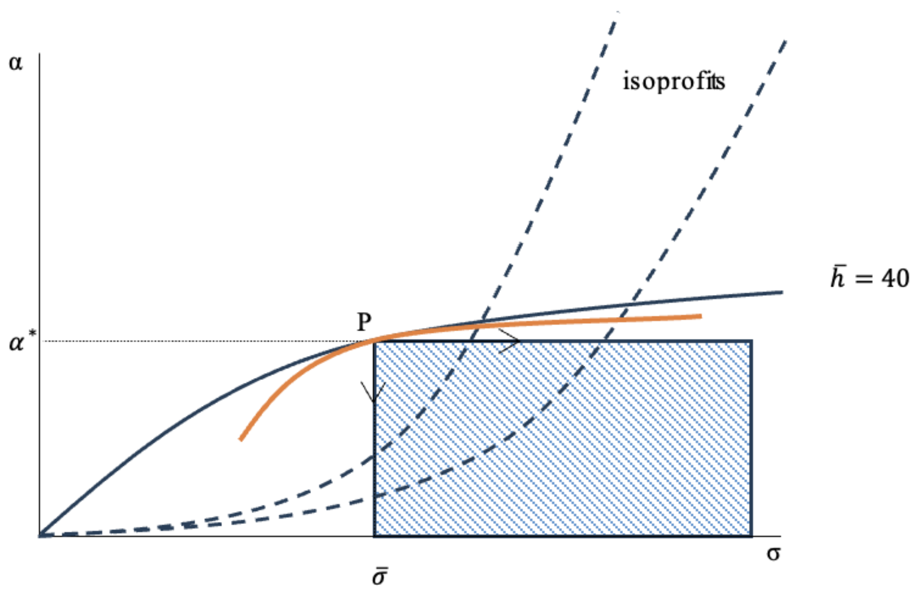
where ε is mean 0. In order to induce self-sorting of workers according to productivity,[12] the employer may offer a wage contract of the following type:

$$w = \begin{cases} \bar{w} = (1-\gamma)A\bar{\sigma}, & \text{for } h \leq \bar{h} \\ w_i = (1-\gamma)y_i = \bar{w} + (1-\gamma)A(\sigma_i - \bar{\sigma}) + (1-\gamma)\varepsilon_i, & \text{for } h > \bar{h} \end{cases} \tag{19}$$

[12] Since all employers are identical, we only consider sorting of workers into different contracts. For an analysis of increasing sorting of workers into workplaces in the US case, (see Song et al. 2019): "...high-wage workers became increasingly likely to work in high-wage firms (i.e., sorting increased), and high-wage workers became increasingly likely to work with each other (i.e., segregation rose)" (p.1).

Workers choosing the standard number of hours or fewer earn wages that are a function of mean productivity while those working more than $\bar{h}$ earn according to their output, (y_i). Risk-averse workers would then face the following alternative: either working their preferred hours for a constant wage up to the reference hours, or choosing to work $h_i > \bar{h}$ hours which then allows them to earn wages according to their productivity. One can envision this as a two-tiered system where workers willing to work long hours are on a piece-rate schedule.

Figure 4: Hourly wage supplied with productivity



The relationship is shown in Figure 4 where the point P along the solid iso-hours line identifies workers optimally choosing the reference amount of hours (exemplified by $\bar{h} = 40$) and possessing the average level of hourly productivity. The variable wage offer potentially applies to all workers aspiring to longer hours (namely below the concave iso-hours solid line). However we can partition this workers pool into different groups:

a. workers with $\alpha_i < \frac{\bar{w}^\beta}{\bar{h}}$ and $\sigma_i < \bar{\sigma}$ (those included in the south-west region wrt point P) face a trade-off: they would like to work longer hours (due to their lower distaste), but they do not want to incur in the expected wage loss associated with their lower productivity. Most of them therefore will remain at the reference point for hours, but a fraction (relatively productive with low distaste for effort - below the orange line) will optimally choose the variable wage contract.

b. symmetrically, there will be a fraction of workers characterized by $\alpha_i > \frac{\bar{w}^\beta}{\bar{h}}$ and $\sigma_i > \bar{\sigma}$ (higher productivity workers with high cost of effort - north-east region with respect to to point P) who will also face a trade-off. This group will have to balance the increasing marginal cost of additional hours against the expected gains of accepting the lottery. A fraction of them (those below the orange line) will accept the offer.

c. workers with $\alpha_i < \frac{\bar{w}^\beta}{\bar{h}}$ and $\sigma_i > \bar{\sigma}$ will accept the variable wage offer, due to their lower cost of work and higher productivity.

One can therefore presume the existence of a convex region delimited by the orange line which encapsulates workers working longer hours with a wage that depends on productivity. More formally, workers accepting the variable wage offer must solve the following problem:

$$\max_h E\left[\frac{((\bar{w}+(1-\gamma)A(\sigma_i-\bar{\sigma})+(1-\gamma)\varepsilon)h)^\beta}{\beta}\right]-\alpha_i\frac{h^{1+\beta}}{1+\beta}, \quad s.t. \quad h\geq\bar{h} \tag{20}$$

Applying the Leibniz rule yields:

$$h_i^{**}=\frac{E[w^{\beta-1}w]}{\alpha_i} \tag{21a}$$

Introducing the following approximation,

$$h_i^{**}=\frac{E[w^{\beta-1}w]}{\alpha_i}\approx\frac{E[w^\beta]}{\alpha_i} \tag{21b}$$

one can then expand a Taylor series for the argument of the expected value around $\varepsilon=0$, recalling that $E[\varepsilon]=0$ and $E[\varepsilon^2]=\text{Var}(\varepsilon)$. We can then obtain the following, somewhat unsightly, expression:

$$h_i^{**}\approx\frac{E\left[(\bar{w}+(1-\gamma)A(\sigma_i-\bar{\sigma}))^\beta+\beta(\bar{w}+(1-\gamma)A(\sigma_i-\bar{\sigma}))^{\beta-1}\cdot\varepsilon_i+\frac{\beta(\beta-1)}{2}(\bar{w}+(1-\gamma)A(\sigma_i-\bar{\sigma}))^{\beta-2}\varepsilon_i^2+o^2(\varepsilon)\right]}{\alpha_i}$$

which is the following, in slightly more compact form:

$$h_i^{**}=\frac{(\bar{w}+(1-\gamma)A(\sigma_i-\bar{\sigma}))^\beta}{\alpha_i}-\frac{\beta(1-\beta)\cdot\text{Var}(\varepsilon)}{2\alpha_i(\bar{w}+(1-\gamma)A(\sigma_i-\bar{\sigma}))^{(2-\beta)}} \tag{22}$$

Equation 22 implies that a worker in point P of Figure 4 will face two options: (1) working the reference hours $\bar{h}=\frac{\bar{w}^\beta}{\alpha^*}$ for a constant wage $\bar{w}$ (corresponding to the iso-hour solid line) or; (2) moving in the south-east region working longer hours $h_i^{**}\geq\bar{h}$ for a variable wage, that is increasing in $(\sigma_i-\bar{\sigma})$. Workers located above the iso-hour concave line will find it more convenient to work the reference hours (or less, if this is available). Less than average productive workers do not find it convenient to work longer hours at a lower expected wage unless their taste for leisure is very low.

More than average productive workers obtain a higher (expected) wage when accepting to work longer hours, but in a close neighborhood of P they may find it preferable to choose the reference hours in order to avoid the risk associated with the wage lottery. But the cost induced by the wage volatility declines with increasing productivity, and there will be a point above which the variable wage offer will dominate: below point P in Figure 4 there exists a convex region where more productive workers will accept a variable hourly wage, allowing them to partially reveal their productivity. This group will be smaller as risk variance increases.

Summing up the model, we have shown that when workers are heterogeneous in terms of preferences and productivity in a flexible economy with full observability of productivity, the distribution of worked hours is supply-determined, and the shape of the aggregate distribution depends on the correlation between taste for leisure and productivity. If the correlation is negative (more productive workers have a lower taste for leisure as in the case of many men) the distribution is more dispersed, while the opposite applies in case of positive correlation.

Abandoning the untenable assumption of perfect observability, worker behavior in response to wage offers by employers may partially reveal their characteristics. When employers and/or unions set a fixed wage leaving hours free, workers choose their optimal amount of hours thus revealing their preference for leisure but not their productivity (unless the correlation between the two is known in advance). Introducing a wage that is variable with hours (as in the case of overtime) does not improve the situation, since this wage offer will only be chosen by workers with a lower taste for leisure.

When productivity is partially observable, employers may offer a pay-for-performance wage for workers available to work beyond a reference threshold of hours. This leads to self-selection of workers into the variable wage contract: in addition to productive workaholic workers, most productive women (with a high preference for leisure) and less productive men (with a low preference for leisure) are likely to choose this type of contract. This self-selection induces positive covariance between productivity and taste for leisure; as a consequence, the distribution of hours beyond the norm, $\bar{h}$, tends to be more compressed. Since workers are modeled as risk-averse (due to decreasing marginal utility of consumption), incentives to accept a variable wage decline with increasing volatility of the measurement error in worker productivity.

When taking these predictions to the data, we have to consider the presence or absence of two institutional dimensions that are relevant in our framework: norms regulating worked hours, and collective wage contracts setting identical wages across heterogeneous workers. Institutional rigidities (like strict hour regulations and wage compression) prevent the signaling of individual productivity through the availability to work longer hours. On the contrary, under full flexibility of individual contracts we do expect some of the strategies highlighted in this section may come to play. In such a case, workers would sort into hour regimes according to taste and productivity, and we would not be surprised in finding positively selected workers working longer hours. This reaction would be stronger the higher the wage elasticity of hours. Since women are characterized by higher elasticities, this sorting will be stronger among women than men, who usually exhibit zero elasticity.

4 Empirical Differences in Hours and Wages

In this section we take observational data from four countries over a long time-horizon to ask who works below the reference point, $\bar{h}$, in hours, who works in the reference point range (i.e. full-time), and who works $h_i > \bar{h}$ across male and female workers. We do so via a standard (Oaxaca) decomposition framework where we decompose the wage gap between men and women not for all workers, but among those who are working different hours regimes.

4.1 Data

We use harmonized datasets that rely on national surveys collected from national statistical institutes, as in Checchi et al. (2022). These are household or labour force surveys for the US, the UK, Germany, and France, covering three decades, starting in 1991 and ending in 2016. We use the Current Population Survey for the US, the British Household Panel Survey and, from 2009, Understanding Society for the UK, the German Socio-Economic Panel for Germany, and the Enquete Emploi for France (which becomes the Enquete Emploi en Temps Continue in 2003). Although changes in survey design, notably the US in 1994, France in 2003 and the UK in 2009 require a careful interpretation of the results, all the surveys have been widely used in the empirical literature on inequality.

Our sample is composed of prime-age workers – individuals aged between 25 and 54 – who are employees in either the private or public sector. We exclude the self-employed since the treatment of this type of worker varies across national surveys. Two key variables of interest are weekly earnings and hours worked, out of which we then compute the hourly wage. For both variables we use questions referring to the current, primary job of the individual.

The measure of earnings we employ is usual gross income from labour that an individual receives over a week from the primary, current job, including both contractual wages and overtime pay.[13] Hourly wages are then computed by dividing earnings by hours worked. Hours are defined as, "usual hours worked in the main current job", which include both contractual hours and "usual hours of overtime" (although exceptional overtime is not included).[14] In some cases this variable is truncated, for example in Germany at 90 hours per week and at 99 hours in the US, though this affects very few workers. In the final version we consider only workers that work at least 2 hours per week on their main job and truncate hours worked at 90 hours for all four countries, though this has little effect as few workers are at these margins. Descriptive statistics in full are reported in Table A1.

Although these same data are commonly employed in labor market analyses, two additional caveats deserve mention. First, data are for the main job and hence income and hours from additional jobs are not accounted for. If those at the bottom of the distribution are more likely to have multiple jobs, we may be underestimating both their hours and income, overestimating inequality; the opposite occurs if those at the top that have multiple jobs. Second, Borjas (1980) argues that computing wages in this manner is problematic due to what he refers to as the "division bias" – the risk of downward-biased estimates of the elasticity of hours with respect to wages if hours are incorrect. Unfortunately, none of these surveys has data on all three measures mooting this point in our case.[15]

Likewise, creating consistent occupational categories across datasets is challenging as no consistent grouping exists, with time adding an additional complicating factor within countries. To meet this challenge, we group occupations and industries into three categories each and interact them in order to create nine occupation-by-industry groups. We follow Goos et al. (2009) and divide occupations into top, middle and bottom-paying ones, while loosely following Autor and Salomons (2017) for the grouping of industries into (1) manufacturing, agriculture, mining and construction, (2) capital-intensive and health and education services, and (3) labour-intensive services. The resulting ranking of occupations and the classification of industries are provided in Table A2 and Table A3, while the distribution of the nine groups is shown for selected groups in Table A4. The need for common measures of occupation and industry comes from our decomposition exercises to follow – if one country has more detailed measures, that country will mechanically have a larger share of the wage gap attributable to observable characteristics. While prior work has demonstrated that changes in the female composition of occupations and industries over time contributes to changes in the wage gap (e.g. Blau and Kahn, 2017), we show in the appendix that these groupings produce similar results to more fine grained measures.[16]

4.2 Hours and Wages by Gender Across Countries and Over Time

While Figure 1 in the introduction depicts the distribution of hours worked across the four economies in addition to wage gaps, here we add a time dimension and include additional evidence in support of a reference point in two of our economies (France and the US) and a lack thereof in the other

[13]Except for France where only labour income net of the employer's social security contributions is available.

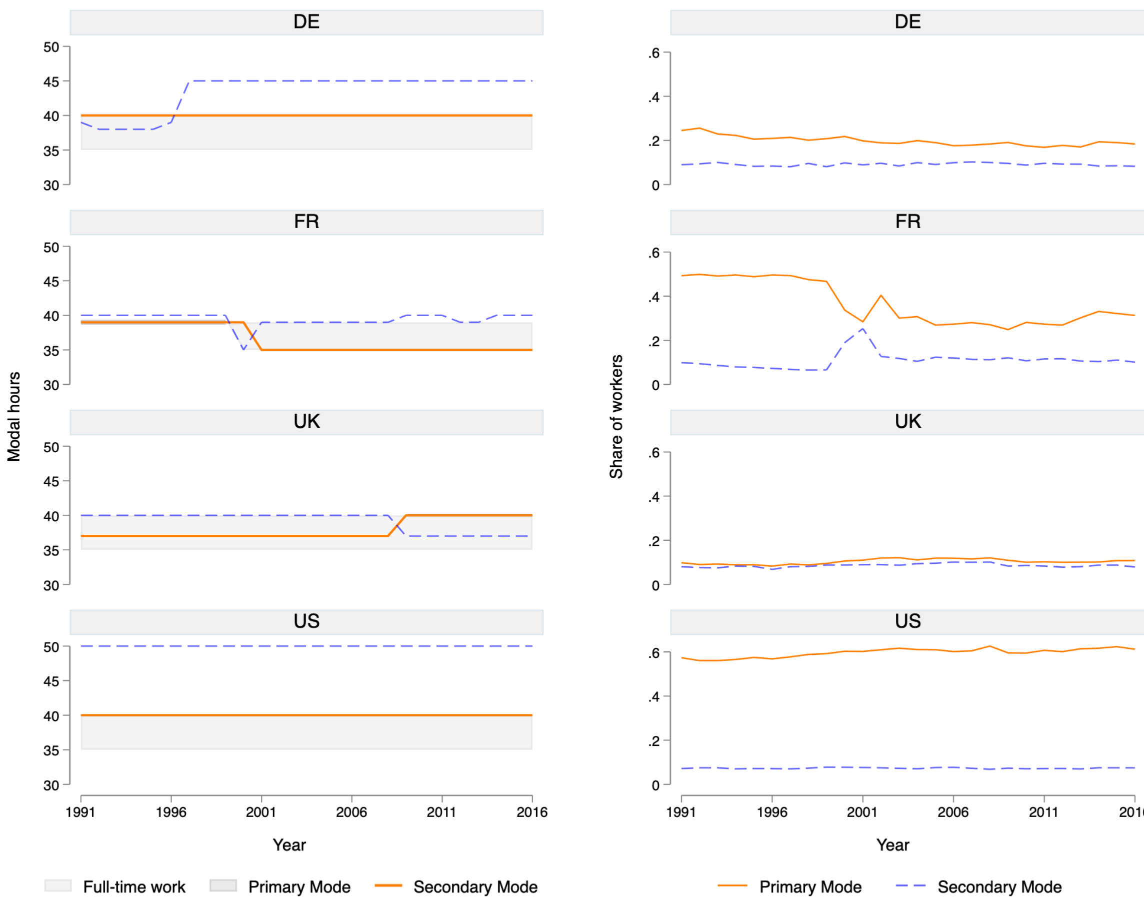
[14]Actual hours, in contrast, may include exceptional over time. Actual hours were used to complement usual hours in the US if respondents answered that usual hours vary. This is not a possible reply in the other surveys.

[15]Bick et al. (2018) analyze the extent of division bias by replacing actual worked hours with usual hours for 5 (out of 80) countries where both information is available. They find that the estimated elasticity changes significantly, still retain its sign. They conclude "...in the United States sample the use of an alternative hours measure leaves the coefficient virtually unchanged. Overall, this leads us to conclude that the division bias might be present, but is unlikely to substantially alter our findings." (Bick et al. (2018), p.193)

[16]In Appendix A3 we explore the robustness of our results when our job definitions are replaced with country-specific definitions of industries and occupations, as done in most of the national studies on gender gap, and Table A6 shows that the fraction of variance explained by the non-harmonized definition is higher, given the larger number of industries and occupations, but the qualitative results remain unaffected.

two (Germany and the UK). Figure 5 shows the relative strength of the "reference point" in worked hours in each country and over time. The left panel (a) of Figure 5 shows the 1st-2nd modal number of hours (among employed workers) in each country over time with full-time hours shaded in gray. The right panel (b) shows the share of workers supplying each of the 1st-2nd modes in each country, representing its relative uniqueness, or lack thereof. A comparison the US and UK is illustrative. The primary mode in the US is 40 hours (left panel), with approximately 60% of employed workers supplying that number of hours (right panel), with a slight increase over time. The second most common number of hours there in the US is 50 (followed by 45, not shown) with fewer than 10% of workers in each of these bins. The UK on the other hand does not feature a single-peaked reference point. While the first two modes are between 37 and 40 hours, fewer than 10% of workers are in any one of these bins. In fact, the first three modes in the UK and Germany account for a smaller share of all workers than the first mode in the US, by more than half in the UK.

Figure 5: Modal hours worked by country over time



(a) 1st-2nd modes in hours worked

(b) Share of workers at 1st-2nd modes of hours

Notes: The left panel (a) plots the most common (orange) and second most common (blue dash) number of hours worked in each economy. The gray bars show full-time work. The right panel (b) plots the share of workers in each of the first two most common hours of work supplied over time.

France looks much like the US, noting that a policy change beginning in 1999 moved the full-time designation for some workers from 39 to 36 hours (see Chemin and Wasmer, 2009, e.g.).[17] Germany, in contrast, looks somewhat like the UK. While there is a consistent mode at 40 hours over time, only about 20% of workers supply that number of hours, noting that the first three modes account for approximately 40% of all hours supplied.

In the following we define work into three regimes: part-time, full-time, and over-time work, where full-time largely abides, or at least includes, the reference point/modal number of hours worked. In Germany, the UK and US, while statutory definitions of work vary, in general full-time work is between 35-40 hours, which is the clear modal value in both the US and Germany. In the UK, the majority of workers are in this range, hence in all three, full-time work is equivalent to the modal value and the two can be used interchangeably. In France, we take account of the Aubry Law change which reduced the workweek from 39 to 35 hours in 1999, hence 35 hours is part-time before the change, but becomes full-time afterwards. We demonstrate in the Appendix A1 that this choice does not meaningfully alter conclusions by comparing regression results to those using a four category definition which includes occasional work (2-19 hours), working 20 hours to the modal value (which is full-time work in most cases), working the modal/reference-point number of hours, and working above the reference point, which is again equal to over-time work (see Figure A2).

In Figure 6 we plot percentage point *changes* in the share of workers supplying each broad category of hours in each country relative to base year 1992 separately by gender, the plots present moving averages to reduce noise. The largest changes are in Germany, where females shifted away from full-time work towards part-time, with some increase in overall labor-force participation. Males also decreased full-time work, gaining in both non-employment and in over-time work. In France, females increased labor supply with a shift to part-time and over-time work. Men decreased full-time work and decreased labor force participation in the latter half of the panel. In the UK and US changes are more muted over time. In the UK men decreased over-time work meaningfully over the time horizon, with a smaller increase in over-time work for females. In the US, over-time work also decreased for men relative to 1992, with an increase in male non-participation.

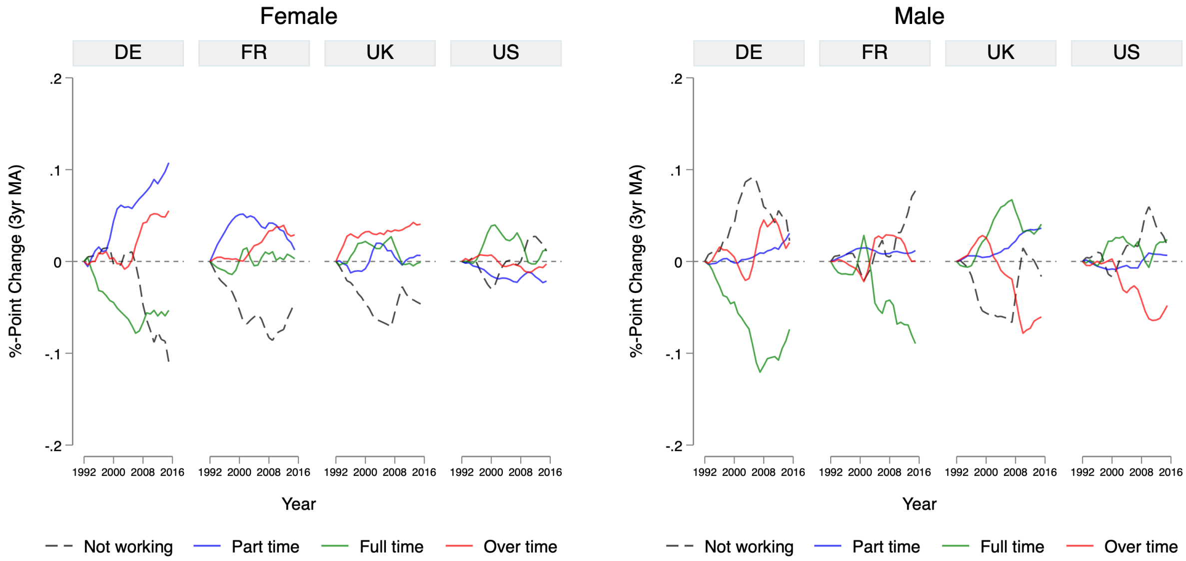
In Figure 7 we accompany this by plotting unadjusted wage *differentials* (female ÷ male) over time by hours regime, again using three-year moving averages. In all countries, the unadjusted wage gap is closing for for all hours groups. In the US, part-time females out earn part-time males beginning around the great recession. In France part-time females see the largest wage gap where full-time females see the smallest (opposite of the US). The UK and Germany have similar patterns, with wage gaps for part-time workers decreasing dramatically over time, and smaller convergence among full-time and more than full-time workers. As of 2016, in all countries but France females see the smallest wage gaps in part-time work, contributing to an overall earnings gap in those countries.

Taken together, only two common patterns emerge from the data: (1) part-time work is female dominated, while more than full-time work is male dominated; and (2) the wage gap is closing in all countries, even in raw means, regardless of hours worked. No clear additional patterns emerge, suggesting different dynamics are at play in each country respectively. In the next section we decompose the wage gap in earnings across the three hours regimes (PT, FT, and OT) to observe not only the evolution of the wage-gap over time, but to do so within each hours regime, and to capture the share of any earnings gap that can be explained by observable worker characteristics and the share that is unexplained.

Before decomposing wage differences, we begin with descriptive regressions showing log wage

[17] Between 1999-2001 France gradually changed the definition of full-time. During that period differing definitions existed for firms that were greater than 20 employees, which transitioned first, while some firms could opt in to that regime before it became largely universal in 2001/02. Unfortunately we cannot observe firm-size of workers and apply the definition change in 1999 (beginning Jan. 1, 2000). In empirical exercises this has minimal effect as we run regressions by year, though we show various robustness to this in the appendix.

Figure 6: Changes in labor force participation, by hours regime, country, and gender over time

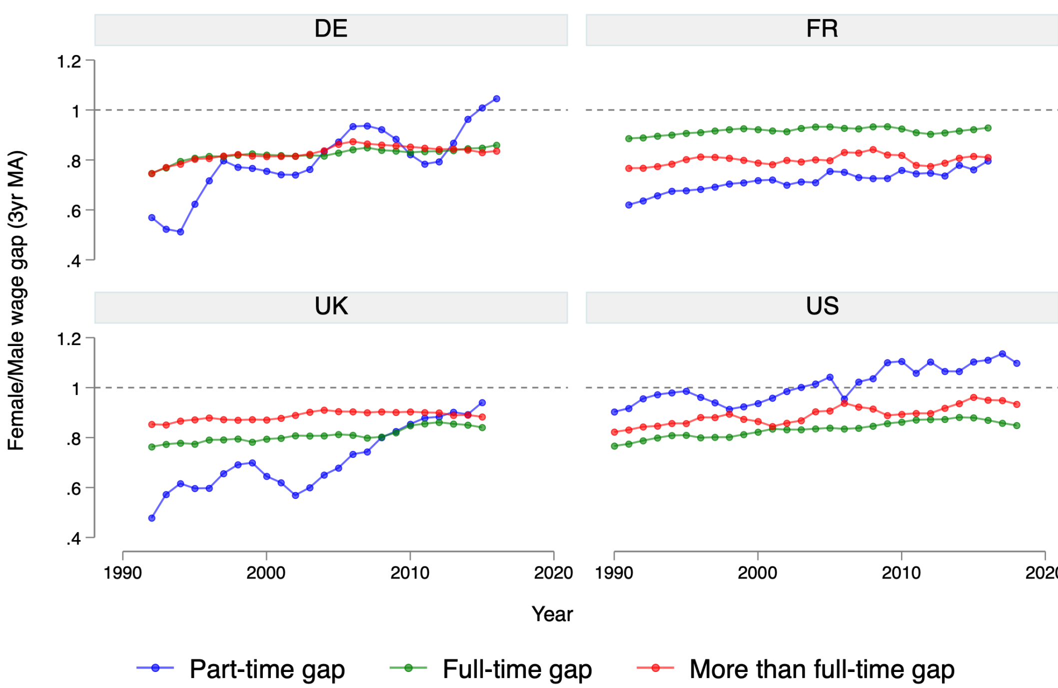


(a) Females

(b) Males

Notes: Figure plots difference in share of males and female employed in each hours grouping over time. First a 3-year MA was created by gender and country, where the figure plots the difference relative to the first period (1992).

Figure 7: Wage gaps by hours regime over time



Notes: Figures plot three-year moving average female as a share of male hourly wages for workers in each hours regime.

differences across gender and hours regime by country. These models are precursors, and thus mirror, our decomposition models to follow. The regression model is as follows:

$$ln(wage)_i = \alpha + \beta_1 PT_i + \beta_1 OT_i + \Pi X_i + \Gamma Job.x.Skill_i + \tau_t + \varepsilon_i \tag{23}$$

which is estimated separately by gender and country, pooled over all years. The full set of controls we include in vector X, in addition to the industry-skill pairs, are a quadratic in age, minority status, whether the individual is married, the number of children in the home, and categorical highest degree of education. β_1 and β_2 show log wage differences compared with working full time. In nearly all cases this is the same as the reference point, though with some deviations in particular for France. To show that these are effectively similar results, in the appendix we replicate the same regression with three hours regimes for below 20 hours, 20 hours to the mode, and more than the mode (in Figure A2).[18]

The β's from Equation 23 are plotted in Figure 8 below. Focusing on different hour regimes we confirm US exceptionalism: unlike the other economies, hourly wages rise with the chosen hour regime above full-time work, and more for women than for men. In the US, women's wages are closer to men's anywhere *other* than the reference point. According to the hourly returns, full-time workers in the UK and Germany earn more per hour, as going beyond, or working less than this standard is typically associated with a lower hourly wage. In the case of France, the highest average wage is paid to the lowest hour regime, which we show in the more detailed appendix version is largely attributable to "occasional work" – those working fewer than 20 hours per week. Note that the case of France is precisely the *opposite* of the case of the US – women's wages are closer to parity with men's at the full-time reference point.

4.3 Decomposing Wage Gaps by Hours Regimes

We now turn to our decomposition model which replicates the pooled regressions above, though now we estimate the model separately by year to show variation over time. To decompose wage differences across gender we use a standard Oaxaca-Blinder decomposition (as in Oaxaca and Ransom, 1994). The general form of the decomposition is:

$$\bar{Y}_M - \bar{Y}_F = \hat{\beta}_M \bar{X}'_M - \hat{\beta}_F \bar{X}'_F$$

which can be rearranged with the addition and subtraction of the term $\hat{\beta}_F \bar{X}'_M$ to give:

$$\bar{Y}_M - \bar{Y}_F = (\hat{\beta}_M - \hat{\beta}_F)\bar{X}'_M + \hat{\beta}_F(\bar{X}'_M - \bar{X}'_F) \tag{24}$$

Equation 24 decomposes, in our case, mean log wage differentials ($\bar{Y}$) into the share due to differences in "returns" to worker attributes (the first term), holding characteristics fixed at the level of males, and the share due to differences in the observable characteristics across the two groups, holding

[18] In estimating labour supply elasticities reported in Appendix A2 we use a two-stage Heckman procedure, modeling the selection into employment on the exclusion restriction of marital status, number of children, household head income and self-employment. However in the present context there are more than two alternatives (not working, working part-time, working full time, working beyond full time) and it is not apriori clear why these exclusion restrictions might be associated to one regime or the other. In order to have a more uniform distribution of the relevant population, in the present analysis we have identified four regimes: "**occasional work**", between zero (included) and 20 (excluded) hours; "**part time work**", between 20 (included) and modal hours (excluded – in case of Germany and UK we take mode–3); "**full time work**", corresponding to the yearly modal hours for France and US and to an interval of ±3 hours around the mode in the case of Germany and UK, where the distribution is more dispersed (included); "**more than full time work**" corresponding to the hours exceeding full-time. The first category (which includes non employment) constitutes our reference case.

Figure 8: Conditional returns (compared with full-time work)

Notes: Dependent variable is log wage over all years (1991-2016) run separately by gender and country. Controls include year, age, job-by-skill categories, education, marital status, whether individual is foreign/minority, and number of children.

holding "returns" to these attributes fixed (in this case at the level of females). In more plain language, we will ask whether the declines in hourly wage gaps within each hours regime is due to changes in the relative characteristics of men and women working in each hours group, or if differences in returns across gender have become more equal.

To do this we estimate a version of Equation 24 above separately by country, year, and each of the three hours regimes. Figure 9 below shows the Oaxaca (log) wage decomposition for each country and hours regime over time. As an analog to bridge the gap between the raw means plotted in Figure 6 above and the decomposition below, in Figure A1 we plot regression adjusted wage gaps which correspond to the gray lines plotted in the decomposition here.

The blue bars in Figure 9 show the share of the total gender wage gap (shown in the gray line overlaid) that is explained by differences in observable characteristics, while the orange bars plot the unexplained portion of the gap, holding observable characteristics fixed as in Equation 24. In almost no case are the orange bars above zero, meaning that the unexplained portion of the wage gap is (nearly) always to the benefit of male workers. That unexplained differential is declining in all countries and in nearly all hours regimes, most notably for part-time workers in all countries except the US, where the part-time wage differential was always low.

The many cases where the blue bars are below zero, indicating that holding returns to observable characteristics constant, if female workers had similar characteristics to their male counterparts they would earn *less*. In other words, women are *positively* selected (on observables in our model). This feature is clear for all workers in the US, in particular part-time female workers, and for overtime workers in the UK. In France, women in over-time and part-time work would earn less than their male counterparts if they had the same average levels of observable skills, noting that they still earn less due to the unexplained portion.

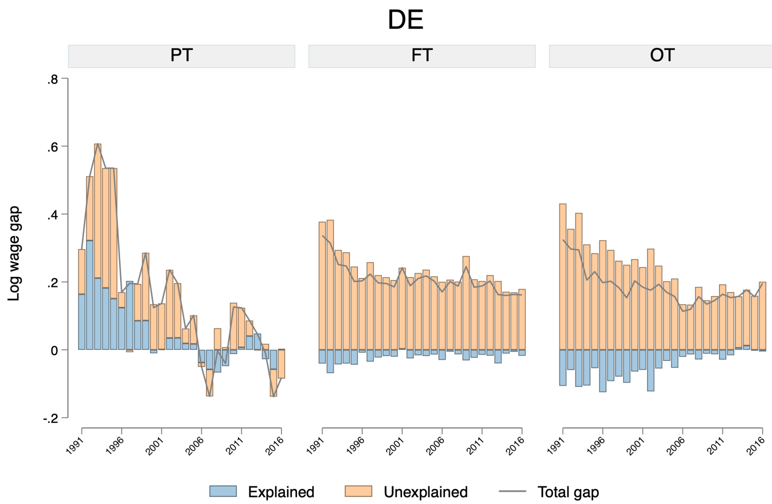
There are two clear exceptions in these figures. The first is the case of part-time work in the US. Unlike in Germany, France and the UK, the wage gap hovers around zero with a small positive unexplained and small negative explained portion. While part-time women were always positively selected in the US, the other three countries are converging to this same result. The final years for Germany, France and the UK look similar to the US.

The second exception is overtime work in France. This is the only case where women are both negatively selected on observables (if they had male's observables they would earn more, holding returns constant). More, the explained and unexplained portions are contributing nearly equally to the large, negative earnings gap for more than full-time work. Given meaningful institutional, in addition to cultural, differences in these countries, it is natural to explore what role these might play. While we are limited by our data as to how much we can attribute these patterns to institutions, in the next section we explore potential factors.

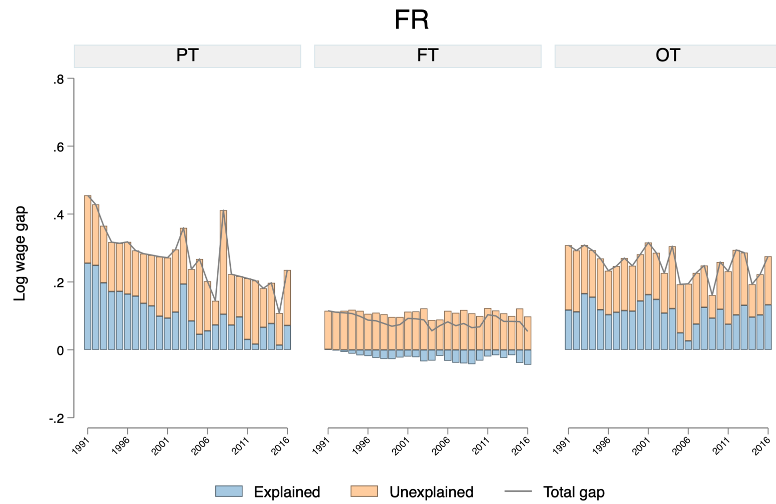
With respect to the reference point in (full-time) work, if female workers are characterized by higher elasticities in response to wages, as in Checchi et al. (2022) and others, we expect sorting to be stronger for women than for men. The share of over-time workers in all economies who are female has increased with exception for Germany, where it has remained flat. Likewise, the wage gap between men and women has decreased for over-time workers in all economies, though only slightly in France. We put these elements together in Figure 10 by combining the share of female workers, the overall (raw) wage gap, and the share of the gap due to explained and unexplained factors. We plot all of these relative to our initial year of 1991 to show changes over time and show the result for over-time workers in panel (a), and for full-time workers in panel (b).

Considering first selection into over-time work, with exception for Germany, in the other three economies women do not become more positively selected on observables over time, evidenced by relatively flat trends in the blue lines (the explained share from the Oaxaca decomposition). This does not mean they are not positively selected, Figure 9 shows that in the US and UK they are, while they have become less positively selected in Germany and remain negatively selected in France. Figure 10 is concerned with changes, abstracting away from the levels shown in Figure 9. Panel (a) shows that declines in the over-time wage gap over time are largely attributable to relative decreases in the unexplained share, which remain positive in level terms in all countries. For example, in the US and UK, the roughly 5 and 10 percentage point decrease in the over-time wage gap came largely from decreases in differential returns to women, as opposed to increasing positive selection. The same is largely true for full-time work as well. We couple this with the fact that the share of female over-time workers in each economy increased over this time, again with exception for Germany where it remained relatively flat. Thus while the female share of over-time workers increased, their relative "quality" as measured by our observable characteristics, was not the cause for the decline in the wage gap. Rather, the decline in differential returns played a stronger role. The case for Germany here is an exception, where the share of female workers in over-time work remained constant, while the direction of the explained and unexplained portions had offsetting effects on the overall wage gap – differential returns favoring men declined dramatically, while the composition effect favoring men increased. Taken together, this suggests that the selection effect into longer hours did not dominate.

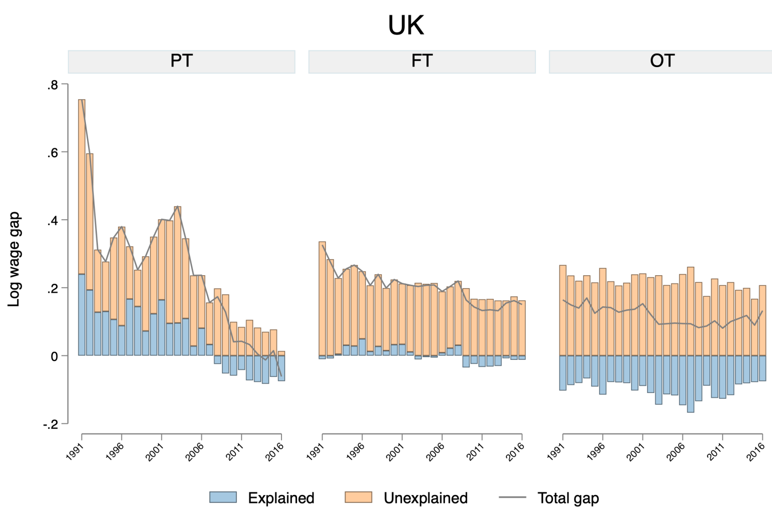
Figure 9: Oaxaca wage decomposition by hours regime



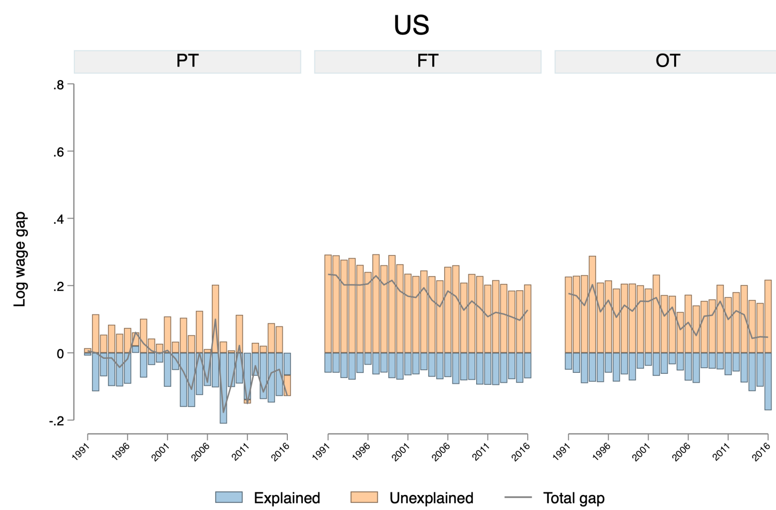
(a) Germany



(b) France



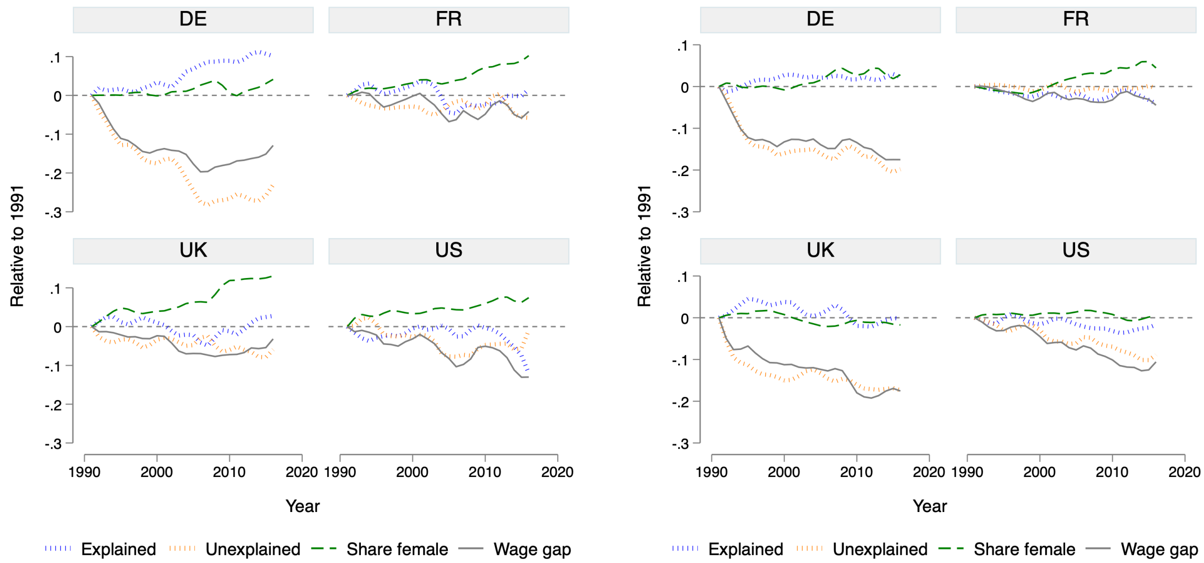
(c) United Kingdom



(d) United States

Notes: Figures plot Oaxaca decomposition of wages by year, country, and hours regime. Blue bars show the share of the total gap explained by included controls. Orange bars show the unexplained portion of the gap.

Figure 10: Wage gap decomposition and share female



(a) Over-time workers

(b) Full-time workers

Notes: Figure plots explained and unexplained shares of the overall wage gap (orange and blue lines) with share of female workers and total wage gap (green and gray) for over-time workers. Lines are smoothed for legibility.

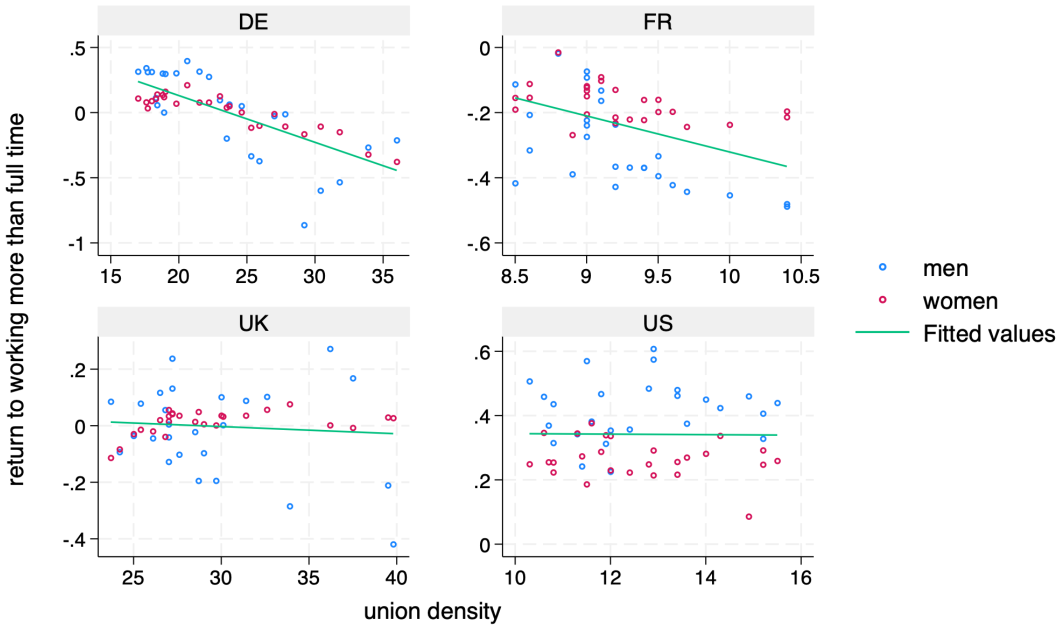
4.4 Wage Gaps and labour market institutions, the case of unions

A possible interpretation of these cross-country differences in returns to hour regimes is the role of institutions. The US represents a prototype of a flexible labour market, where pay and hours are largely set on an individual basis, with exception for the minimum wage. In such a framework, working longer hours may constitute a signal to the employer for career ambitions and/or adherence to company goals and values. On the contrary, when wages are set by collective bargaining and hours are regulated by public authorities (as in France and Germany), workers choose hours under constraints, undermining the signaling value of working longer hours. The same logic may apply to the gender gap: while in a flexible environment more productive women can take advantage of hours as signal, in the European context they lack this option possibly making it a less appealing proposition.

To explore this, we estimate the same model presented in Equation 23 now for each year×country and gender in order to exploit temporal variation and measure the gender gap in the return to over-time work. We add to this OECD measures of trade union membership in Figure 11. The scatter plot of the association between the returns to working longer hours and union density shows uncontroversially that the returns are lower when union are stronger in continental Europe but not in US and partly in UK. The egalitarian attitude of unions leads to wage compression, limiting the wage variations by hours regime. This has also implications for the gender gap in working longer hours.

In Figure 12 we plot the country×year differences between men's and women's estimated returns to over-time against trade union penetration on the horizontal axis. This graph suggests that when unions are stronger or their membership is higher, the wage compression benefits women more, as the gap is negative even when working more than full time (but the graph is almost identical if we

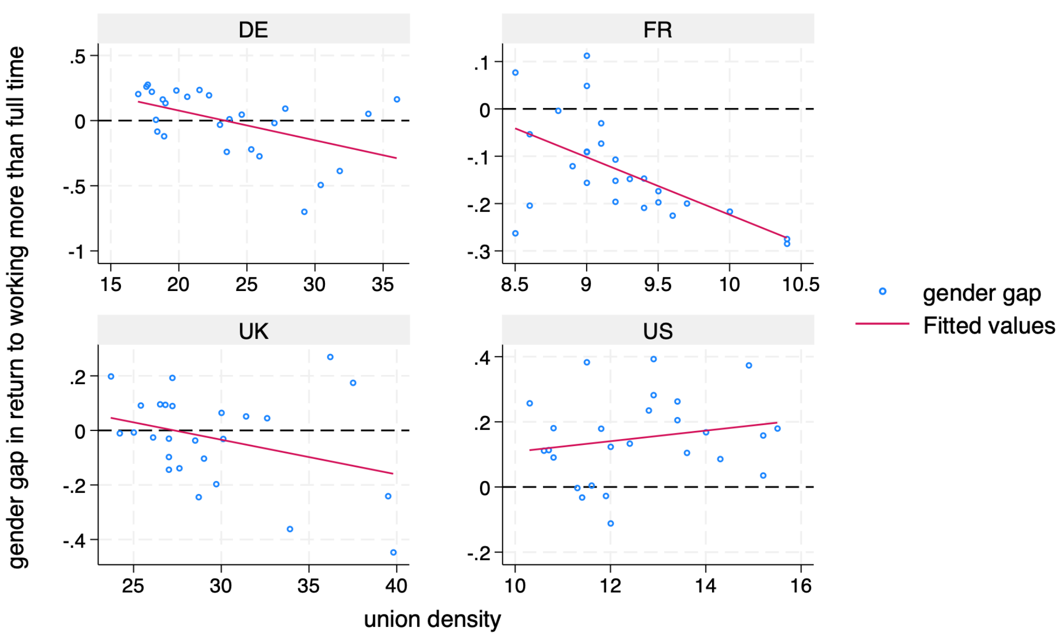
Figure 11: Return to working more than full time and union density



Notes: dots correspond to estimated return to hour regimes by year, controlling for age, education, minority, marital status and number of children.

consider either full time or part time regimes). We note that we do not have sectoral measures of union membership and hence can only make broad generalizations for the economy as a whole.

Figure 12: Gender gap in return to working more than full time and union density



Notes: dots correspond the difference between men and women estimated return to hour regimes by year, controlling for age, education, minority, marital status and number of children.

Nonetheless, we use this to highlight a potential trade-off: labour market flexibility offers more productive female workers the possibility of signaling their value via working longer hours under individual wage bargaining only. The presence of collective bargaining by unions reduces the effectiveness of this strategy, but at the same time compresses wage distribution and reduces the associated gender gap.

5 Conclusions

In this paper we consider potential explanations for cross-country differences in the distribution of hours worked across genders and its relationship to the gender wage gap. We began by observing that some countries (like US and France) exhibit distributions of hours that are quite concentrated around "normal" hours (39 or 40) which likely reflect legal norms and/or coordination in production. Other economies, like the UK and Germany on the contrary, exhibit more dispersed distributions, potentially due to heterogeneity in preferences or more flexible norms for working hours.

In order to reflect on potential determinants of this heterogeneity, we propose a model where workers are heterogeneous in terms of preference for work/leisure and productivity where production is linear in worker productivity. Under full observability, the observed distribution of hours is supply determined and depends on the covariance in the distribution of these characteristics. Under imperfect observability, the more likely case, employers can use the wage offer to induce partial revelation of preferences and productivity. When a pay-to-performance contract is offered, workers that are more productive and have a lower cost of effort self-select into working longer hours. This result holds in an institution-free environment. When labor market institutions are taken into account (legal constraints to work hours, unions bargaining over wages) these results may not hold since the set of opportunities is reduced.

We have then taken these ideas to data of four economies (the US,UK, Germany and France) covering 25 years (1991-2016). We harmonized the definition of hours and standardized a rough definition of jobs and educational attainment in order to control for job allocation and skill endowment. We partitioned observations into three hour regimes: part-time, full-time, and over-time work, where full-time largely includes the modal number of hours worked, which is strong in two of the four economies. Using this partition, we study the gender gap in the hourly wage. We show that in all economies with exception for Germany, the share of more than full-time workers increased while it was relatively flat for full-time work.

When we compute the gender gap within each hours regime, observing that it is closing in all countries over the years, disappearing under part-time regimes in three countries (Germany, UK and US) while persisting in over-time work in all countries. However, when controlling for observable individual and job characteristics, the hourly wage return for overtime work is positive only in US, at a greater extent for women. This may reflect positive self-selection of women in this hour regime.

It becomes therefore consistent to investigate the selection into hour regimes using the Oaxaca decomposition, by country and hour regime. We show that women are positive selected in longer hours in all countries but France. In the US and UK the gender gap in this hour regime is declining, while it remains persistent for the other two European countries. Said differently, it pays back to worker longer hours as a strategy to achieve parity for women in the Ango-Saxon economies but not in European ones. The data suggest that the declining wage gap for over-time and for full-time workers was largely attributable to declines in the unobserved component (i.e. differences in returns holding observable factors fixed).

A potential explanation for these cross-country differences may have to do with institutions. As a tentative exploration, we propose a correlation between the gender return to overtime work and national union densities. We show that when unions membership is higher, the wage compression reduces the relative return to working longer hours, and this benefits women more, as the gender gap in this return ends up negative for country/years when membership is high. We conclude by highlighting a potential trade-off: labor market flexibility (i.e. low union power) offers more productive female workers the possibility of signaling their value via working longer hours under individual wage bargaining only. The presence of collective bargaining (i.e. high union power) reduces the effectiveness of this strategy, but at the same time compresses wage distribution and reduces the associate gender gap.

This opens the policy debate over the best strategy to achieve gender parity, especially in high-paying occupations. Improving screening strategies by employer reduces the need for using availability to work longer hours as signaling strategy by more productive female workers, at the same time smoothing the conciliation with household needs. However, our results indicate that women are already positively selected, indicating that lower returns to endowments continue to disadvantage them, though this is decreasing. In the absence of spontaneous adjustment in the labor market (and in housework allocation within the couples), legal limitations to work hours for both genders remains in our view preferable as strategy to cope with the double burden of works that disadvantage women in the labor market.

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Table A1: Summary statistics for men and women across different periods and countries.

	Men					Women				
	W (mean)	W (sd)	H (mean)	H (sd)	Obs	W (mean)	W (sd)	H (mean)	H (sd)	Obs
1991-1995										
DE	11.03	5.44	42.99	8.18	14451	8.55	4.64	34.76	11.25	10799
FR	8.90	4.97	40.02	6.88	116841	7.78	4.54	34.52	9.53	103410
UK	7.83	4.10	45.66	10.16	7895	5.68	3.31	31.18	13.33	8658
US	14.41	8.08	42.81	8.52	25964	11.02	6.60	36.95	9.61	25162
1996-2000										
DE	13.21	5.88	43.48	8.50	16034	10.60	5.26	33.68	11.97	12560
FR	9.50	5.18	39.51	7.01	120481	8.41	4.61	33.81	9.61	112658
UK	9.07	4.78	45.50	10.01	10668	6.91	3.94	32.12	12.81	11624
US	16.57	9.54	43.01	8.23	22459	12.90	7.82	37.60	9.30	21843
2001-2005										
DE	16.33	8.23	43.77	8.48	19900	12.57	6.21	32.20	12.60	17886
FR	10.61	5.56	38.12	7.19	55579	9.31	5.11	33.14	9.02	52609
UK	10.99	5.92	44.19	9.46	13350	8.73	4.89	32.28	12.07	15132
US	19.90	11.84	42.71	8.16	24511	15.91	9.62	37.66	9.10	24318
2006-2010										
DE	16.88	8.68	43.95	8.86	18469	13.08	6.62	31.76	12.76	18232
FR	11.51	5.62	39.35	8.06	13026	10.19	4.78	34.05	9.53	12694
UK	13.45	7.46	42.80	10.07	22005	10.97	6.12	32.67	12.19	26852
US	22.59	13.25	42.54	8.40	22538	18.48	11.35	37.67	9.09	22687
2011-2016										
DE	18.34	9.80	42.98	9.05	29162	13.95	7.31	30.42	12.63	32141
FR	12.88	6.53	38.88	8.19	17528	11.16	5.16	34.29	9.40	18182
UK	14.72	8.17	42.65	10.00	37121	12.18	6.88	33.07	12.31	46213
US	24.59	14.69	42.10	8.49	25874	20.93	13.19	37.88	9.10	24998

A1 Appendix 1

Table A2: Occupations by Pay Category

Top-Paying Occupations
Corporate managers
Engineering professions
Life science professions
Other professions
Small enterprise managers
Engineering associate professions
Other associate professions
Life science associated professions
Middling-Paying Occupations
Drivers plant operators
Stat. plant operators
Metal and trade workers
Precision trade workers
Office clerks
Customer service clerks
Extraction workers
Machine operators
Other craft workers
Bottom-Paying Occupations
Personal services
Constr. transports
Models, demonstrators
Sales and elementary occupations

Notes: from Goos et al. (2009) referred to 1993. Occupations are classified referring to the two digit-level international standard classification of occupations (ISCO) variable.

Table A3: Classification of industries

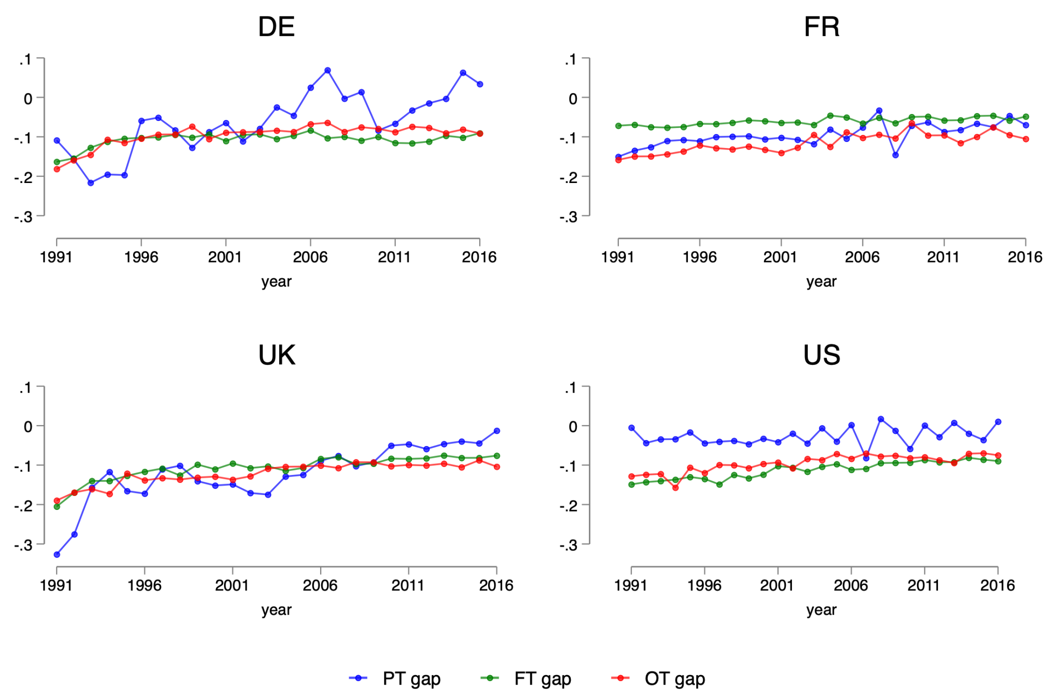
Our classification	**Autor and Salomons (2017)**
Agriculture, mining, construction and manufacturing	(1) agriculture, mining, construction: industries C, E, F (2) manufacturing: industries 15 to 37
Capital-intensive services	(3) education and health services: industries M to N (4) capital-intensive (high-tech) services: industries 64, J, and 71 to 74
Labour-intensive services	(5) labour-intensive (low-tech) services: industries 50 to 52, H, 60 to 63, 70 and O

Notes: industries are classified referring to the two digit-level standard industry classification (SIC) variable. The distinction between high- and low-tech services is obtained from the OECD.

Table A4: Distribution of occupations and industries (selected years)

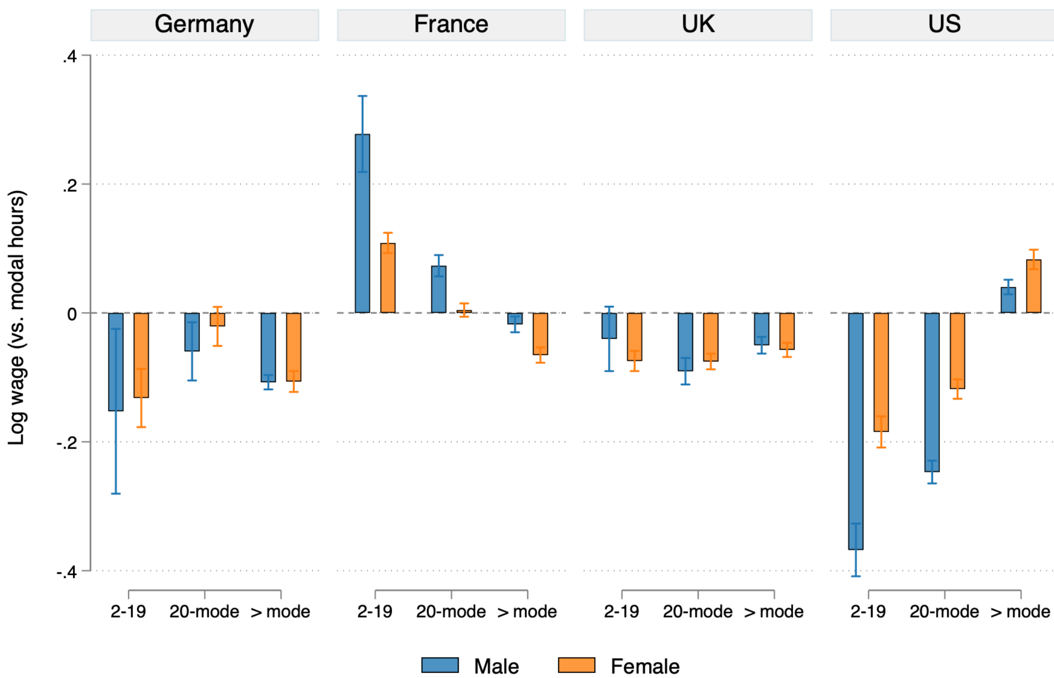
	1991				2001				2011			
	DE	FR	UK	US	DE	FR	UK	US	DE	FR	UK	US
agric.,mining,constr. x bottom skill	0.05	0.06	0.03	0.04	0.03	0.04	0.02	0.04	0.03	0.03	0.02	0.02
agric.,mining,constr. x medium skill	0.33	0.24	0.20	0.20	0.23	0.20	0.16	0.17	0.17	0.15	0.10	0.13
agric.,mining,constr. x top skill	0.11	0.06	0.10	0.06	0.10	0.06	0.09	0.06	0.11	0.08	0.06	0.06
capital-int. services x bottom skill	0.05	0.06	0.08	0.10	0.05	0.05	0.08	0.10	0.06	0.05	0.14	0.17
capital-int. services x medium skill	0.04	0.18	0.10	0.15	0.05	0.19	0.10	0.14	0.04	0.16	0.10	0.10
capital-int. services x top skill	0.15	0.18	0.22	0.19	0.21	0.22	0.25	0.24	0.27	0.28	0.33	0.30
labour-int. services x bottom skill	0.08	0.03	0.10	0.17	0.09	0.08	0.10	0.16	0.09	0.07	0.10	0.13
labour-int. services x medium skill	0.10	0.09	0.08	0.06	0.10	0.09	0.09	0.06	0.09	0.09	0.07	0.06
labour-int. services x top skill	0.09	0.10	0.09	0.03	0.13	0.08	0.10	0.03	0.14	0.11	0.07	0.04
Total	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Figure A1: Regression adjusted wage gaps by hours regime over time



Notes: Figures plot regression adjusted average female as a share of male hourly wages for workers in each hours regime by year.

Figure A2: Conditional returns (compared with modal hours)



Notes: Dependent variable is log wage over all years (1991-2016) run separately by gender and country. Controls include year, age, job-by-skill categories, education, marital status, whether individual is foreign/minority, and number of children.

A2 Appendix 2 – Estimates of wage elasticities

To describe the changing pattern of labour supply, we draw on Checchi et al. (2022) who estimate the hours elasticity to hourly wage, controlling for self-selection into the labour market in order to account for the extensive margin. The exclusion restrictions include marital status, number of children, household head income and self-employment. Looking at column 1 of Table A4, on average women are less likely to be in employment (-13.6%), but this is offset by educational attainment (+18.1% if college educated, +11.1% if secondary graduates). Foreign born individuals exhibit a lower participation (-7.3%). The selection equation is then used to compute the Mill's ratio, which corrects the potential bias when estimating the relationship between hours and hourly wage in column 2 of Table A4, where we have estimated the following equation:

$$\log H_{ict} = \alpha + \beta_{\text{men}} \cdot \log W_{ict} + \beta_{\text{female}} \cdot \log W_{ict} + \zeta \cdot X_{ict} + \theta \cdot \text{Mills} + \eta_{ct} + \varepsilon_{ict} \tag{A1}$$

where H_{ict} indicates the (usual) hours worked by individual i in country c in year t, W_{ict} their corresponding hourly wage, X_{ict} a vector of individual characteristics (female, age, age^2, foreign born, educational attainment), Mills $= \frac{\phi(\omega)}{\Phi(\omega)}$ represents the Mill's ratio estimated from the residual of the selection equation, and η_{ct} are country×year dummies.

We estimate two separate wage elasticities for men and women using interaction, finding a small negative elasticity for men (-0.021) and a positive one ($+0.093$) for women. This is an average effect in the entire sample. If we want to investigate potential changes over time across countries, we resort to using a quadruple interaction estimation as follows:

$$\log H_{ict} = \alpha + \sum_{f=0}^{1} \sum_{c=1}^{4} \sum_{t=1989}^{2019} \beta_{fct} \cdot \log W_{ict} + \zeta \cdot X_{ict} + \theta \cdot \text{Mills} + \eta_{ct} + \varepsilon_{ict} \tag{A2}$$

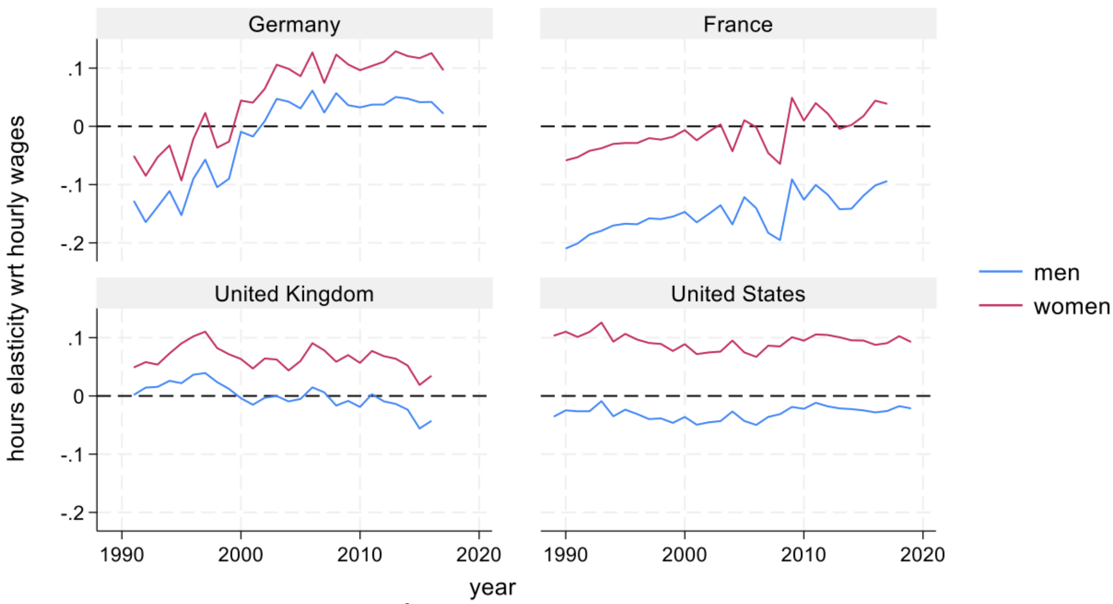
The estimated wage elasticities β's are identified by the within-group (country × year × sex) variations. The results are plotted in Figure A3. The UK and the US look similar, with a rigid supply of hours by men (the elasticities fluctuate around zero) and a positive elasticity for women. Conversely, in the case of France, it is the female elasticity which is close to zero, while the male one is clearly negative. Germany represents an intermediate case, transiting from an initial situation similar to that of France to one closer to that observed in the other two countries, although it has higher (positive) values.

The fact that the female elasticity exhibits a positive coefficient even when controlling for job characteristics is consistent with the idea that compositional changes are important in understanding the evolution of overall elasticities. As the share of women in the labour market increased, overall wage elasticities became more positive, thus making hours dispersion an increasingly important aspect in accounting for earnings inequality.

Table A5: Hours elasticity

VARIABLES	(1) Selection Equation	(2) Hours
log(W)		-0.021***
		[0.007]
female	-0.136***	-0.444***
	[0.005]	[0.028]
log(W) x female		0.114***
		[0.009]
age	0.036***	-0.013***
	[0.001]	[0.002]
age^2	-0.000***	0.000***
	[0.000]	[0.000]
foreign born	-0.073***	0.008*
	[0.006]	[0.004]
education (secondary)	0.111***	0.001
	[0.004]	[0.004]
education (college)	0.181***	-0.002
	[0.005]	[0.007]
agric.,mining,constr. x medium skill		0.044***
		[0.006]
agric.,mining,constr. x top skill		0.109***
		[0.006]
capital-int. services x bottom skill		-0.096***
		[0.007]
capital-int. services x medium skill		0.006
		[0.005]
capital-int. services x top skill		0.051***
		[0.006]
labour-int. services x bottom skill		-0.120***
		[0.008]
labour-int. services x medium skill		0.013***
		[0.005]
labour-int. services x top skill		0.092***
		[0.006]
public sector		-0.014***
		[0.003]
household head income	0.012***	
	[0.001]	
household head self-employed	0.046***	
	[0.005]	
single	0.014***	
	[0.003]	
number of children	-0.037***	
	[0.002]	
Mill's ratio		-0.590***
		[0.067]
Constant	-0.009	4.260***
	[0.026]	[0.075]
Observations	1,822,737	1,309,375
R^2	0.085	0.202

Figure A3: Estimated wage elasticity



Notes: Estimates include controls for age, age^2, education, foreign born, job skill requirements, sector and country x year dummies, self-selection into employment (inverse Mills ratio) using controls for single, # of children and other HH member's income.

A3 Appendix 3 – Sectors and occupations versus our job definition

A further robustness check deals with job characteristics. In the original data sources there is information on occupations and sectors of employment, but they change over time and are hard to harmonize in a comparable way across countries and years. For this reason we chose to aggregate sectors into three large groups (see Table A3) and similarly we did for occupations, using skill levels (see Table A2). In the statistical analysis we then used the nine interactions sector×occupation to control for job allocation, which the literature considers as one of the main determinants of the gender gap.

In order to check whether our strategy biases our results in the Oaxaca decomposition, we have replicated the same exercise using the original sector and occupation variables (which are not comparable across countries and years). In order to keep the largest information available we have retained the original sample for each country. As it can be seen from the sequel, in all cases the fraction of variance accounted by endowments ("explained" coefficient) rises by 2 to 4 percentage points when considering original information on sectors and occupations. Nevertheless the general result holds: the unexplained fraction dominates the explained one.

Table A6: Comparing Oaxaca decompositions using occupation and sectors or jobs

	Germany		**UK**		**US**		**France**	
	jobs (9 items)	occupations (27 items) and sectors (28 items)	jobs (9 items)	occupations (28 items) and sectors (95 items)	jobs (9 items)	occupations (13 items) and sectors (22 items)	jobs (9 items)	occupations (18 items) and sectors (48 items)
group_1	2.8334	2.8334	2.2963	2.2963	2.7236	2.7236	3.4347	3.4347
group_2	2.5782	2.5782	2.1030	2.1030	2.5267	2.5267	3.2838	3.2838
difference	0.2552	0.2552	0.1933	0.1933	0.1969	0.1969	0.1509	0.1509
explained	**0.0779**	**0.0865**	**0.0237**	**0.0608**	**-0.0311**	**0.0040**	**0.0393**	**0.0616**
unexplained	**0.1773**	**0.1687**	**0.1696**	**0.1325**	**0.2279**	**0.1929**	**0.1116**	**0.0894**
Group 1 (males)	135080	135080	114947	114947	206355	206355	465340	465340
Group 2 (females)	121286	121286	135627	135627	203997	203997	432596	432596
observations	256366	256366	250574	250574	410352	410352	897936	897936

Explained: $(X_1 - X_2) \times b$. *Unexplained:* $X_1 \times (b_1 - b) + X_2 \times (b - b_2)$ *- estimates of b from pooled model (including group dummy). Dependent variable is the log of hourly wage. OLS regression includes education (3 items), age, marital status, number of children, foreign born and year dummies. All reported coefficients are statistically significant at 99%.*