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Part-time hours and wages

Ana I. Moro-Egido* Joaquín Naval† José I. Silva‡§

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Abstract

This paper studies the non-linear relationship between part-time hours and wages in 10 European Union countries. We use the harmonized 2018 Structure of Earnings Survey, that provides comparable microdata on the link between the level of earnings and paid hours. We empirically assess the relevance of the relationship correcting for self-selection and endogeneity. We show the presence of two effects going in opposite directions. First, a part-time wage premium due to the presence of decreasing returns in the production function. Second, a wage penalty due to the presence of coordination costs that arises when a part-time worker deviates from the usual hours worked in the firm. We also show that the unexplained part-time wage penalty is considerably affected by the hours-wage relationship.

JEL Classifications: C21, J31, J32.

Keywords: Hours-wage relationship, full-time equivalent, coordination costs, fixed labor costs.

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†University of Girona

‡Corresponding author, Universitat de Girona and University of Kent. Universitat de Girona, Campus de Montilivi, C/Universitat 10, FCEE, 17003, Girona, Spain, email: jose.silva@udg.edu

§Restrictions apply to the availability of these public data. However, the files generating our variables and findings are available from the journal, which will make them public upon request to the authors.

1 Introduction

According to data from the OECD database, there is a significant disparity in the proportion of part-time workers across countries, ranging from 1.6% in Bulgaria to 37.0% in the Netherlands. Empirical research has identified a negative raw gap between the hourly wages of part-time and full-time employees in various countries.[1] This paper aims to investigate the non-linear relationship between part-time hours and wages in 10 European Union countries. Notably, most of previous studies have yet to explore how the wage penalty in part-time work changes with the number of hours worked. Wolf (2002) is an exception, as her analysis of gross hourly wage rates for West German women using a non-linear hours-wage model found that the hourly wage of part-time women working under 20 hours per week was lower than the wage of other part-time workers. Hirsch (2005) and Golden (2020) have also reported the presence of an hours-related wage penalty within part-time jobs in the US. These findings align with those of Aaronson & French (2004), who estimate the part-time wage effects of hours variations caused by the social security rules. They found a 25% wage penalty for older men who reduced their workweek from 40 to 20 hours. This part-time wage penalty decreases when the number of weekly hours worked by part-time workers approximates the usual 40 hours worked by full-time employees. Therefore, assuming a constant part-time wage penalty across hours may obscure important non-linearities between these two variables, potentially introducing bias into the unexplained part-time wage gap.

From a theoretical perspective, the relationship between hours worked and hourly wages can be complex. While a premium to short hours can arise due to decreasing returns to hours worked or if firms compensate workers for taking a part-time job, a penalty is more commonly observed in the data. This is because firms' labor costs may not increase proportionally with the hours worked, due to the presence of quasi-fixed costs of labor such as training, hiring, and labor-related operating costs (Oi, 1962). Hence, part-time workers' fixed costs may be relatively higher than per-hour costs of full-time workers, and their wage rates might be adjusted downward to equalize all labor costs. As a result, the part-time penalty decreases with hours worked.

Additionally, the relationship between hours and wages can just be related to changes in the returns of the production function (Barzel, 1973). For example, Bick et al. (2022) present a structural labor supply model with increasing returns for short hours and decreasing returns for long hours worked to account for the hump-shaped relationship between hours worked and hourly wages found in the US and Denmark.

Furthermore, firms may incur costs associated with coordinating workers with different work schedules, and the net productivity of part-time workers may decrease as a result. This could lead to a penalty for working lower hours than the usual ones, as their low productivity penalizes their wages (Yurdagul, 2017; Labanca & Pozzoli, 2018).

In this paper, we investigate the relationship between the part-time wage gap and the weekly hours worked. Initially, we present a bargaining model that extends Del Rey et al. (2022) model over hours and wages. Our model accounts for various factors, such as quasi-fixed costs of labor, different returns to hours worked, and coordination costs of part-time workers. Thus,

[1] See Ramos et al. (2016) for a summary of the empirical literature.

the theoretical model provides a framework to analyze how hours affect hourly wages through multiple channels. For instance, the amount of hours worked has a direct impact on hourly wages, with the returns of production and fixed costs determining whether there is a wage premium or penalty for short or long hours. Another channel that arises is when a part-time worker deviates from the usual hours worked. This deviation captures the coordination issues of part-time workers that affect their net productivity and result in a lower hourly wage. Therefore, the model highlights the significance of considering both how many hours a part-time worker works and how far away the worker is from the usual hours worked by a full-time worker in the same firm.

We empirically address cross-country differences in the hours-wage relationship using the 2018 Survey of Earnings Structure (SES) from 10 European Union economies. The SES is a employer-employee representative survey on firms that covers employees working in establishments with at least 10 employees across EU countries. Compared to others surveys, the SES provides detailed information on wages as well as other characteristics of workers, jobs and firms. It also presents a more accurate definition of full-time and part-time workers based on the collectively agreed or customary hours worked in the local unit under consideration. In addition, the SES provides information about the share of full-time's normal hours per employee at the establishment level, which can be used to capture the costs of deviating from the usual hours worked in the firm.

We estimate simple OLS wage equation to stablish some raw correlations with hours worked. To better fit the theoretical model we present a extended regressions model (ERM) for each of the 10 EU countries. To control for part-time self-selection bias, we use coarsened exact matching (CEM) in our analysis previous to the estimation. We deal with endogeneity issues instrumenting the weekly hours worked by using annual paid days of holiday leave (in full days). Our results indicate the presence of two opposing effects. The first effect generates a part-time wage premium, which is consistent with the presence of decreasing returns in the production function. The second effect is a wage penalty due to the presence of coordination costs that arises when a part-time worker deviates from the usual hours worked in the firm.

To account for the total effect, we analyse that simultaneously changes in both part-time hours as well as the hours-gap with respect to a full-time employee working 40 hours. We observe a net wage premium in Spain and Italy and a penalty in the rest of the countries, except France. In the former countries, the hours effect related to the presence of decreasing returns in productivity dominates the wage behavior while, in the latest countries, the deviation from usual full-time hours worked becomes more important. In contrast, France shows a part-time wage premium below 15 hours and a wage penalty between 15 and 40 hours. As expected, the the total effect is much lower when combining the two effects. Specifically, working 10 hours with a FTE of 25% generates a part-time wage gap that goes from a wage premium of 20% in France to a wage penalty of -50% in Finland.

We also performed a group analysis to verify if differences in gender, age or education affect the shape of the hours-wage relationship. Our analysis confirms the presence of two opposite effects in the hours-wage relationship in all countries. Finally, we also show that the unexplained part-time wage penalty is considerably affected by the hours-wage relationship. More in detail,

we observe an important reduction in the part-time wage penalty or even the presence of a premium when individual characteristics and hours worked are simultaneously included as control variables.

The rest of the paper is organized as follows. In Section 2, we present the theoretical model that captures the hours-wage relationship. In Section 3, we describe the data and document several facts about hours worked and wages in the 10 European countries included in our study. Section 4 presents the empirical model and the identification strategy. In Section 5, we present the estimated results. Finally, in Section 6, we conclude.

2 The theoretical model

We adopt a bargaining framework for wages and hours between firms and workers, building on the work of Del Rey et al. (2022). This approach considers that wages may be influenced by fixed costs and coordination costs of labor, rather than being solely determined by the marginal product of labor.

We assume that workers obtain

$$W = h(w - x) \tag{2.1}$$

where h stands for hours, w is the hourly wage, and x captures preferences for leisure and characterises workers. In turn, firms obtain

$$J = ah^{\alpha} - hw - F - \delta(\hat{h} - h), \tag{2.2}$$

where ah^{α} is the output generated in h hours of work, a characterises firms' productivity, $\alpha > 0$ is the elasticity of output with respect to hours worked and captures the returns to hours worked, F stands for the fixed costs incurred by firms, and $\delta(\hat{h} - h)$ is the output loss that reflect coordination costs of deviating from the usual hours $\hat{h}$ worked in the firm ($\delta \geq 0$).

Wages and hours are determined by Nash bargaining

$$\max_{h,w} \ (W)^{\beta} (J)^{1-\beta},$$

where β is the worker bargaining power relative to the firm's one $(1 - \beta)$. The first order condition that determines wages is

$$\beta J \frac{\partial W}{\partial w} = -(1 - \beta)(W) \frac{\partial J}{\partial w}.$$

Since $\frac{\partial W}{\partial w} = -\frac{\partial J}{\partial w} = h$, this implies

$$\beta J = (1 - \beta)W. \tag{2.3}$$

Substituting (2.1) and (2.2) in (2.3), we obtain

$$w^{*} = \beta a h^{\alpha - 1} - \beta \frac{F}{h} - \beta\delta(\frac{1}{\theta} - 1) + (1 - \beta)x, \tag{2.4}$$

where w^* corresponds to the hourly wage and $\theta = h/\hat{h}$ is the ratio between hours worked by the employee and the usual hours worked in the local unit. We call θ the full-time equivalent employee (FTE), because it represents an employee's hours h divided by the employer's hours for an usual full-time schedule $\hat{h}$.

Similarly, the first order condition that determines hours of work is

$$\beta J \frac{\partial W}{\partial h} = -(1-\beta) W \frac{\partial J}{\partial h}, \tag{2.5}$$

which can be simplified using (2.3) to obtain

$$\frac{\partial W}{\partial h} = -\frac{\partial J}{\partial h}.$$

From (2.1) and (2.2), we obtain

$$\frac{\partial W}{\partial h} = w - x,$$

and

$$\frac{\partial J}{\partial h} = \left(\alpha a h^{\alpha-1} - w + \delta\right).$$

Then, (2.5) implies

$$h^* = \left(\frac{\alpha a}{x-\delta}\right)^{\frac{1}{1-\alpha}}. \tag{2.6}$$

Hence, firm's coordination cost δ, productivity a and elasticity α increase the hours, while worker's costs x reduce them. Finally, we plug (2.6) into (2.4) to obtain the equilibrium wage

$$w^* = \beta(ah^*)^{\alpha-1} - \beta\frac{F}{h^*} - \beta\delta(\frac{1}{\theta^*} - 1) + (1-\beta)x \tag{2.7}$$

The first component of wage equation (2.7) captures the relationship between wages and the returns of the production function. For instance, Bick et al. (2022) assume that there are increasing returns ($\alpha > 1$) to hours worked when workers work short hours (below 50 hours per week), while there are decreasing returns ($0 < \alpha < 1$) for greater numbers of hours worked, as suggested by (Barzel, 1973). This implies that hourly wages w initially increase when workers work below a certain threshold of hours and then decrease when hours worked increase above that threshold. The presence of increasing returns captures the idea that if there are set-up costs, the returns will be convex for short hours worked, but fatigue can lead to decreasing returns for long hours (Pencavel, 2015).

Thus, for $F = 0$ and $\theta = 1$, the presence of different returns in the production function can generate a hump-shaped relationship between hours and the hourly wage. However, other studies that estimate the production function find evidence of decreasing returns to hours worked, even in part-time jobs (Collewet & Sauermann, 2017). Therefore, we can also expect the presence of a wage premium for short hours worked due to the presence of decreasing returns in the production function.

The second component of wage equation (2.7) captures the presence of quasi-fixed costs F. The idea of quasi-fixed costs of labor was first introduced by Oi (1962). Quasi-fixed costs of labor do not vary with the number of hours worked and include the costs of hiring and training new workers, supervising and maintaining records for each worker, and other components of fringe

benefits that are unrelated to hours worked. The magnitude of fixed costs can be substantial. For instance, using Belgian firm-level data on production, labor costs, workers, and hours, Delmez & Vandenberghe (2018) find evidence of quasi-fixed labor costs in the range of 20% of total labor costs. Equation (2.4) shows that F generates a wage penalty for workers who work fewer hours, and this penalty decreases monotonically as the number of hours worked increases because the relative size of fixed costs decreases as hours worked increase.

The third term in the wage equation captures the cost of deviating from the typical hours worked by a full-time worker. According to Labanca & Pozzoli (2018), it can be costly for firms to have workers with different work schedules, and coordination of part-time workers can reduce their net productivity, resulting in a wage penalty for working lower hours than the usual ones. Additionaly, Yurdagul (2017) suggests that there is complementarity between part-time and full-time workers, which captures coordination desires across and within firms (Rogerson, 2011). In other words, workers are more productive if their hours are similar to each other. Hence, there is a cost associated with coordination failures that penalizes part-time workers.[2]

The last term in the wage equation captures the impact preferences for leisure. If the cost of working is higher for certain workers, firms need to offer higher wages to attract them. Thus, this term reflects the idea that workers may have different preferences for leisure, and those who value leisure more highly will require higher wages to compensate for the disutility of working.

The model suggests that the hourly wage of part-time workers is influenced by two factors related to the hours worked. First, the effect of decreasing returns to labor productivity as hours worked increase, which reduces the hourly wage. However, the hourly wage can increase if there are increasing returns or fixed costs. Second, there is a cost associated with deviating from the usual hours worked by full-time workers in the same firm, reducing their productivity and consequently, their hourly wage. Therefore, it is crucial to consider not only the number of hours worked but also the extent to which they deviate from the usual hours worked by full-time workers in the same firm.

3 Data and variables

This section describes the data and documents a set of cross-sectional facts about hours worked and wages in 10 different European Union countries. In contrast to other surveys, hours and hourly wages are provided by employers and determined by contractual working time. The sample includes 3 countries in Western Europe (France, Germany and the Netherlands), 3 in Southern Europe (Italy, Portugal and Spain) and 4 in Northern Europe (Denmark, Finland, Norway and Sweden).

3.1 Data

Our empirical analysis for the 10 European economies economy relies on the use of a matched cross-section employer-employee dataset: the 2018 Survey of Earnings Structure (SES) from the

[2]The analysis in this paper focuses on the short-hours wage penalty and does not consider the wage penalty for long hours worked that deviates from the usual hours in the firm, which is also discussed in Yurdagul (2017).

Eurostat. The SES is a country representative survey on firms, covering employees working in establishments with at least 10 employees. The SES provides detailed information on wages as well as other characteristics of workers, jobs and firms in the month of reference (mainly October).[3]

The SES defines full-time workers as those whose normal working hours are the same as the collectively agreed or customary hours worked in the local unit under consideration. In turn, part-time employees are those who work fewer hours than the normal working hours of full-time employees in the local unit. The SES also calculates the share of full-time's normal hours per employee at the establishment level. For a full-time employee, this share is always 100%. For a part-time employee, the number of hours contractually worked is expressed as a percentage of the number of normal hours worked by a full-time employee in the local unit. In line with our theoretical model, we call this variable the full-time equivalent employee (FTE).

The SES excludes agriculture and domestic service, contains uncensored wages without maximum and minimum limits, and includes information regarding the number of hours actually paid during the reference month. It does not cover earnings by the same employee elsewhere in a second or third job. Moreover, since the statistical information is provided by the employer and corresponds to the hours and wages paid, it does not suffer from severe measurement error in hours. This measurement error is observed in other surveys were individuals who work long journeys tend to over-report their hours worked (Borjas, 1980; Bick et al., 2022).

Since we focus the analysis on the normal hours worked, we exclude overtime hours from the total hours worked. We also exclude individuals below 20 and above 60 years old. We weight the sample data using the grossing-up factor for employees. Finally, we winsorize hourly wages at 1th and 99th percentiles to avoid a bias in the hours-wages relationship due to outliers.

We divide the monthly hours paid by 4.35 weeks to obtain the weekly hours paid. Table 1 shows very similar average number of hours worked when comparing the weekly hours paid in the SES with respect to the average usual weekly hours worked in the main job reported by dependent employees in the Labour Force Survey.

3.2 Cross-sectional facts about hours and wages

Table 2 presents some statistics related to the extensive and intensive margin of part-time and full-time workers per country. It first shows important differences in the share of part-time workers across countries, ranging from 19.0% in France to 50.9% in the Netherlands (see column 1). Regarding the intensive margin, column 2 indicates low dispersion in the average number of hours worked by full-time workers, varying between 35.9 in Denmark to 39.5 in Sweden. In turn, column 3 shows that the average part-time worker works between 51.1% and 64.4% of the hours worked by a full-time employee, while column 4 reveals the presence of an important dispersion in hours worked among part-time workers, with a standard deviation in FTE between 18.7 and 32.6 percentage points in Italy and Denmark, respectively.

[3]Most of the questions of the SES refer to October because this month has the advantage of being considered normal in all EU countries, in the sense that it is not affected much by seasonal variations or by payments which fall due in more than one month's time, such as Christmas bonuses.

Table 1: Average weekly hours worked according to SES and LFS

Country:	Hours paid (SES)	Hours worked (LFS)
Finland	36.2	36.5
France	35.9	36.2
Germany	32.0	34.5
Italy	34.0	35.7
Netherlands	29.7	29.4
Norway	32.8	33.9
Portugal	38.2	39.5
Spain	36.0	36.5
Sweden	36.1	36.2

Note: The hours paid are taken from the 2018 Survey of Earnings Structure (SES) and correspond to the monthly hours effectively paid in the reference month divided by 4.35 weeks. In turn, the hours worked from the Labor Force Survey (LFS) are taken from the OECD Statistics and correspond to the average usual weekly hours worked of all dependent employees on their main job in 2018.

Figure 1 shows the distribution of weekly normal hours of part-time (grey) and full-time (blue) workers.[4] First, there is an important concentration of full-time hours worked between 35 and 40 hours in all countries, except in France and Italy where there is higher dispersion. Secondly, there is much more dispersion in the hours of part-time employees, fluctuating between 1 and 40 hours. Finally, some part-time workers overlap their hours worked with full-time employees. This is mainly explained by the fact that the collectively agreed number of full-time hours worked is not equal across establishments.

The wage equation (2.7) in Section 2 states that the presence of costs of deviating from the usual hours within the firms can generate lower hourly wages for those working few hours. In Figure 2 we plot the distribution of such deviations (measured by full-time equivalent). We find that there is an important dispersion in the distribution of normal hours per part-time employee at the establishment level.

Regarding the relationship between hours worked and hourly wage, the continuous line in Figure 3 suggests that the hourly wage rate is strongly non-linearly affected by working hours. It indicates that the hours-wage relationship is not constant across hours worked, displaying a hump-shaped pattern in most of the countries except in Portugal an France, where they show some kind of U-shaped relationship.

Additionally, in terms of FTE and hourly wage (dashed line), the relationship is positive in most of the countries suggesting the presence of a wage penalty that increases with the gap of hours worked between full and part-time workers.

[4]Long hours, which we define as more than 50, are relatively uncommon, accounting for less than 1 percent of observations in most of the countries. Thus, we re-coded them as 50 hours.

Table 2: Descriptive statics of weekly paid hours in 2018

Country:	Part-time share (%)	Full-time hours	FTE-Average (%)	FTE-Std.
Denmark	24.8	35.9	51.1	32.6
Finland	13.7	38.2	61.5	20.8
France	19.0	35.6	64.4	22.7
Germany	39.6	39.0	50.2	27.0
Italy	17.9	38.8	62.0	18.7
Netherlands	50.9	38.9	60.8	25.0
Norway	27.0	37.3	62.5	24.4
Spain	22.9	39.0	57.4	25.1
Sweden	46.0	39.5	64.4	25.9

Note: The hours paid are taken from 2018 Survey of Earnings Structure(SES) and correspond to the monthly hours effectively paid in the reference month divided by 4.35 weeks. FTE refers to Full-time equivalent employee.

4 Empirical model and identification strategy

We first estimate a series of ordinary least squares models (OLS) for each country to establish correlations between our variables of interest. Thus, we use the following empirical equation:

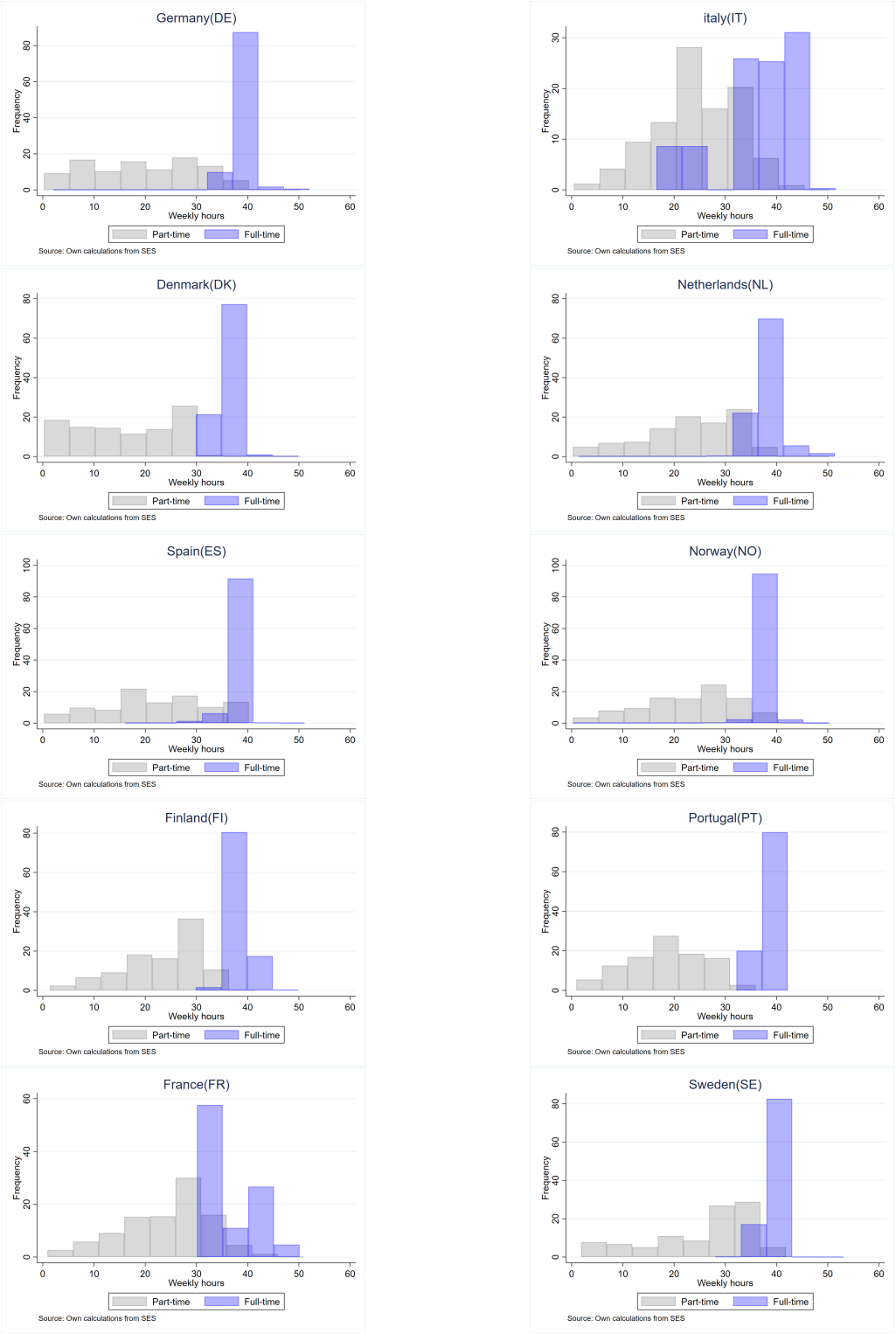
$$lnw_i = \beta_0 + \beta_1 h_i + \beta_2 h_i^2 + \beta_3 FTE_i + \beta_4 FTE_i^2 + \beta_5 PT_i + \gamma' \mathbf{X_i} + \varepsilon_i \tag{4.1}$$

where i denotes an individual, lnw_i denotes log of the paid hourly wage, FTE_i the full-time equivalent measure, h_i the number of paid weekly normal hours and PT_i is a dummy equals 1 for part-time employees and 0 for full-time ones. This last variable captures the unexplained wage gap between part-time and full-time workers. Notice that we are considering the quadratic terms in h_i and FTE_i to capture non-linearities in the wage-hours relationship. This corresponds to the theoretical implication in equation (2.7). The variable h captures the effect of hours on wages, while FTE_i captures the part-time wage penalty for deviating from the usual hours worked in the firm. $\mathbf{X_i}$ includes a set of characteristics that may reflect the firms characteristics (in the theoretical model those are mainly related to the productivity of the job positions (a in the theoretical model), and individual characteristics (the worker's cost of working x in the theoretical model). Importantly, we do not attach any causal significance to this estimated relationship but to establish correlations between our variables of interest.

According to our theoretical model presented in section 2, hours worked can affect hourly wage in two different ways. First, there is an effect related to presence of increasing or decreasing returns in labor productivity. In the first (second) case hourly wage increases (decreases) with hours worked. An increase in hours worked can also increase hourly wage by reducing the relative importance of fixed cost per worker. In the empirical model we cannot distinguish both effects, and we capture the potential non-linear effect of hours on wages with parameters β_1 and β_2.

Second, the presence of costs of deviating from the usual hours at the firm level can create problems of coordination of part-time workers, affecting their productivity and, therefore, re-

Figure 1: **Distribution of hours among part-time workers**

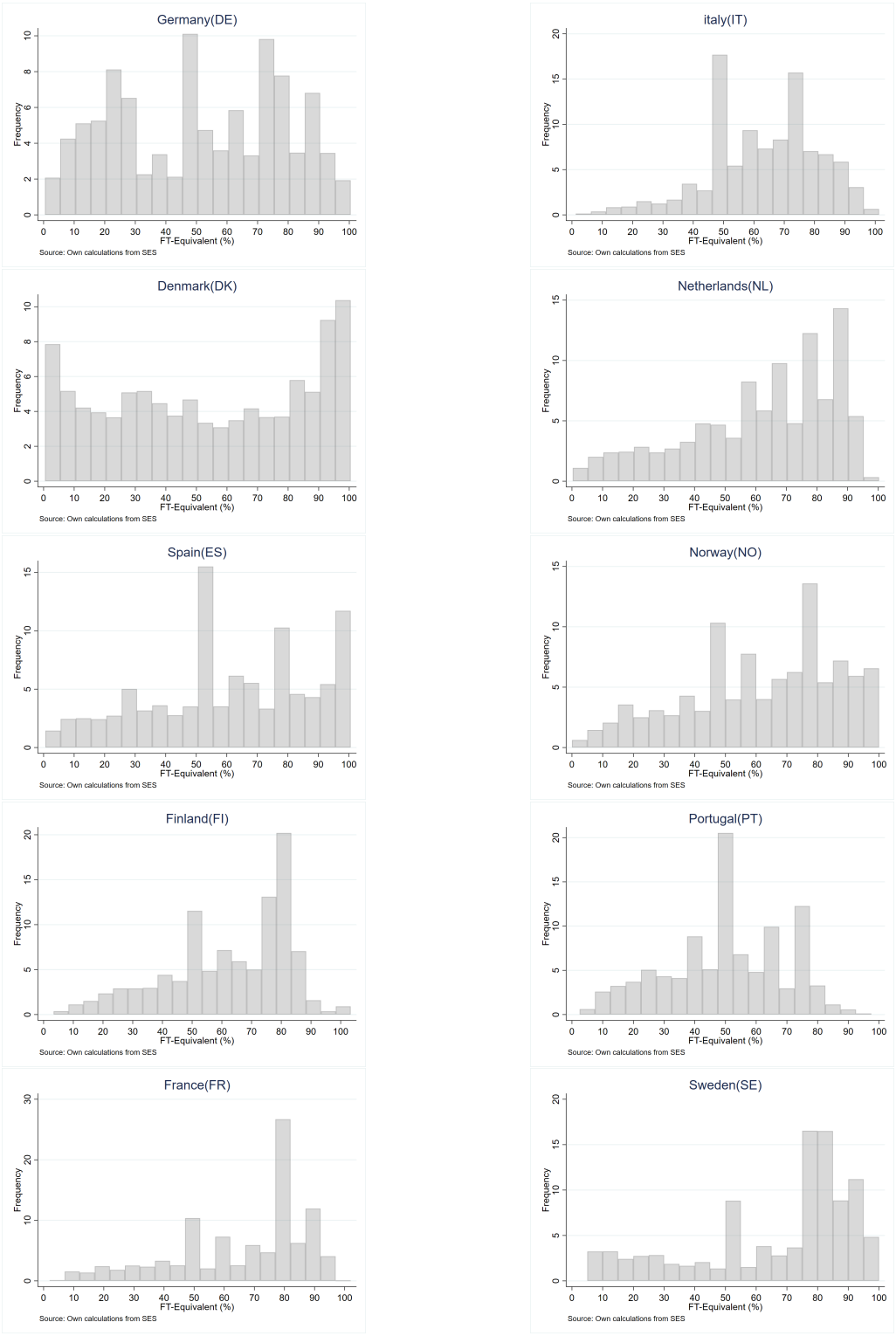


Note: Bands contain widths of 5 hours.

ducing their hourly wage. To capture this effect, we incorporate the FTE in a non-linear way (parameters β_3 and β_4).

To capture more complex relationships between our variables of interest an identification

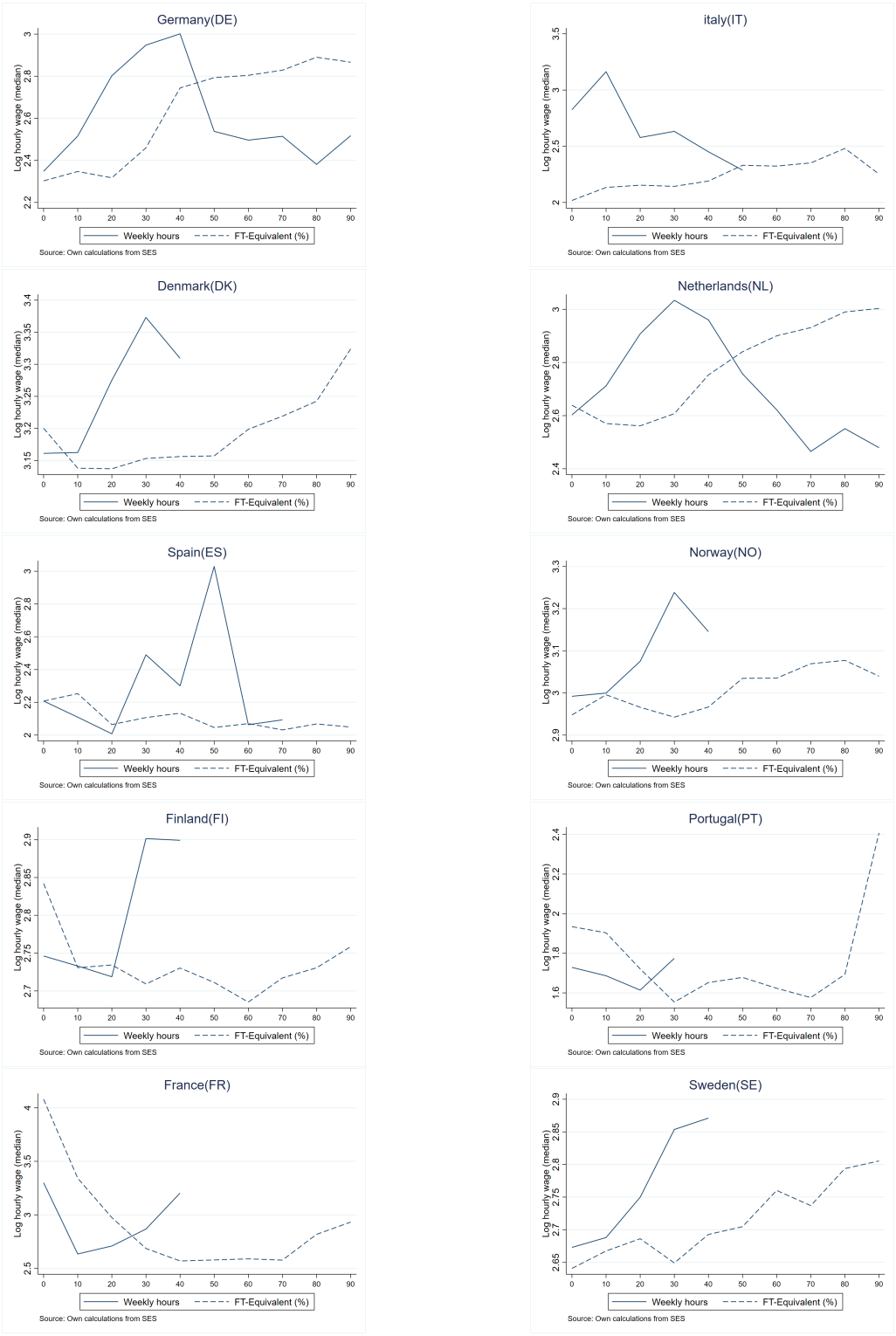
Figure 2: **Distribution of FTE among part-time workers**



Note: Bands contain widths of 5 hours.

strategy is implemented. We try to estimate an empirical model equivalent to the theoretical model reflected in equations (2.6) and (2.7) in alternative ways. A primary challenge to evaluating outcomes of non-randomised groups is self-selection bias. Individuals who choose to work

Figure 3: **Hours and FTE relationship with hourly wage**



Note: Bands contain widths of 5 hours.

part-time may differ from individuals who choose to work full-time (Rubin (2008); Rosenbaum (2009)). Unobservable factors that affect the probability of an individual being in a part-time employment are likely to be correlated with the unobservable factors that affect the outcome

variable (earnings).

The most common matching approach is to match on a propensity score (Rosenbaum & Rubin, 1983). More recently, however, some researchers have advocated using coarsened exact matching (CEM; Iacus et al., 2011). The advantages of using CEM rather than propensity matching include the fact that increasing the balance on one variable cannot increase the imbalance on another (this can happen in propensity matching), ease of implementation, less sensitivity to measurement error, and greater computational efficiency. In CEM, variables are *coarsened* by categorising prior to creating the strata, after which individuals are placed into the appropriate stratum (Iacus et al., 2011). Strata including at least one individual in each group (full-time and part-time) are retained in the analysis, while all other strata (and the individuals in them) are excluded. A weight is created for each unit in the retained strata.

Then, we estimate the hourly wage taking into account the self-selection into part-time and the potential endogeneity of hours worked. Hence, our model includes the mechanisms determining (i) the hourly wage, as in equation (2.7) and (ii) the hours worked, as in equation (2.6). In order to identify the model, we instrument the weekly hours worked by using annual paid days of holiday leave (in full days). This variable is used by Bick et al. (2019) to estimate the number of weeks worked per year in the US and European countries. We assume there is a joint negotiation of hours worked and holidays without affecting hourly wages. More in detail, an increase in paid days of vacation is compensated by increasing hours worked per week without affecting hourly wages.[5] This mechanics may be relatively more important in part-time than in full-time workers since the former ones have more flexibility to adjust the number of weekly hours worked.

As stated before, the other explanatory variables included in the vector X capture characteristics of individuals and the attributes of their jobs and firms. We include controls relating to gender (male or female), age group category (4 groups), education (4 groups, ISCED-97), length of service in enterprise (and its squared) as individual characteristics. The characteristics of the job and firm are the size of the enterprise to which the local unit belongs (1-249, 205-499 and more than 500 employees), principal economic activity of the local unit (16 activities, NACE 1-digit), occupation (9 categories, ISCO-08)[6], form of economic and financial control (private or public), collective pay agreement (4 categories), type of employment contract (indefinite duration, fixed duration and apprentice), and if the worker does shift work (yes or not). See Table 3 for main descriptive statistics.

[5] Altonji & Usui (2007) and Fakih (2014) show the presence of a positive relationship between hourly wages and paid vacation leave in Canada and the US. The authors, however, do not control for hours worked in the empirical estimation of wages, which can be behind the significance of the estimated coefficients.

[6] The white collar occupation variable includes managers, professionals, technicians and associate professionals, clerical support workers and services and sales workers (ISCO-08). The blue collar occupation variables includes skilled agricultural, forestry and fishery workers, craft and related trades workers, plant and machine operators and assemblers and elementary occupations (ISCO-08).

Table 3: **Main descriptive statistics**

	Mean	Std. Dev.	Min	Max
Variable	Mean	Std. dev.	Min	Max
DE (Germany)	13.8%			
DK (Denmark)	30.6%			
ES (Spain)	3.3%			
FI (Finland)	4.5%			
FR (France)	3.8%			
IT (Italy)	3.5%			
NL (Netherlands)	2.2%			
NO (Norway)	33.2%			
PT (Portugal)	1.4%			
SE (Sweden)	3.8%			
Part-time	0.252	0.434	0	1
Hours	33.14	9.106	0.23	94.3
FTE	89.45	22.84	0.01	100
Individual Characteristics				
Female	0.494	0.500	0	1
Education				
Basic Educ.	0.155	0.362	0	1
Secondary Educ.	0.409	0.492	0	1
Tertiary Educ.	0.273	0.445	0	1
Tertiary Educ (+4y)	0.163	0.370	0	1
Tenure	7.205	8.286	0	45
Age				
20-29	0.186	0.389	0	1
30-39	0.255	0.436	0	1
40-49	0.282	0.450	0	1
50-59	0.277	0.448	0	1
Job-Firm Characteristics				
Annual days of holiday leave (in full days)	21.77	8.771	0	119
Form of economic and financial control				
Public control	0.393	0.489	0	1
Private control	0.607	0.489	0	1
Special payments for shift work				
No	0.667	0.471	0	1
Yes	0.333	0.471	0	1
Contract				
Indefinite	0.922	0.268	0	1
Temporary/fixed	0.067	0.250	0	1
Apprentice	0.011	0.105	0	1
Firm size				
50-249	0.218	0.413	0	1
250-499	0.212	0.398	0	1
+500	0.570	0.495	0	1
Activity				
Mining and quarrying	0.017	0.127	0	1
Manufacturing	0.131	0.338	0	1
Electricity, gas, steam and air conditioning supply	0.003	0.053	0	1
Water supply; sewerage, waste management and remediation activities	0.005	0.072	0	1
Construction	0.058	0.233	0	1
Wholesale and retail trade; repair of motor vehicles and motorcycles	0.112	0.315	0	1
Transportation and storage	0.040	0.196	0	1
Accommodation and food service activities	0.031	0.172	0	1
Information and communication	0.039	0.192	0	1
Financial and insurance activities	0.048	0.214	0	1
Real estate activities/professional, scientific and technical activities	0.037	0.188	0	1
Administrative and support service activities	0.081	0.273	0	1

(continued on next page)

Table 3: Main descriptive statistics (continued)

	Mean	Std. Dev.	Min	Max
Public administration and defence; compulsory social security	0.077	0.266	0	1
Education	0.097	0.296	0	1
Human health and social work activities	0.190	0.392	0	1
Arts, entertainment and recreation/other service activities	0.036	0.186	0	1
Occupation				
Managers	0.013	0.114	0	1
Professionals	0.064	0.246	0	1
Technicians and associate professionals	0.062	0.242	0	1
Clerical support workers	0.038	0.191	0	1
Service and sales workers	0.043	0.204	0	1
Skilled agricultural, forestry and fishery workers	0.001	0.031	0	1
Craft and related trades workers	0.023	0.151	0	1
Plant and machine operators and assemblers	0.019	0.138	0	1
Elementary occupations	0.735	0.441	0	1
Collective				
National level or inter-confederal agreement	0.124	0.330	0	1
Industry agreement	0.417	0.493	0	1
Agreement for individual industries in individual regions	0.018	0.134	0	1
Enterprise or single employer agreement	0.039	0.194	0	1
Agreement applying only to workers in the local unit	0.001	0.033	0	1
Any other type of agreement	0.024	0.153	0	1
No collective agreement exists	0.376	0.484	0	1
N. observations	6,223,755			

[a] Information not available in 2005.

[b] Information only available in 2019.

[c] F refers to father and M refers to mother.

[d] WC (BC) refers to white-collar (blue-collar) occupation.

5 Results

Table 4 (Panel A) shows the OLS estimated coefficients capturing the correlations between hours worked and hourly wage as well as the unexplained part-time wage gap. We can observe that the coefficients related to hours and FTE are significant in all countries. Notice that, hours worked has a negative coefficient except in Portugal, indicating that the hourly wage falls with hours worked. This relationship, however, can be non-linear since the coefficient of hours square is also significant in most of the countries. In turn, in all countries except in France and Portugal the estimated coefficient of FTE is positive, implying that a reduction in the hours gap between full-time and part-time hours worked (an increase in FTE) is positively associated to an increase in hourly wages.

Regarding the coefficient of the part-time dummy PT, we observe a negative coefficient in most of the countries. This would imply the presence of a potential unexplained part-time wage penalty after controlling not only for the employer and employee characteristics but also for the hours-wage relationship. This unexplained wage penalty ranges from -0.9% in Germany to -14.0% in Italy. In contrast, Denmark and France shows a part-time wage premium of 2.9% and 14.2%, respectively. Finally, the unexplained part-time wage gap is not statistically significant in Netherlands and Portugal.

To capture the most complex relationship between hours and wages, controlling for self-selection and estimating extended regression models, we present in Table 4 (Panel B). The

Table 4: **Relationship between weekly worked hours and gross hourly wage**

	DE	DK	ES	FI	FR	IT	NL	NO	PT	SE
PANEL A: OLS										
Hours	-0.010***	-0.022***	-0.005	-0.006	-0.053***	-0.055***	0.005	-0.163***	0.031***	-0.169***
	[0.001]	[0.001]	[0.007]	[0.006]	[0.004]	[0.002]	[0.003]	[0.002]	[0.008]	[0.005]
$Hours^2$	0.000	0.000***	-0.000*	-0.000*	0.001***	0.000***	-0.000***	0.002***	-0.001***	0.002***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
FTE	0.006***	0.005***	-0.005	-0.001	-0.007***	0.023***	-0.003*	0.060***	-0.012**	0.064***
	[0.001]	[0.000]	[0.003]	[0.002]	[0.002]	[0.001]	[0.001]	[0.001]	[0.004]	[0.002]
FTE^2	0.000	-0.000***	0.000***	0.000**	0.000***	-0.000***	0.000***	-0.000***	0.000***	-0.000***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
PT	-0.020***	0.029***	-0.099***	-0.057***	0.142***	-0.140***	-0.003	-0.042***	-0.066	-0.009*
	[0.003]	[0.001]	[0.008]	[0.006]	[0.011]	[0.008]	[0.005]	[0.001]	[0.042]	[0.004]
PANEL B: CEM-ERM										
Hours	-0.011***	-0.009***	-0.068***	-0.014*	-0.047***	-0.074***	0.014***	-0.143***	0.037***	-0.131***
	[0.002]	[0.001]	[0.004]	[0.006]	[0.004]	[0.001]	[0.003]	[0.002]	[0.006]	[0.004]
$Hours^2$	0.000***	0.000***	0.001***	0.000*	0.001***	0.001***	-0.000***	0.002***	-0.001***	0.001***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
FTE	0.010***	0.002***	0.021***	0.010***	-0.014***	0.025***	-0.008***	0.053***	-0.023***	0.051***
	[0.001]	[0.000]	[0.002]	[0.002]	[0.002]	[0.001]	[0.001]	[0.001]	[0.003]	[0.002]
FTE^2	-0.000***	-0.000**	-0.000***	0.000	0.000***	-0.000***	0.000***	-0.000***	0.000***	-0.000***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
PT	-0.066***	0.010***	-0.150***	-0.053***	0.130***	-0.159***	0.023***	-0.078***	0.094+	-0.014***
	[0.003]	[0.001]	[0.007]	[0.008]	[0.012]	[0.007]	[0.006]	[0.001]	[0.053]	[0.004]
Var(Resid)	0.081***	0.061***	0.118***	0.066***	0.144***	0.089***	0.099***	0.064***	0.101***	0.044***
	[0.000]	[0.000]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.000]	[0.001]	[0.000]
Var(horas)	30.333***	50.830***	31.076***	31.019***	31.927***	29.210***	41.358***	2.395***	8.302***	14.514***
	[0.103]	[0.070]	[0.190]	[0.227]	[0.209]	[0.136]	[0.356]	[0.022]	[0.119]	[0.107]
Corr(h,lnw)	-0.134***	-0.151***	-0.062***	-0.465***	-0.005	-0.109***	-0.033***	-0.092***	-0.105***	-0.152***
N	852,413	1,884,340	202,550	279,401	230,644	215,751	136,480	2,053,659	88,090	236,738

Note: Standard errors into parenthesis. $^{+}p < 0.1$, $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

Note: In all models we control for gender, age, education level, tenure, size of the firm, activity, occupation, private sector, shift work, type of contract and the existence of collective agreement. Parameters regarding these characteristics are reported in Table **??**

estimated coefficient of FTE is now significantly in all countries. It is positive in all countries except France, Netherlands and Portugal, implying that the hourly wage increases with a reduction in the hours gap between full-time and part-time hours worked (an increase in FTE). Additionally, the coefficient of the squared FTE is also significant in most of the countries, implying a non-linear relationship between FTE and wages. In turn, hours worked has a negative coefficient except, again, in Netherlands and Portugal, indicating that the hourly wage falls with hours. This relationship, however, is non-linear since the coefficient of the squared $Hours$ is also significant all countries.[7]

Note that the correlation between the errors of earnings and hours is significantly different from zero in all countries except in France. In particular, the negative correlation implies that the unobserved factors that increase the number of hours worked decrease the level of earnings.

The weekly hours are instrumented by paid holidays, which is not weak. The F-statistic of the first stage, for each country, is large enough to be higher than the critical values obtained in Stock & Yogo (2005).[8] As we only incorporate one instrument (due to availability of data) a test of overidentification cannot be performed. So, alternatively, we perform different tests to show the goodness of our instrument. First, we have calculated the correlations between our dependent variable (log of hourly wage), our endogenous variable (hours worked) and the instrument (holidays). Data shows that the correlation of the instrument with hours worked more than doubles the correlation with log of hourly wages. Secondly, we run a regression of the residuals of the hourly wage equation onto the instrument. Although the parameter cannot be rejected to be zero, the magnitude is so small (around e(-04)) that there is no economic relevance on this relationship.[9] Third, the variability of holidays is large and the parameter of holidays into hours worked is significantly different from zero. Thus, although we are conscious that our instrument are far from perfect, it is not a weak instrument and it would help to better identify the relationship between hourly wage and hours worked.

To better visualize the relationship between hours and wages, we next plot the effects of increasing the number of hours worked as well as the FTE.[10] We present in Figure 4 the effect of hours worked by keeping constant the FTE and the rest of control variables. It displays the difference in the log of the hourly wage with respect to an individual working 40 hours per week. We do not include hours above 40 because we focus the analysis in part-time workers. Moreover, long hours represent a small fraction of hours worked across our sample of European countries. Interestingly, the figure shows the presence of a wage premium that, in general, decreases monotonically with the increase in the number of hours worked. According to our

[7] Table A.1 in the appendix shows the estimated system of equations for hours and log of hourly wages with the covariates considered in each equation.

[8] Table A.1 includes the statistics.

[9] Figure A.2 in the appendix shows, the estimated effects of holidays on the unexplained wages are around zero, suggesting the no economic impact of holidays on wages. In contrast, holidays and hours worked are positively correlated. A statistical significant regressor in large sample does not necessary means that it is economically relevant. It may implies that the sample size is large enough so that we can be highly confident that we will have similar estimates if we have data on the entire population. See McCloskey (1985) and McCloskey & Ziliak (1996) for an interesting discussion on the statistical and economic significance of the regressors.

[10] We present both estimations the OLS regresssions and the extended regression model with CEM matching. However, we only comment on the latter one.

theoretical model in section 2, this behavior can be explained by the presence of decreasing returns in the production function that reduces the labor productivity with an increase in hours worked. The only exceptions are Netherlands and Denmark where our results show the presence of a small wage penalty (not higher than 8%) in part-time hours worked. The former country shows a wage penalty that first increases until 25 hours worked and then decreases. The latest country displays a hump-shaped hours-wage relationship with a wage penalty until 20 hours worked and a premium after these hours worked. According to our theoretical model, fixed costs can be important enough in these two countries to generate a wage penalty in individuals working few hours.

Figure 4 also shows an important differences in the magnitude of the wage premium for working short hours across countries. For example, we observe that the log of the hourly wage of an individual working 10 hours in Sweden is 1.8 times higher with respect to an employee working 40 hours per week. In contrast, that wage premium is less than 20% in Finland.

Regarding the cost of deviating from the usual hours working by full-time workers, Figure 5 shows the effect of FTE by keeping constant the hours worked. We can observe a wage penalty that decreases with FTE. The exceptions are the Netherlands, France and Portugal, showing an U-shaped wage penalty. Through the lens of our model, if the distance between part-time hours worked and usual hours of full-time workers increases, then it is more difficult to coordinate the production of part-time workers, which penalizes their wages.

Figure 5 also compares the size of the effect of FTE on wages across countries. For example, the wage of a part-time worker working 10% of the usual full-time hours in Spain is almost 1.5 times lower with respect to working 100% of the usual hours. In contrast, the corresponding wage penalty is less than 5% in the Netherlands.

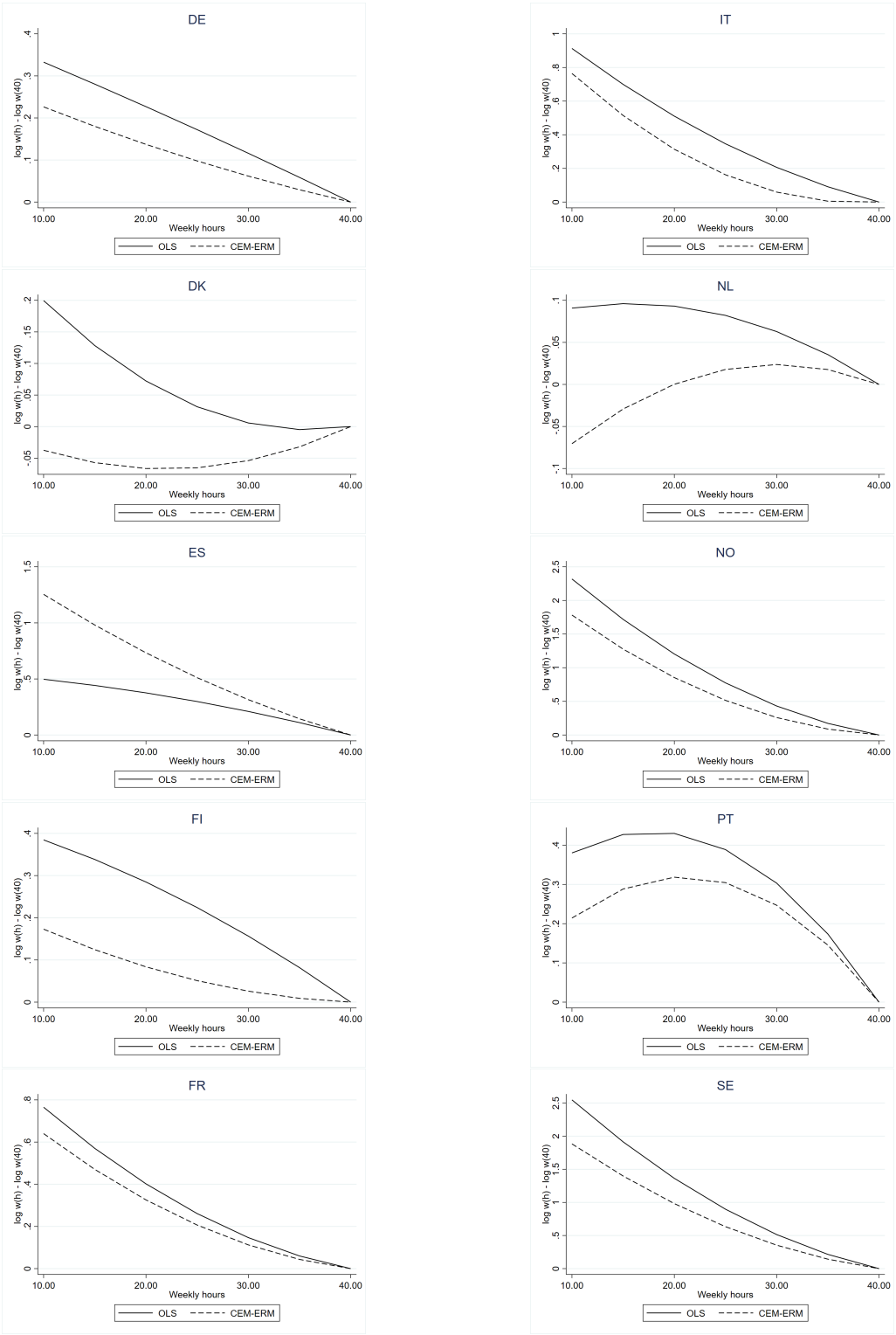
Summarizing, the hours-wage relationship shows the presence of two effects going in opposite directions. First, a part-time wage premium due to the presence of decreasing returns in the production function. Second, a FTE effect that generates a part-time wage penalty due to the presence of coordination costs. Thus, since both hours (h) and FTE (θ) change simultaneously, a natural question is to ask which of the two effects dominates the hours-wage relationship.

To account for the total effect, we next present an analysis that simultaneously changes hours and FTE when full-time individuals are working 40 hours. Thus, we simulate the predicted wage of an individual increasing her working hours from 10 to 40, with the corresponding adjustment in FTE.[11]

Figure 6 shows the total effect for each country. There is a final wage premium effect of hours worked in Spain and Italy and a penalty in the rest of the countries, except France. In the former countries, the hours effect related to the presence of decreasing returns in productivity dominates the wage behavior, while in the latest countries, the deviation from usual full-time hours worked becomes more important. In contrast, France show a part-time wage premium below 15 hours and a wage penalty between 15 and 40 hours. As expected, the magnitude of the net effect is much lower when comparing the two effects. More in detail, working 10 hours with a FTE=25% generates a highest wage premium of 20% in France and a highest wage penalty of 50% in Finland.

[11] We use combinations of $h = 10$ with $\theta = 25\%$, $h = 15$ with $\theta = 37.5\%$,..., to $h = 40$ with $\theta = 100\%$

Figure 4: **Total effect of hours on the part-time wage gap**

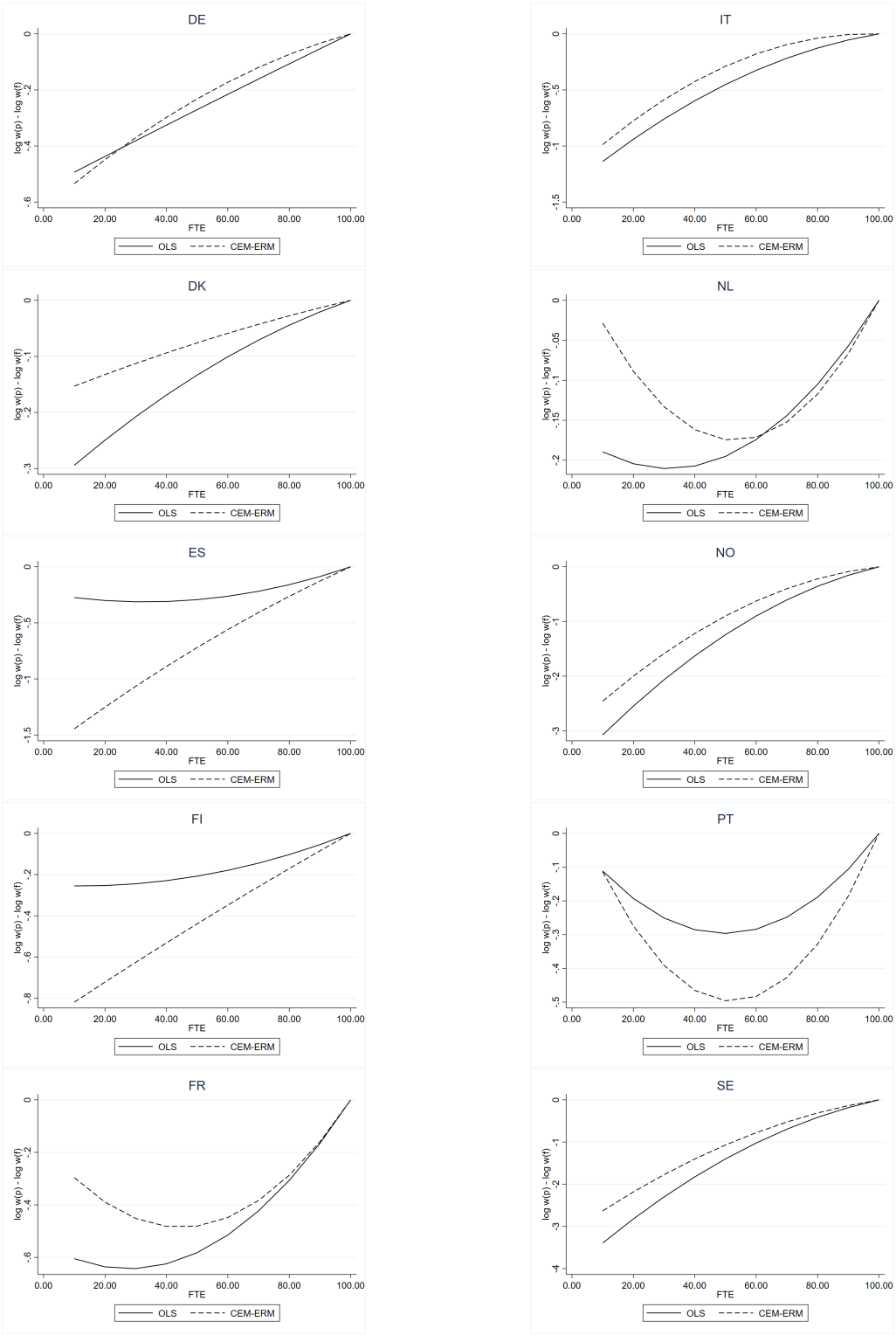


Note: Lines correspond to a predicted margins of hourly wage gap with respect to $h = 40$.

5.1 The unexplained part-time wage gap

The empirical literature shows the presence of a negative raw gap between the hourly wage of part-time and full-time employees across countries (Ramos et al., 2016). An important part

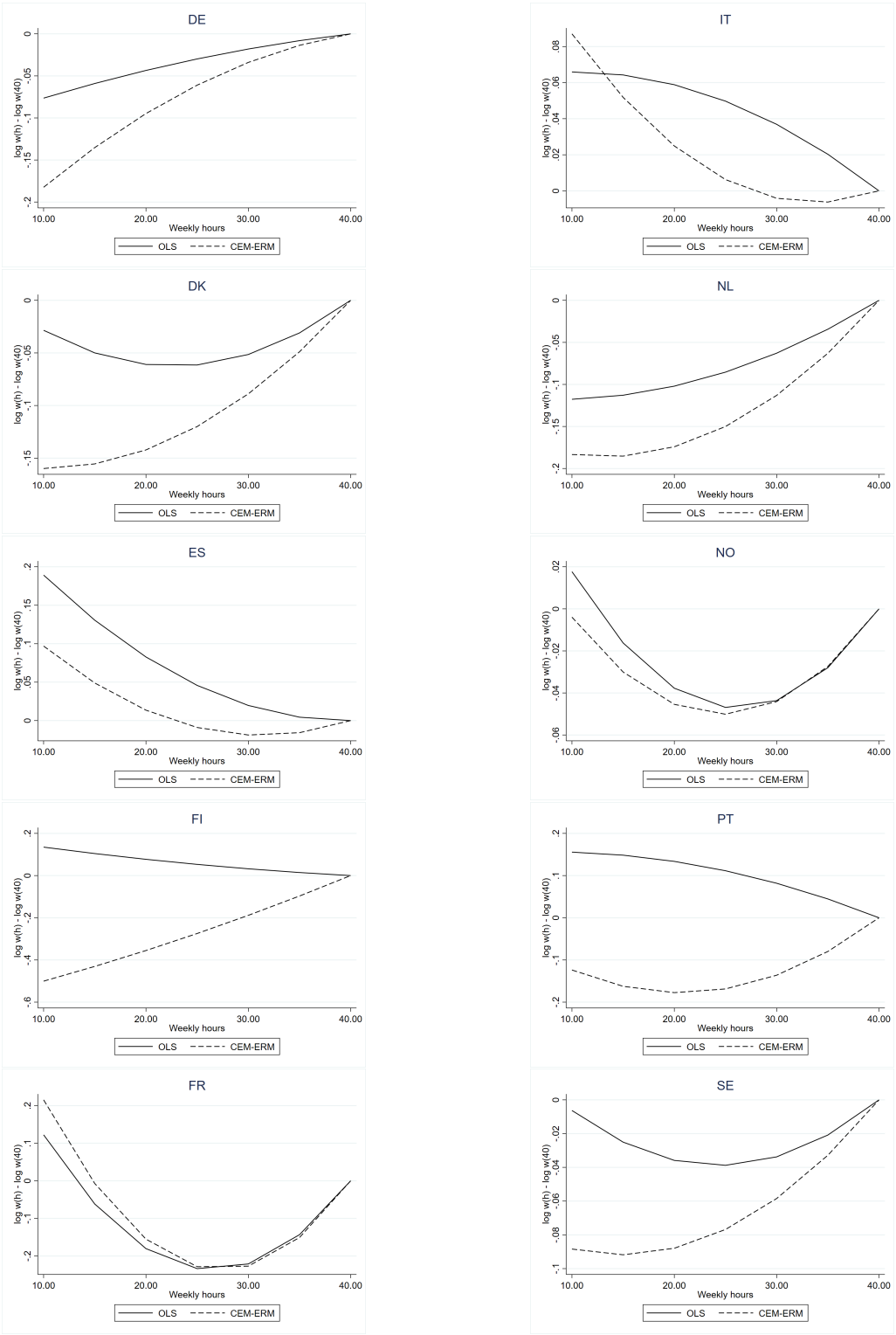
Figure 5: **Total effect of FTE on the part-time wage gap**



Note: Lines correspond to a predicted margins of hourly wage gap with respect to a $FTE = 100$.

of the wage penalty is explained by individual, job and firm characteristics. As we mention in the introduction, the empirical literature has not explored yet how the hours-wage relationship affects the unexplained part-time wage gap.

Figure 6: **Total effect of hours and FTE on the part-time wage gap**



Note: Lines correspond to a predicted margins of hourly wage gap with respect to $h = 40$ and $FTE = 100$.

We next analyze the impact of including hours and the FTE on it. Column (1-3) in Table 5 shows the raw wage gap between part-time and full-time workers using OLS. It shows the presence of an unconditional part-time wage penalty ranging between -7.9% in Portugal or -

12.9% in France to -32.2% in Italy. In turn, columns (2-3) show an important reduction in the part-time wage penalty of all countries when individual characteristics are included (column 2), changing to a wage premium in Denmark and Portugal. In turn, the third column shows that the wage gap also changes considerably when we do not only control for workers and firms characteristics but also for hours and FTE. For example, in France the wage penalty of -2.2% shift to a wage premium of 14.2%, while in Spain the wage penalty increases from -2.2% to -9.9%.

When we move to our main specification (last column), we obtain a negative coefficient in most of the countries, except in Denmark, Netherlands, France and Portugal. In those countries we find that the wage premium appears (from 1.0% in Denmark to 13.0% in France). The wage penalty characterizes the rest of the countries, ranging from -1.4% in Sweden to -15.9% in Italy. This implies the presence of an unexplained part-time wage penalty after controlling not only for the employer and employee characteristics but also for the hours-wage relationship.

Table 5: **Relationship between weekly worked hours and gross hourly wage**

	OLS			CEM	CEM-ERM
	Null	X_i	X_i, h, FTE	X_i, h, FTE	X_i, h, FTE
DE	-28.1%***	-6.6%***	-2.0%***	-5.4%***	-6.6%***
DK	-15.4%***	3.8%***	2.9%***	0.5%***	1.0%***
ES	-23.4%***	-2.2%***	-9.9%***	-15.3%***	-15.0%***
FI	-19.0%***	-1.3%***	-5.7%***	-6.4%***	-5.3%***
FR	-12.9%***	-1.0%***	14.2%***	12.9%***	13.0%***
IT	-32.2%***	-9.4%***	-14.0%***	-15.9%***	-15.9%***
NL	-20.0%***	-7.7%***	-0.3%	2.1%***	2.3%***
NO	-22.5%***	-2.8%***	-4.2%***	-7.8%***	-7.8%***
PT	-7.9%***	2.0%*	-6.6%	8.0%	9.4%+
SE	-16.2%***	-2.0%***	-0.9%*	-1.5%**	-1.4%***

Note: Standard errors into parenthesis. $^{+}p < 0.1$, $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

Note: In all models concerning OLS extended, we control for set of characteristics X_i which include gender, age (and its squared), immigrant status, labour status, household type, equivalent income, tenure, number of children and degree of urbanization. We also control for parent characteristics like their level of education, number of parents and siblings, labour status, gender and age. Finally we consider also county fixed effects.

5.2 Heterogeneity

We now are interested in verifying the hours-wage relationship varies across subgroups of workers. While our previous analysis allowed for several controls variables, it did not allow them to interact with the shape of the wage-hours profile. To pursue this possibility, we repeat the analysis by splitting the sample by gender, age and education. The main goal from this subsection is to verify if the hours-wage pattern observed at the aggregate level holds for different groups of workers.

Starting with the gender differences, women are more likely to work part time because they spend more time on unpaid care work (Landivar, 2015; Charmes, 2019). According to the 2018

SES database, women range between 56.4% and 77.7% of total part-time workers in Denmark and France, respectively. Thus, it is important to study if there are differences in the hours-wage relationship by gender.

Regarding the number of hours worked, Figure 7 shows interesting patterns in the hours-wage relationship by gender, for the corresponding FTE.[12] In line with the general result observed in Figure 4, there is a wage premium in both males and females that tends to decrease with hours worked in Germany, Italy, Spain, Norway, Finland, France and Sweden. In the case of Denmark and Finland we observe a wage premium for males and a wage penalty in women. In turn, Netherlands and Portugal show an inverted U-shaped wage gap, which favours part-time males. Finally, we do not observe clear differences in the part-time wage gap by gender. For example, in Spain and France part-time males show higher wage premium (continuous line) while the opposite happens in Italy, Norway, and Sweden.

In turn, Figure 8 shows the presence of part-time penalty in the FTE-wage relationship of both males and females by keeping constant hours worked. This penalty monotonically decreases as FTE increases in all countries except in Netherlands, France and Portugal, which show a U-shaped penalty. Notice that the penalty is higher for males (continues line) in all countries except in Italy and Sweden.

Finally, we obtain that, once controlling for hours worked and FTE, the part-time wage penalty is higher for males than for females in Germany (-5.3% vs -4.6%), Spain (-15.8% vs 14.8%), Finland (-8.7% vs -4.0%), Italy (-21.7% vs -9.0%), Norway (-8.3% vs -4.6%) and Sweden (-2.1% vs -0.6%). This result is in line with Hirsch (2005) and Golden (2020), who also show a higher part-time wage penalty in males. In turn, France and Netherlands show an unexplained part-time wage premium in males and females. In the former case, the male part-time wage premium is 12.3% while the female one is 13.8%. In the latest country, the wage premium is 2.5% in both sexes. Finally, there is not a significant unexplained part-time wage gap in Portugal by gender.

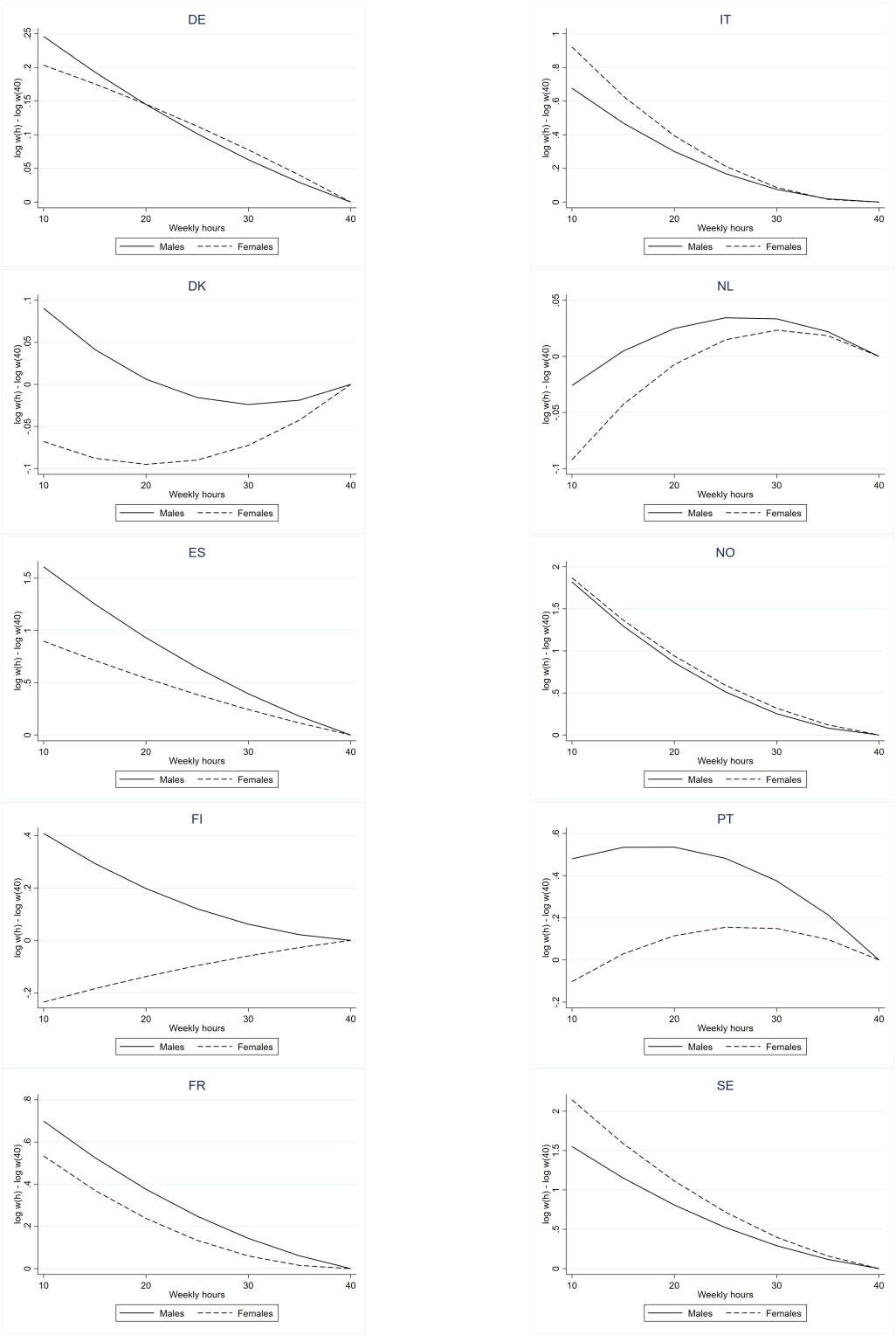
A person's age is relevant as an indicator of professional experience, career development and vertical segregation. It also indicates to what extent seniority and professional experience are reflected in pay. Looking for differences across age groups, Figure 9 shows the presence of a hours-wage part-time premium at ages 30-39 (blue line), 40-49 (red line) and 50-59 (green line) in Germany, Italy, Spain, Norway, France and Sweden.[13] The wage premium is higher for short-hours worked and tends to fall monotonically in these countries, suggesting the presence of decreasing returns in the production function. In contrast, we observe much more heterogeneity in the rest of the countries. For example, Denmark shows a part-time wage premium in only workers at age 20-29 and a penalty in the three others age groups. In turn, Finland shows a wage premium in all age groups except the youngest one. Important differences in the hours wage-relationship by different group of ages is also observed in Netherlands and Portugal. According to our theoretical model, differences in the size of fixed costs may help to explain the observed heterogeneity in the hours-wage relationship across age groups.

Figure 10 displays, for a given hours worked, the FTE-wage relationship for part-time workers

[12] Table A.2 in the appendix shows the estimated coefficients by gender.

[13] Table A.3 in the appendix shows the estimated coefficients by age.

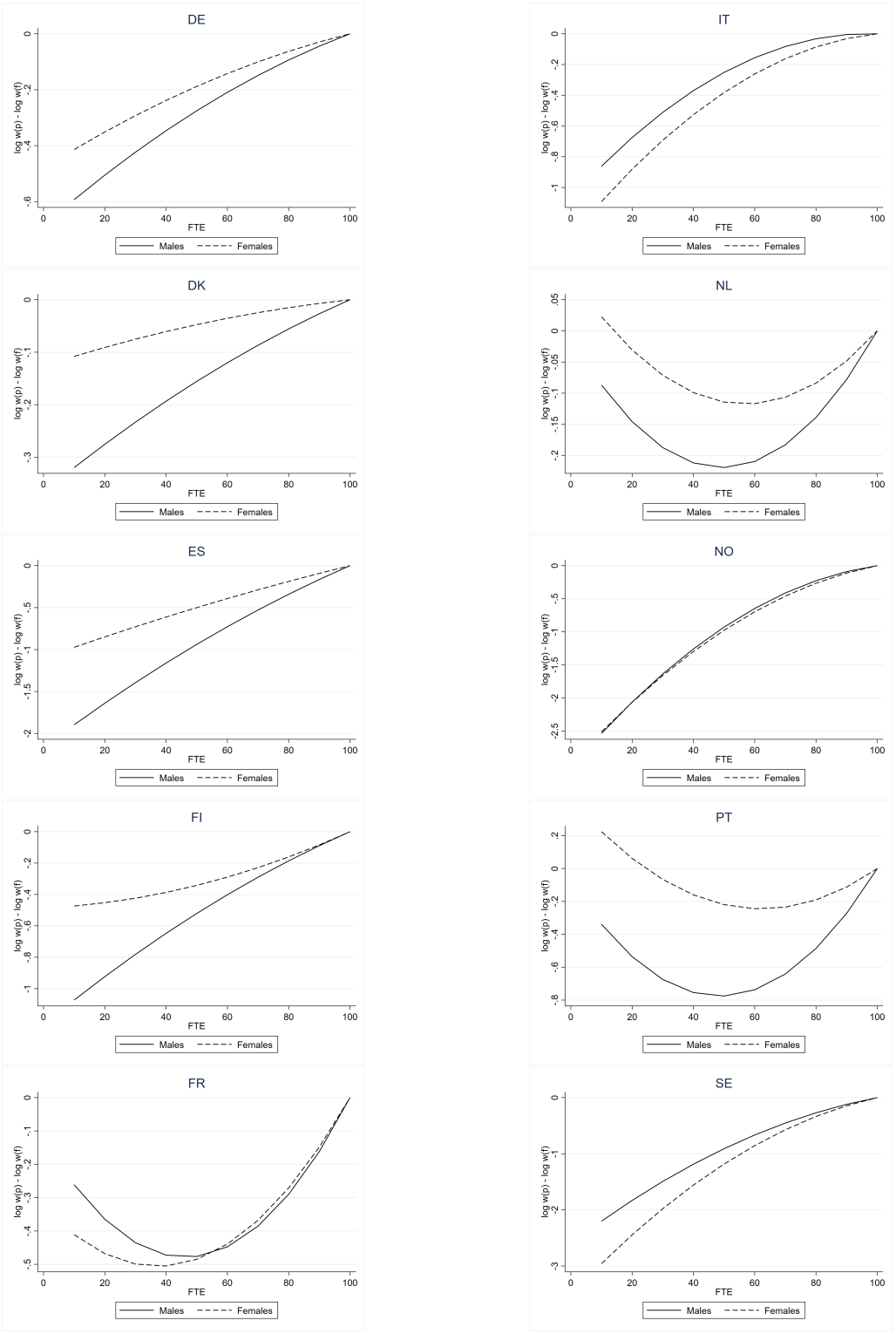
Figure 7: **Total effect of hours on the part-time wage gap (Gender)**



Note: Lines correspond to a predicted margins of hourly wage gap with respect to $h = 40$.

by group of age. Similar to what we observe by gender, there is a wage penalty that tend to decreases with FTE across age in all countries except in Netherlands, France and Portugal which shows a U-shaped part-time wage penalty. Regarding the unexplained part-time wage gap, we

Figure 8: **Total effect of FTE on the part-time wage gap (Gender)**

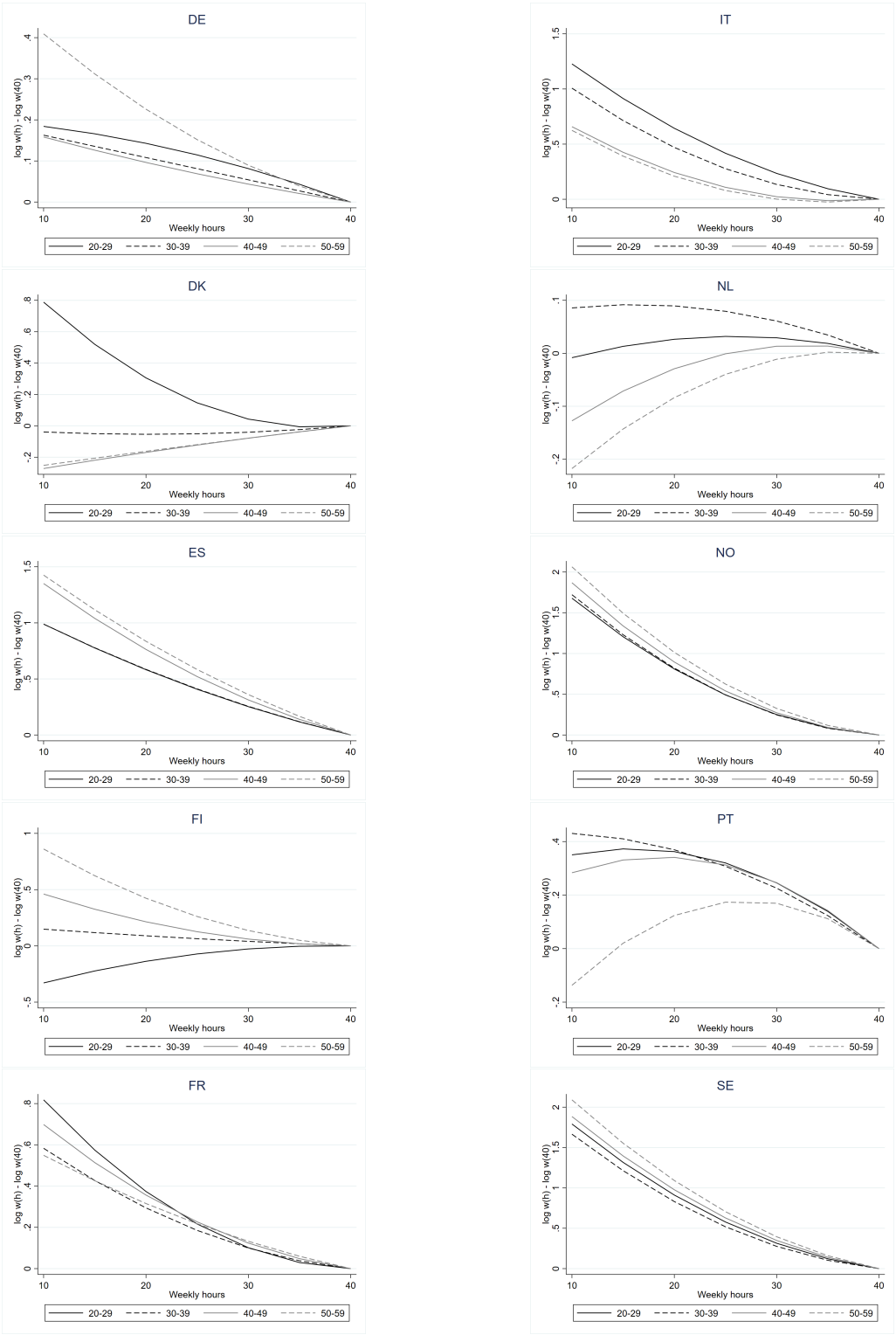


Note: Lines correspond to a predicted margins of hourly wage gap with respect to $FTE = 100$.

find that this gap is present in all age groups with no clear pattern among them.

Education is another important characteristic that can help to explain part-time wage gap. Figure 11 shows, for a given FTE, the hours-wage relationship for workers with primary, sec-

Figure 9: **Total effect of hours on the part-time wage gap (Age)**

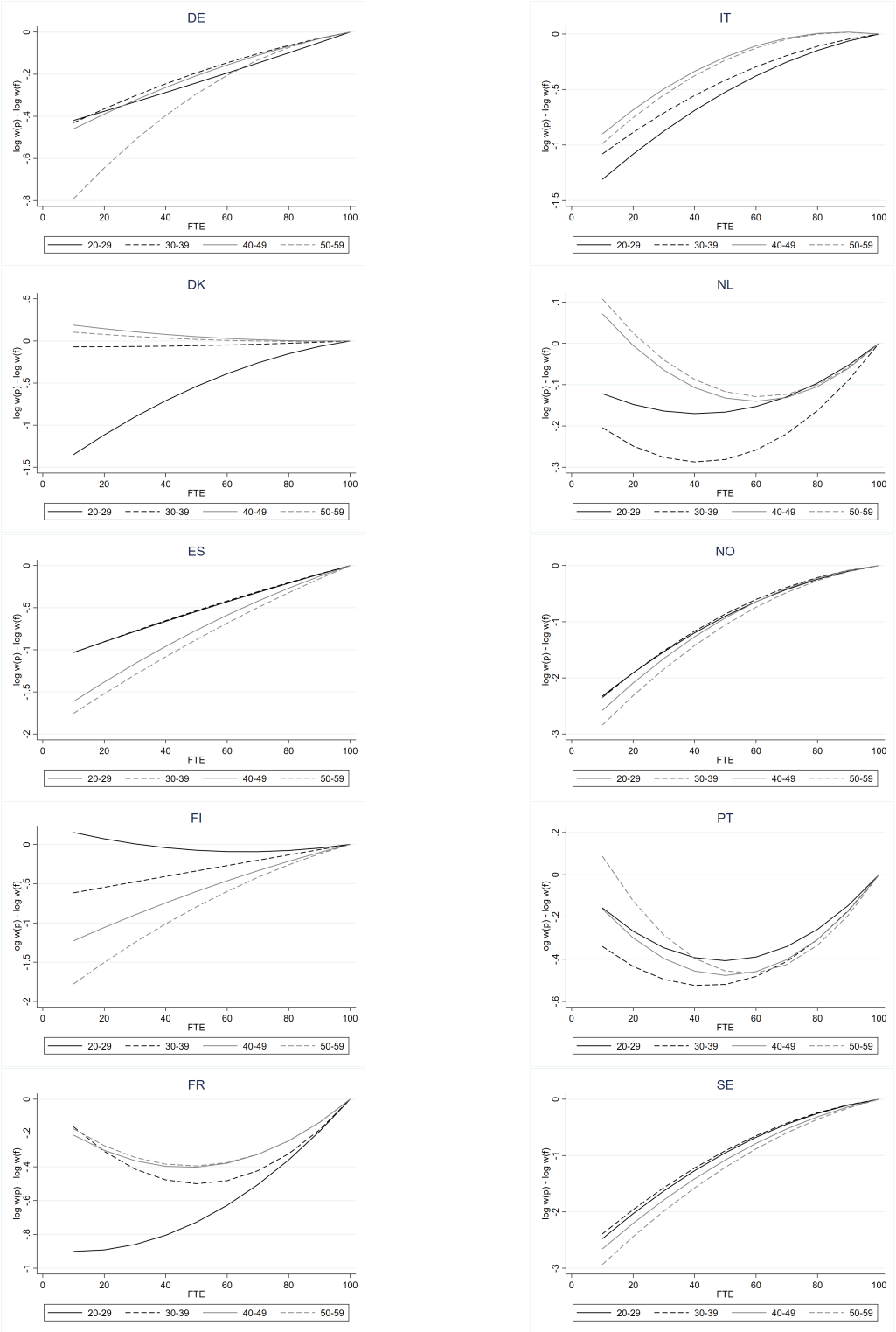


Note: Lines correspond to a predicted margins of hourly wage gap with respect to $h = 40$.

ondary and tertiary educational levels.[14] One more time, we can observe the presence of a wage premium in all educational levels that tend to decrease with the number of hours worked in Ger-

[14]Table A.4 in the appendix shows the estimated coefficients by education.

Figure 10: **Total effect of FTE on the part-time wage gap (Age)**



Note: Lines correspond to a predicted margins of hourly wage gap with respect to $FTE = 100$.

many, Italy, Spain, Norway, France and Sweden. Denmark, Netherlands, Portugal and Finland show different behaviors across educational groups. While primary and secondary education show a premium in Denmark, tertiary education presents a wage penalty that decreases with

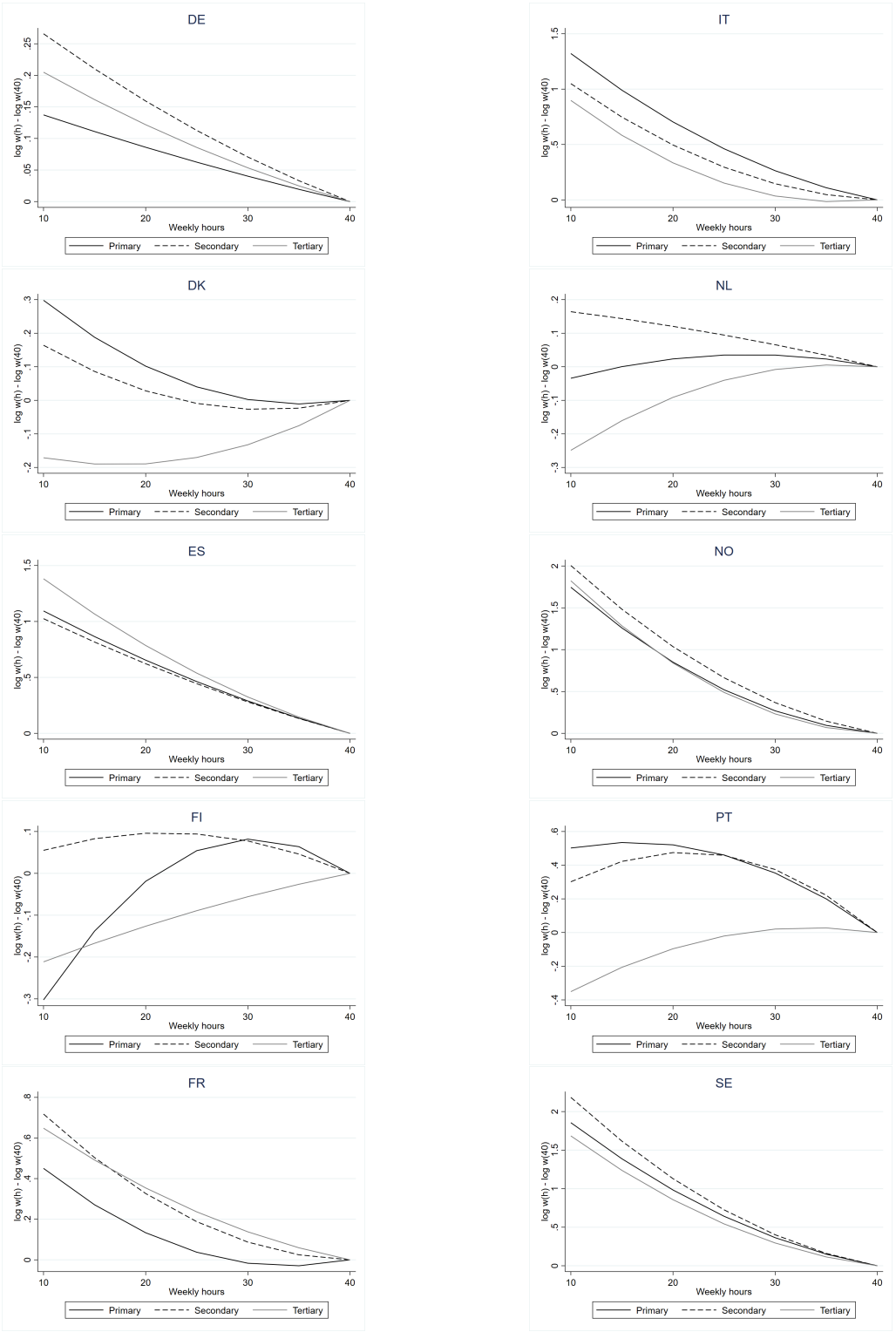
hours worked. Netherlands and Portugal also shows a part-time wage premium in secondary education and penalty in tertiary education. Finland shows similar behavior than Portugal in secondary and tertiary education but a penalty in primary education.

Focusing the analysis in the deviation of hours workers with respect to the usual full-time hours worked, Figure 12 shows the FTE-wage relationship for a given hours worked. Most of the educational groups show a wage penalty across countries. This penalty decreases monotonically in Germany, Italy, Denmark, Spain, Norway and Sweden. Finland shows a premium in primary and a penalty in the others two groups. France shows a U-shape part-time wage penalty in all groups while Portugal and Netherlands show a U-shaped wage premium in tertiary education and a penalty in primary and secondary education.

Finally, regarding the unexplained part-time wage gap, our results show the presence of a penalty in all educational groups of Germany, Spain, Finland, Italy and Norway, and a wage premium in Denmark, France and Netherlands. In Portugal the unexplained part-time wage gap is also positive and significant in tertiary education, while in Sweden is positive in secondary but negative in tertiary.

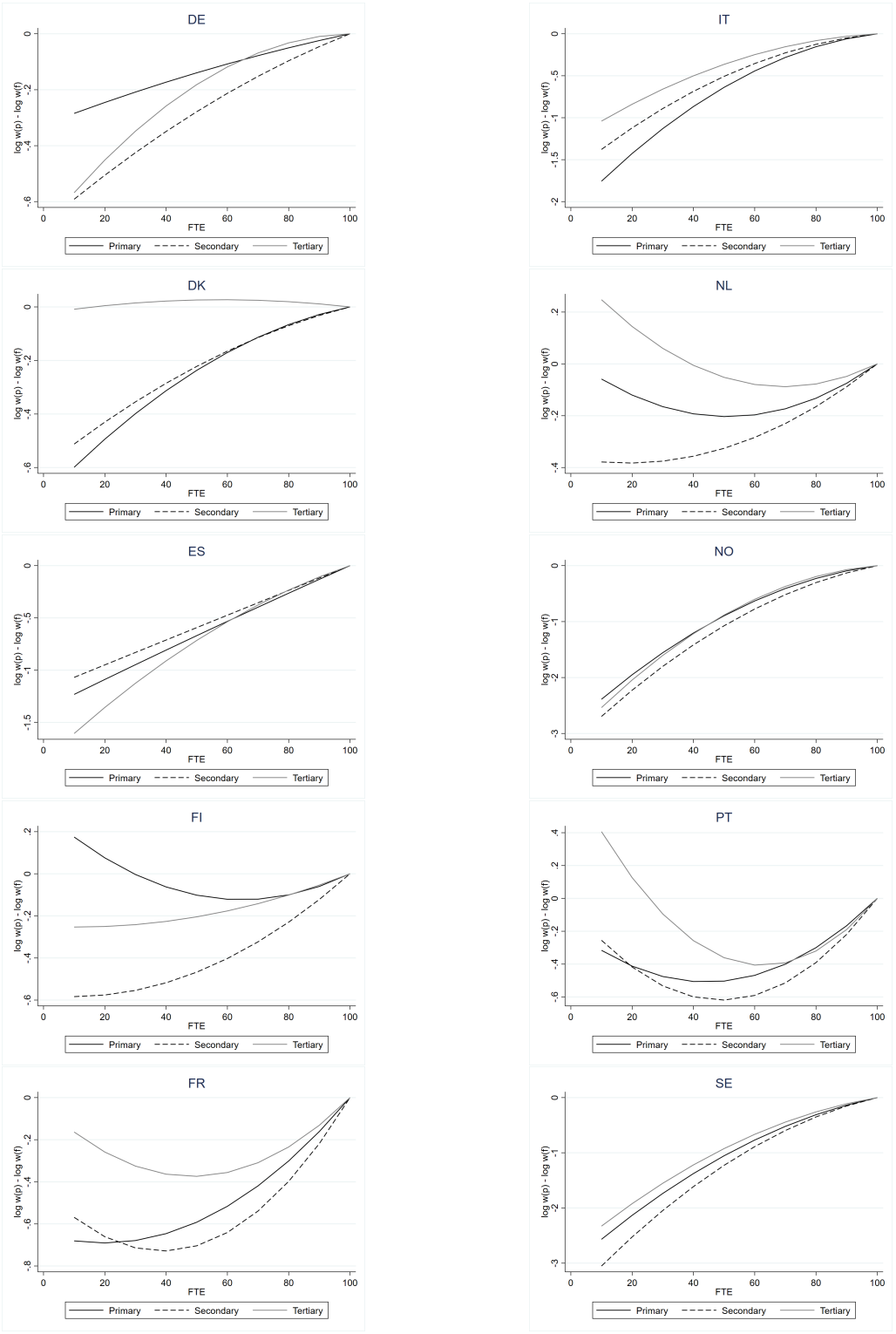
Summarizing, we observe in most of the countries the presence of a part-time wage premium that decreases with the number of hours worked and a part-time wage penalty that decreases with FTE across gender, education and age in all countries. According to our theoretical model, the former is due to the presence of decreasing returns in the production while the latest is related to the presence of coordination costs that penalize the hourly wage of short-hours worked. In some countries, however, we observe important heterogeneity in the hours-wage relationship across groups. According to our theoretical model, differences in the size of fixed costs may help to explain it.

Figure 11: **Total effect of hours on the part-time wage gap (Education)**



Note: Lines correspond to a predicted margins of hourly wage gap with respect to $h = 40$. Basic education includes less than primary, primary and lower secondary. Secondary education includes upper secondary and post-secondary (non-tertiary). Tertiary education includes short-cycle tertiary and bachelor or equivalent (up to four years).

Figure 12: **Total effect of FTE on the part-time wage gap (Education)**



Note: Lines correspond to a predicted margins of hourly wage gap with respect to $FTE = 100$. Basic education includes less than primary, primary and lower secondary. Secondary education includes upper secondary and post-secondary (non-tertiary). Tertiary education includes short-cycle tertiary and bachelor or equivalent (up to four years).

6 Conclusions

According to the OECD database, there is an important part-time raw wage penalty across countries. There is also an important dispersion in hours worked among part-time workers. Most of the empirical literature, however, has not explored yet how this wage penalty changes with the number of hours worked. Assuming a constant part-time wage penalty across hours may hide important non-linearities in the relationship between hours and hourly wages and, therefore, generates bias in the unexplained part-time wage gap.

In this paper, we study the hours-wage relationship in part-time jobs across 10 European countries. We first present a wage bargaining model with fixed and coordination costs. The model predicts that hours affect hourly wages through two different channels. First, there is an effect that can increase or decrease the hourly wage depending on the relative importance of the decreasing returns of production with respect to the size of the fixed costs. The second channel takes place when the part-time worker deviates from the usual hours worked. This deviation creates problems of coordination of part-time workers, which are costly for the firm, passing them to part-time workers in form of lower wages. Thus, according to the model, it is not only important to consider how many hours a part-time worker works but also how far away is from the usual hours worked by a full-time worker in the same firm.

We empirically test our model using employer-employee cross-sectional data from 10 European Union countries. We use the 2018 Survey of Earnings Structure (SES), which presents a more accurate definition of full-time and part-time workers based in the collectively agreed or customary hours worked in the local unit under consideration. The SES also provides information about the share of full-time's normal hours per employee at the establishment level, which we use to capture the costs of deviating from the usual hours worked in the firm.

We estimate a set of OLS regression models for each country. We also control for part-time self-selection bias using coarsened exact matching (CEM) and use extended regression models (ERM) by using paid holidays as an instrument of weekly hours. Our estimated results confirm the presence of two effects going in opposite directions. First, a part-time wage premium due to the presence of decreasing returns in the production function. Second, a part-time hour's gap effect that generates a wage penalty due to the presence of coordination costs.

We also perform the analysis by gender, education and age groups and observe similar hours-wage pattern across different groups of workers in all countries. Finally, we also show that the unexplained part-time wage penalty is considerably affected by the hours-wage relationship.

Future work can use other databases with more accurate information related to the presence of coordination and fixed costs and their effects on the relationship between hours worked and hourly wage. Moreover, even though holidays helps to better identify the relationship between hourly wage and hours worked, we are conscious that this instrument is far from perfect. Thus, future research should address the issue of endogeneity in hours worked by adding better or more instruments to avoid for possible bias in this relationship.

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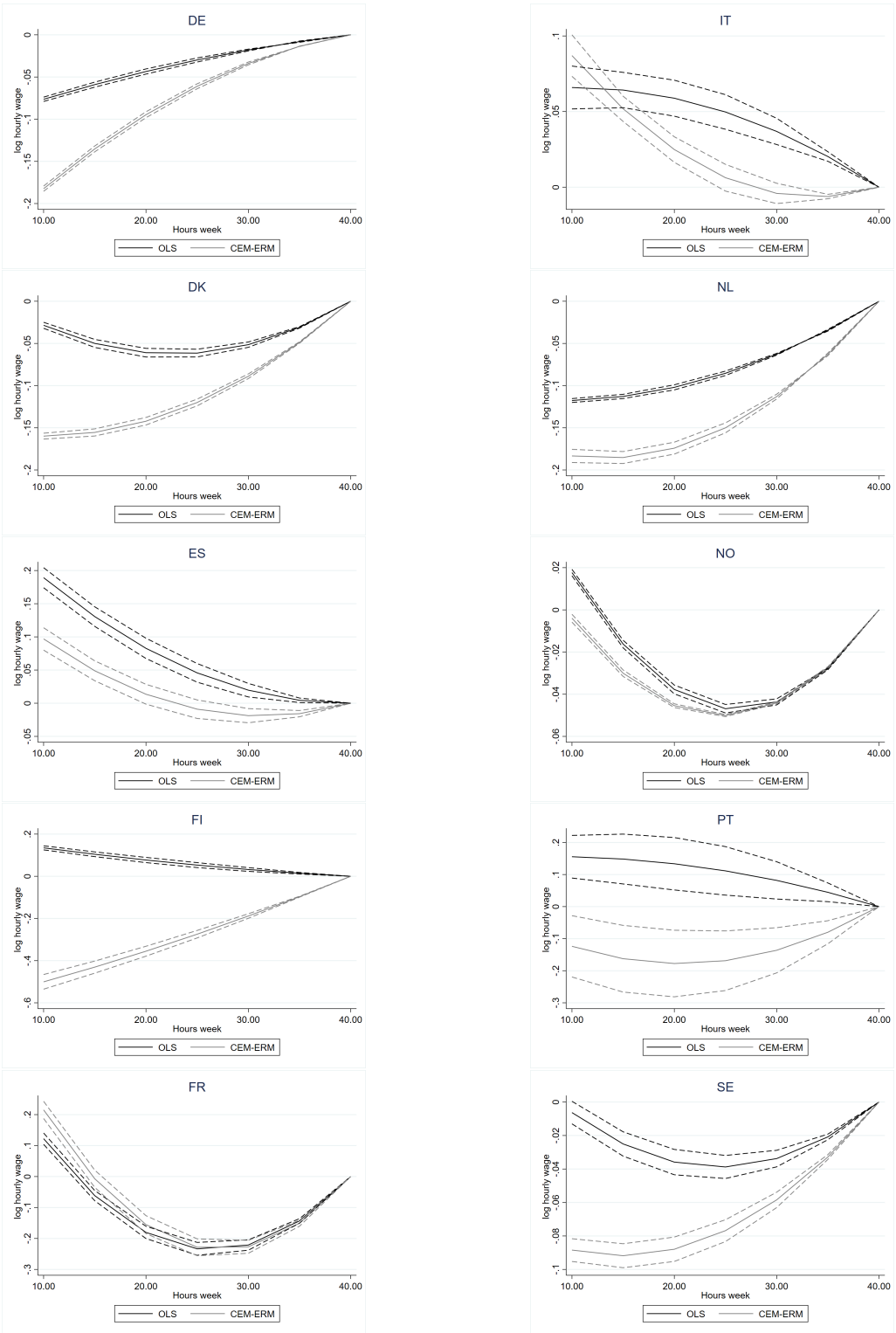
A Supplemental

Figure A.1: **Effect of hours and FTE among part-time workers**



Note: Figures correspond to a predicted margins of hourly wage gap with respect to an individual working 40 hours and FTE=100 with level of (90%)CIs.

Figure A.2: **The effect of holidays on hours and wage residuals**

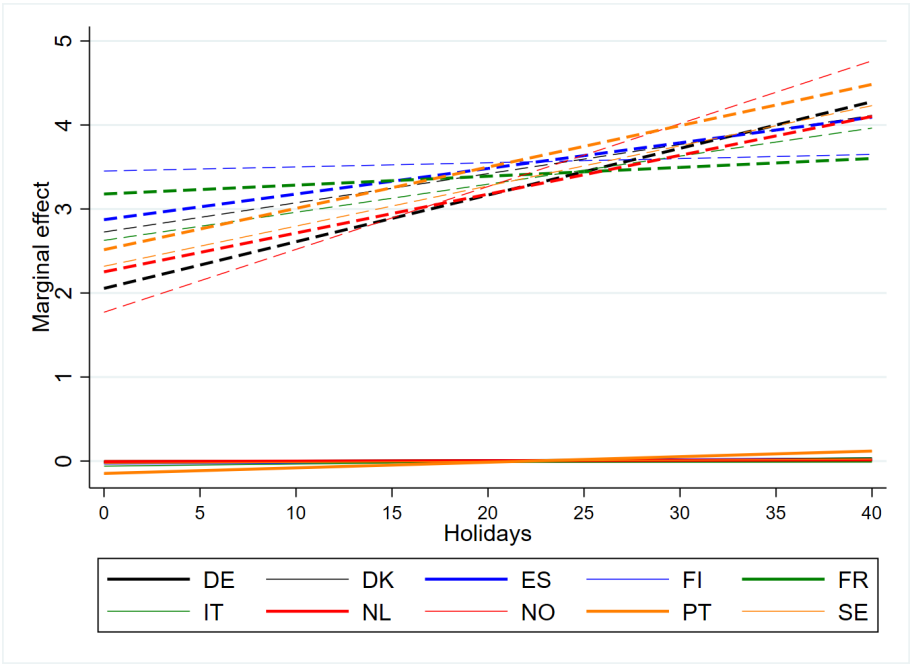


Table A.1: **Estimation results (full set of covariates)**

	DE		DK		ES		FI		FR		IT		NL		NO		PT		SE	
	Earnings	Hours	Earnings	Hours	Earnings	Hours	Earnings	Hours	Earnings	Hours	Earnings	Hours	Earnings	Hours	Earnings	Hours	Earnings	Hours	Earnings	Hours
Hours	-0.011***	-0.009***	-0.068***	-0.014*	-0.047***	-0.074***	0.014***	-0.143***	0.037***	-0.131***										
	[0.002]	[0.001]	[0.004]	[0.006]	[0.004]	[0.001]	[0.003]	[0.002]	[0.006]	[0.004]										
Hours^2	0.000***	0.000***	0.001***	0.000*	0.001***	0.001***	-0.000***	0.002***	-0.001***	0.001***										
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]										
FTE	0.010***	0.002***	0.021***	0.010***	-0.014***	0.025***	-0.008***	0.053***	-0.023***	0.051***										
	[0.001]	[0.000]	[0.002]	[0.002]	[0.002]	[0.001]	[0.001]	[0.001]	[0.003]	[0.002]										
FTE^2	-0.000***	-0.000**	-0.000***	0	0.000***	-0.000***	0.000***	-0.000***	0.000***	-0.000***										
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]										
PT	-0.066***	0.010***	-0.150***	-0.053***	0.130***	-0.159***	0.023***	-0.078***	0.094+	-0.014***										
	[0.003]	[0.001]	[0.007]	[0.008]	[0.012]	[0.007]	[0.006]	[0.001]	[0.053]	[0.004]										
Female	-0.081***	0.342***	-0.087***	-0.183***	-0.140***	0.238***	-0.122***	0.647***	-0.122***	0.259***	-0.077***	0.111***	-0.075***	0.045	-0.089***	0.014***	-0.133***	0.042	-0.058***	0.022
	[0.001]	[0.015]	[0.000]	[0.014]	[0.002]	[0.033]	[0.001]	[0.034]	[0.002]	[0.031]	[0.002]	[0.028]	[0.002]	[0.050]	[0.000]	[0.003]	[0.003]	[0.025]	[0.001]	[0.020]
Sec. Educ.	0.059***	-0.538***	0.062***	-0.098***	0.086***	-0.222***	0.018***	0.623***	0.054***	0.457***	0.078***	0.138***	0.100***	-0.383***	0.065***	-0.194***	0.113***	-0.267***	0.040***	-0.405***
	[0.001]	[0.031]	[0.001]	[0.021]	[0.002]	[0.042]	[0.002]	[0.064]	[0.003]	[0.049]	[0.002]	[0.041]	[0.004]	[0.094]	[0.001]	[0.004]	[0.003]	[0.031]	[0.002]	[0.047]
Ter. Educ.	0.160***	-1.236***	0.124***	-1.704***	0.161***	-0.607***	0.079***	-0.732***	0.141***	0.181**	0.116***	-0.581***	0.240***	-0.591***	0.122***	-0.185***	0.340***	-0.426***	0.117***	-0.991***
	[0.002]	[0.042]	[0.001]	[0.025]	[0.003]	[0.049]	[0.003]	[0.075]	[0.003]	[0.058]	[0.003]	[0.066]	[0.005]	[0.105]	[0.001]	[0.004]	[0.005]	[0.043]	[0.002]	[0.052]
Ter.Educ.(4+)	0.315***	-0.545***	0.279***	-1.074***	0.333***	-0.872***	0.278***	-0.791***	0.318***	0.799***	0.226***	-0.659***	0.438***	-0.043	0.263***	0.120***	0.500***	-0.031	0.392***	-3.317***
	[0.002]	[0.038]	[0.001]	[0.029]	[0.004]	[0.063]	[0.003]	[0.080]	[0.004]	[0.063]	[0.003]	[0.053]	[0.006]	[0.115]	[0.001]	[0.005]	[0.008]	[0.061]	[0.006]	[0.079]
Tenure	0.007***		0.005***		0.011***		0.002***		0.003***		0.006***		0.005***		0.005***		-0.068***		0.002***	
	[0.000]		[0.000]		[0.000]		[0.000]		[0.000]		[0.000]		[0.000]		[0.000]		[0.005]		[0.000]	
30-39 y.o.	0.069***	-0.224***	0.133***	-0.769***	0.082***	-0.327***	0.075***	-0.215***	0.159***	-0.134*	0.047***	-1.246***	0.165***	-0.656***	0.092***	-0.041***	0.104***	-0.252***	0.082***	-0.156***
	[0.001]	[0.024]	[0.001]	[0.018]	[0.003]	[0.052]	[0.002]	[0.039]	[0.003]	[0.053]	[0.003]	[0.057]	[0.004]	[0.082]	[0.001]	[0.004]	[0.003]	[0.032]	[0.001]	[0.030]
40-49 y.o.	0.098***	-0.897***	0.229***	-1.411***	0.128***	-0.824***	0.138***	-0.593***	0.298***	-0.321***	0.126***	-1.977***	0.296***	-1.231***	0.159***	-0.039***	0.211***	-0.611***	0.157***	-2.650***
	[0.001]	[0.024]	[0.001]	[0.019]	[0.003]	[0.052]	[0.002]	[0.044]	[0.003]	[0.053]	[0.003]	[0.056]	[0.004]	[0.082]	[0.001]	[0.004]	[0.003]	[0.033]	[0.002]	[0.031]
50-59 y.o.	0.076***	-1.284***	0.243***	-1.716***	0.136***	-1.198***	0.152***	-1.021***	0.362***	-0.656***	0.178***	-1.998***	0.308***	-2.133***	0.179***	-0.065***	0.272***	-1.042***	0.176***	-3.332***
	[0.001]	[0.023]	[0.001]	[0.019]	[0.003]	[0.057]	[0.002]	[0.047]	[0.004]	[0.053]	[0.004]	[0.056]	[0.004]	[0.079]	[0.001]	[0.004]	[0.004]	[0.038]	[0.002]	[0.032]
Holidays		1.057***		0.518***		0.618***		0.108***		0.226***		0.757***		0.844***		1.508***		1.087***		0.971***
		[0.001]		[0.001]		[0.005]		[0.002]		[0.003]		[0.003]		[0.004]		[0.000]		[0.010]		[0.003]
Size (50-249)			0.037***	0.853***	0.086***	0.567***	0.015***	0.249***	0.019***	1.398***	0.039***	-0.544***	0.019***	0.912***	0.047***	-0.066***	0.062***	-0.298***	0.022***	-0.091*
			[0.001]	[0.022]	[0.003]	[0.052]	[0.003]	[0.064]	[0.004]	[0.070]	[0.003]	[0.055]	[0.004]	[0.073]	[0.001]	[0.003]	[0.003]	[0.033]	[0.003]	[0.041]
Size (250-499)	0.064***	0.318***	0.047***	2.105***	0.127***	0.549***	0.032***	0.018	0.001	1.646***	0.082***	0.640***	0.010**	0.342***	0.055***	-0.226***	0.097***	-0.689***	0.037***	-0.031
	[0.001]	[0.024]	[0.001]	[0.020]	[0.003]	[0.048]	[0.002]	[0.059]	[0.003]	[0.062]	[0.003]	[0.049]	[0.004]	[0.066]	[0.001]	[0.003]	[0.003]	[0.032]	[0.002]	[0.032]
Size (+500)	0.171***	-1.257***			-0.003	0.195***														

(continued on next page)

Table A.1: Estimation results (full set of covariates (Cont.)

	DE		DK		ES		FI		FR		IT		NL		NO		PT		SE	
	Earnings	Hours	Earnings	Hours	Earnings	Hours	Earnings	Hours	Earnings	Hours	Earnings	Hours	Earnings	Hours	Earnings	Hours	Earnings	Hours	Earnings	Hours
	[0.001]	[0.023]			[0.003]	[0.058]														
Act 1[a]	-0.031***	-0.705***	-0.132***	-0.759***	-0.164***	0.217	-0.081***	0.580***	-0.058***	1.131***	0.010	-0.762***	-0.123***	-1.053***	-0.240***	1.331***	-0.162***	0.690***	-0.096***	-0.136*
	[0.007]	[0.102]	[0.002]	[0.047]	[0.010]	[0.153]	[0.006]	[0.092]	[0.007]	[0.116]	[0.006]	[0.112]	[0.017]	[0.304]	[0.002]	[0.012]	[0.009]	[0.067]	[0.004]	[0.068]
Act 2	-0.052***	0.161			-0.032**	-0.291														
	[0.007]	[0.113]			[0.012]	[0.178]														
Act 3			-0.107***	-0.425***	-0.196***	-1.244***	-0.110***	-0.381	-0.116***	0.784***	-0.031***	-3.576***	-0.117***	0.903+	-0.258***	1.703***	-0.288***	1.483***	-0.083***	0.256*
			[0.004]	[0.110]	[0.011]	[0.191]	[0.010]	[0.253]	[0.012]	[0.167]	[0.007]	[0.156]	[0.023]	[0.470]	[0.003]	[0.016]	[0.012]	[0.107]	[0.006]	[0.110]
Act 4	-0.083***	0.329**	-0.075***	-0.484***	-0.140***	1.184***	-0.046***	0.955***	-0.054***	0.896***	0.026***	-1.071***	-0.044**	1.177***	-0.199***	1.567***	-0.189***	0.473***	0.005	0.271***
	[0.007]	[0.110]	[0.002]	[0.050]	[0.010]	[0.164]	[0.007]	[0.111]	[0.008]	[0.131]	[0.008]	[0.154]	[0.017]	[0.324]	[0.002]	[0.012]	[0.010]	[0.086]	[0.005]	[0.075]
Act 5	-0.111***	0.380***	-0.236***	-0.020	-0.240***	0.712***	-0.078***	-1.825***	-0.114***	1.215***	-0.043***	-3.404***	-0.212***	-0.958**	-0.317***	1.476***	-0.153***	0.520***	-0.111***	-1.724***
	[0.007]	[0.105]	[0.002]	[0.047]	[0.010]	[0.162]	[0.006]	[0.098]	[0.008]	[0.119]	[0.006]	[0.120]	[0.017]	[0.305]	[0.002]	[0.012]	[0.010]	[0.076]	[0.005]	[0.076]
Act 6	-0.159***	0.613***	-0.117***	-1.175***	-0.080***	-0.688***	-0.026***	-0.330**	-0.044***	-0.572***	-0.015*	-3.975***	-0.114***	-1.072***	-0.213***	1.619***	-0.060***	0.623***	-0.098***	-0.924***
	[0.007]	[0.109]	[0.002]	[0.056]	[0.011]	[0.174]	[0.007]	[0.113]	[0.008]	[0.117]	[0.007]	[0.125]	[0.018]	[0.323]	[0.002]	[0.014]	[0.010]	[0.085]	[0.005]	[0.084]
Act 7	-0.198***	0.591***	-0.258***	-3.185***	-0.165***	-1.240***	-0.167***	-1.468***	-0.098***	-0.890***	-0.095***	-5.265***	-0.241***	-2.635***	-0.435***	1.117***	-0.188***	0.494***	-0.177***	-1.803***
	[0.007]	[0.113]	[0.003]	[0.072]	[0.011]	[0.192]	[0.007]	[0.118]	[0.011]	[0.173]	[0.007]	[0.137]	[0.021]	[0.351]	[0.002]	[0.015]	[0.010]	[0.082]	[0.006]	[0.131]
Act 8	-0.029***	-0.592***	-0.153***	-0.306***	-0.221***	0.573***	-0.089***	-1.639***	-0.085***	-1.704***	-0.094***	-0.905***	-0.222***	-1.222***	-0.189***	1.596***	-0.198***	0.709***	-0.076***	-1.541***
	[0.007]	[0.107]	[0.002]	[0.051]	[0.011]	[0.165]	[0.006]	[0.109]	[0.008]	[0.124]	[0.007]	[0.132]	[0.017]	[0.316]	[0.003]	[0.012]	[0.010]	[0.077]	[0.005]	[0.077]
Act 9	0.022**	-0.264*	-0.080***	-1.350***	-0.116***	-0.554***	-0.057***	-0.181+	-0.019*	-0.496***	0.134***	-4.403***	-0.105***	-0.460	-0.192***	1.174***	-0.118***	-2.426***	-0.022***	-1.705***
	[0.007]	[0.107]	[0.002]	[0.049]	[0.011]	[0.160]	[0.007]	[0.100]	[0.008]	[0.119]	[0.008]	[0.120]	[0.017]	[0.311]	[0.002]	[0.012]	[0.010]	[0.089]	[0.006]	[0.075]
Act 10	-0.046***	-0.194+	-0.180***	-2.053***	-0.261***	-0.283+	-0.126***	-1.263***	-0.082***	-0.705***	-0.040***	-2.777***	-0.174***	-1.471***	-0.249***	1.465***	-0.157***	0.816***	-0.096***	-1.087***
	[0.007]	[0.105]	[0.002]	[0.062]	[0.011]	[0.168]	[0.008]	[0.143]	[0.008]	[0.137]	[0.008]	[0.142]	[0.018]	[0.328]	[0.003]	[0.013]	[0.012]	[0.094]	[0.005]	[0.081]
Act 11	-0.227***	1.926***	-0.149***	-5.210***	-0.272***	-0.582***	-0.175***	-1.045***	-0.054***	-0.500***	-0.093***	-3.286***	-0.185***	-0.723*	-0.260***	1.712***	-0.206***	0.290***	-0.172***	-0.304***
	[0.007]	[0.109]	[0.002]	[0.050]	[0.011]	[0.165]	[0.006]	[0.100]	[0.008]	[0.119]	[0.007]	[0.125]	[0.017]	[0.310]	[0.002]	[0.012]	[0.010]	[0.080]	[0.005]	[0.073]
Act 12	-0.276***	0.202+	-0.161***	-2.915***	-0.253***	-1.491***	-0.136***	-0.920***	-0.206***	-3.905***	-0.143***	-9.502***	-0.105***	0.645+	-0.344***	1.592***	0.000	0.000	-0.175***	-2.680***
	[0.007]	[0.104]	[0.002]	[0.048]	[0.011]	[0.179]	[0.006]	[0.089]	[0.007]	[0.109]	[0.006]	[0.112]	[0.018]	[0.331]	[0.002]	[0.011]	0.000	0.000	[0.005]	[0.081]
Act 13	-0.283***	-1.958***	-0.229***	-5.324***	-0.300***	-7.889***	-0.282***	-1.263***	-0.418***	-7.187***	-0.205***	-17.046***	-0.110***	-4.293***	-0.395***	1.575***	-0.239***	-1.860***	-0.255***	-2.033***
	[0.007]	[0.106]	[0.002]	[0.048]	[0.012]	[0.208]	[0.006]	[0.096]	[0.010]	[0.128]	[0.007]	[0.122]	[0.018]	[0.327]	[0.002]	[0.011]	[0.010]	[0.080]	[0.004]	[0.072]
Act 14	-0.148***	-0.755***	-0.267***	-4.058***	-0.248***	-1.660***	-0.145***	-0.872***	-0.167***	-3.792***	-0.108***	-7.793***	-0.049**	-3.131***	-0.340***	1.036***	-0.377***	-0.261***	-0.242***	-1.873***
	[0.007]	[0.108]	[0.002]	[0.046]	[0.011]	[0.166]	[0.006]	[0.091]	[0.008]	[0.117]	[0.006]	[0.110]	[0.018]	[0.323]	[0.002]	[0.011]	[0.009]	[0.076]	[0.004]	[0.068]
Act 15	-0.172***	-0.562***	-0.234***	-3.390***	-0.277***	-2.352***	-0.263***	-1.413***	-0.097***	-4.155***	-0.100***	-4.922***	-0.173***	-3.433***	-0.371***	1.213***	-0.188***	-0.616***	-0.213***	-2.632***
	[0.007]	[0.107]	[0.002]	[0.061]	[0.011]	[0.175]	[0.007]	[0.114]	[0.008]	[0.144]	[0.008]	[0.143]	[0.019]	[0.329]	[0.002]	[0.014]	[0.013]	[0.112]	[0.005]	[0.094]
Ocup 1[b]	-0.284***	-0.229***	-0.235***	-1.964***	-0.354***	-0.657***	-0.339***	-0.359***	-0.111***	-2.064***	-0.432***	-7.700***	-0.168***	-1.109***	-0.159***	-0.020***	-0.328***	0.015	-0.269***	0.415***
	[0.003]	[0.037]	[0.001]	[0.023]	[0.008]	[0.096]	[0.004]	[0.061]	[0.003]	[0.045]	[0.008]	[0.070]	[0.006]	[0.094]	[0.001]	[0.003]	[0.011]	[0.064]	[0.003]	[0.028]
Ocup 2	-0.440***	-1.055***	-0.308***	-1.385***	-0.499***	-0.400***	-0.512***	-0.672***	-0.316***	-5.119***	-0.619***	-4.110***	-0.258***	-0.910***	-0.226***	-0.020***	-0.517***	0.241***	-0.409***	0.650***

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Table A.1: Estimation results (full set of covariates (Cont.)

	DE		DK		ES		FI		FR		IT		NL		NO		PT		SE	
	Earnings	Hours	Earnings	Hours	Earnings	Hours	Earnings	Hours	Earnings	Hours	Earnings	Hours	Earnings	Hours	Earnings	Hours	Earnings	Hours	Earnings	Hours
	[0.003]	[0.037]	[0.001]	[0.024]	[0.008]	[0.097]	[0.004]	[0.062]	[0.004]	[0.054]	[0.008]	[0.083]	[0.007]	[0.104]	[0.001]	[0.004]	[0.011]	[0.063]	[0.003]	[0.031]
Ocup 3	-0.563***	-0.939***	-0.422***	-3.009***	-0.661***	-0.282**	-0.653***	-1.703***	-0.488***	-4.347***	-0.773***	-3.862***	-0.407***	-1.275***	-0.388***	-0.145***	-0.712***	0.191**	-0.563***	1.257***
	[0.004]	[0.041]	[0.002]	[0.028]	[0.008]	[0.099]	[0.005]	[0.079]	[0.004]	[0.058]	[0.007]	[0.081]	[0.008]	[0.120]	[0.001]	[0.006]	[0.011]	[0.066]	[0.003]	[0.041]
Ocup 4	-0.648***	-1.755***	-0.407***	-5.547***	-0.727***	-0.964***	-0.651***	-2.216***	-0.487***	-3.910***	-0.780***	-6.631***	-0.398***	-1.509***	-0.407***	-0.115***	-0.826***	0.541***	-0.532***	-0.315***
	[0.004]	[0.050]	[0.002]	[0.027]	[0.008]	[0.109]	[0.005]	[0.078]	[0.005]	[0.072]	[0.008]	[0.091]	[0.007]	[0.124]	[0.001]	[0.005]	[0.011]	[0.073]	[0.003]	[0.040]
Ocup 5	-0.596***	-1.736***	-0.434***	-2.772***	-0.771***	0.251	-0.755***	0.032	-0.564***	-2.248***	-0.806***	-3.852***	-0.502***	-1.497***	-0.460***	0.126***	-0.881***	0.910***	-0.576***	0.901***
	[0.007]	[0.138]	[0.003]	[0.136]	[0.014]	[0.269]	[0.011]	[0.229]	[0.020]	[0.620]	[0.019]	[0.305]	[0.018]	[0.284]	[0.004]	[0.022]	[0.017]	[0.248]	[0.007]	[0.160]
Ocup 6	-0.608***	-0.746***	-0.380***	-4.766***	-0.657***	0.660***	-0.676***	-0.929***	-0.529***	-3.844***	-0.833***	-4.171***	-0.405***	-0.784***	-0.423***	-0.110***	-0.773***	0.674***	-0.544***	1.823***
	[0.004]	[0.045]	[0.002]	[0.030]	[0.008]	[0.104]	[0.005]	[0.094]	[0.005]	[0.067]	[0.008]	[0.106]	[0.008]	[0.137]	[0.001]	[0.005]	[0.011]	[0.070]	[0.004]	[0.046]
Ocup 7	-0.689***	-0.229***	-0.459***	-5.646***	-0.656***	0.413***	-0.677***	-1.373***	-0.560***	-5.244***	-0.828***	-3.566***	-0.443***	-0.800***	-0.466***	-0.574***	-0.829***	0.748***	-0.580***	1.195***
	[0.004]	[0.049]	[0.002]	[0.034]	[0.008]	[0.109]	[0.005]	[0.094]	[0.006]	[0.079]	[0.008]	[0.102]	[0.009]	[0.166]	[0.001]	[0.007]	[0.011]	[0.069]	[0.004]	[0.047]
Ocup 8	-0.692***	-3.478***	-0.502***	-7.278***	-0.752***	-0.692***	-0.784***	-3.073***	-0.675***	-6.030***	-0.904***	-3.879***	-0.509***	-2.342***	-0.485***	-0.302***	-0.870***	0.142+	-0.642***	0.043
	[0.004]	[0.049]	[0.002]	[0.032]	[0.008]	[0.111]	[0.006]	[0.106]	[0.006]	[0.108]	[0.008]	[0.093]	[0.009]	[0.167]	[0.001]	[0.010]	[0.011]	[0.078]	[0.004]	[0.067]
Private	-0.003**	0.798***	0.109***	-1.993***	-0.036***	1.218***	0.007**	-0.106*	0.043***	-0.512***	-0.148***	7.068***	0.058***	0.440***	0.021***	0.133***	0.061***	1.687***	0.068***	0.352***
	[0.001]	[0.021]	[0.001]	[0.029]	[0.004]	[0.064]	[0.002]	[0.045]	[0.003]	[0.061]	[0.003]	[0.068]	[0.008]	[0.121]	[0.001]	[0.004]	[0.005]	[0.049]	[0.002]	[0.033]
Collec 1[c]	0.115***						0.063***		-0.158***								0.028***			
	[0.001]						[0.002]		[0.006]								[0.007]			
Collec 2	0.145***				0.025***				-0.169***								0.035***			
	[0.003]				[0.002]				[0.007]								[0.008]			
Collec 3	0.124***		0.032***		0.080***				-0.132***				0.150***				0.186***			
	[0.001]		[0.001]		[0.003]				[0.009]				[0.005]				[0.005]			
Collec 4					0.078***												0.000			
					[0.004]												0.000			
Collec 5			0.019***						-0.172***				0.187***				0.003			
			[0.001]						[0.005]				[0.043]				[0.004]			
Collec 6			0.031***		0.042***		0.127***		-0.189***				0.034***				0.044***		0.021***	
			[0.001]		[0.004]		[0.005]		[0.032]				[0.004]				[0.005]		[0.003]	
Shift work	0.028***		0.023***		0.061***		0.044***		0.040***		0.040***		0.085***		0.052***		0.105***		0.044***	
	[0.001]		[0.000]		[0.002]		[0.001]		[0.002]		[0.002]		[0.015]		[0.000]		[0.003]		[0.001]	
Indef.	-0.099***		0.043***		-0.047***		-0.046***		-0.079***		-0.057***		-0.097***		0.000		-0.116***		-0.028***	
	[0.001]		[0.001]		[0.003]		[0.002]		[0.005]		[0.003]		[0.004]		0.000		[0.003]		[0.001]	
Temp.	-1.041***		-0.405***		-0.739***		-0.100***		-0.452***		-0.237***		-1.721***		-0.409***					
	[0.002]		[0.002]		[0.011]		[0.016]		[0.010]		[0.004]		[0.031]		[0.004]					
Const.	2.923***	10.570***	3.406***	30.217***	3.064***	23.257***	2.787***	35.945***	3.942***	30.714***	3.359***	25.569***	2.746***	14.947***	3.593***	-1.472***	2.557***	12.804***	3.151***	14.619***

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Table A.1: Estimation results (full set of covariates (Cont.)

	DE		DK		ES		FI		FR		IT		NL		NO		PT		SE	
	Earnings	Hours	Earnings	Hours	Earnings	Hours	Earnings	Hours	Earnings	Hours	Earnings	Hours	Earnings	Hours	Earnings	Hours	Earnings	Hours	Earnings	Hours
	[0.009]	[0.119]	[0.004]	[0.060]	[0.024]	[0.241]	[0.032]	[0.141]	[0.031]	[0.164]	[0.027]	[0.171]	[0.029]	[0.384]	[0.004]	[0.013]	[0.050]	[0.261]	[0.009]	[0.130]
Var(w)	0.081***		0.061***		0.118***		0.066***		0.144***		0.089***		0.099***		0.064***		0.101***		0.044***	
	[0.000]		[0.000]		[0.001]		[0.001]		[0.001]		[0.001]		[0.001]		[0.000]		[0.001]		[0.000]	
Var(h)	30.333***		50.830***		31.076***		31.019***		31.927***		29.210***		41.358***		2.395***		8.302***		14.514***	
	[0.103]		[0.070]		[0.190]		[0.227]		[0.209]		[0.136]		[0.356]		[0.022]		[0.119]		[0.107]	
Corr(w,h)	-0.134***		-0.151***		-0.062***		-0.465***		-0.005		-0.109***		-0.033***		-0.092***		-0.105***		-0.152***	
	[0.002]		[0.002]		[0.004]		[0.012]		[0.007]		[0.006]		[0.006]		[0.007]		[0.006]		[0.003]	
F(1,N)	8.40E+05		3.00E+05		12897.77		1918.53		7024.50		29538.35		44387.90		7.50E+07		1.09E+04		85486.33	
N	852,413		1,884,340		202,550		279,401		230,644		215,751		136,480		2,053,659		88,090		236,738	

Note: Standard errors into parenthesis. $^{+}p < 0.1$, $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$. Activity 1digit Nace2: 0 "Mining and quarrying (Ref.)" 1 "Manufacturing" 2 "Electricity, gas, steam and air conditioning supply" 3 "Water supply; sewerage, waste management and remediation activities" 4 "Construction" 5 "Wholesale and retail trade; repair of motor vehicles and motorcycles" 6 "Transportation and storage" 7 "Accommodation and food service activities" 8 "Information and communication" 9 "Financial and insurance activities" 10 "Real estate activities/professional, scientific and technical activities" 11 "Administrative and support service activities" 12 "Public administration and defence; compulsory social security" 13 "Education" 14 "Human health and social work activities" 15 "Arts, entertainment and recreation/other service activities" Occupation in the refrence month (ISCO-08): 0 "Managers (Ref.)" 1 "Professionals" 2 "Technicians and associate professionals" 3 "Clerical support workers" 4 "Service and sales workers" 5 "Skilled agricultural, forestry and fishery workers" 6 "Craft and realted trades workers" 7 "Plant and machine operators and assemblers" 8 "Elementary occupations" Collective pay agreement: 0 "National level or interconfederal agreement (Ref.) 1 "industry agreement" 2 "Agreement for individual industries in individual regions" 3 "Enterprise or single employer agreement" 4 "Agreement applying only to workers in the local unit" 5 "Any other type of agreement" 6 "No collective agreement exists"

Table A.2: **Estimation results (Gender)**

Males	DE	DK	ES	FI	FR	IT	NL	NO	PT	SE
Hours	-0.004*	-0.014***	-0.090***	-0.046***	-0.045***	-0.057***	0.013**	-0.149***	0.028***	-0.124***
	[0.002]	[0.002]	[0.006]	[0.009]	[0.005]	[0.002]	[0.004]	[0.003]	[0.007]	[0.008]
$Hours^2$	0.000	0.000***	0.001***	0.000**	0.000***	0.001***	-0.000***	0.002***	-0.001***	0.001***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
FTE	0.008***	0.004***	0.030***	0.018***	-0.016***	0.022***	-0.008***	0.060***	-0.026***	0.043***
	[0.001]	[0.001]	[0.002]	[0.004]	[0.002]	[0.001]	[0.002]	[0.001]	[0.004]	[0.003]
FTE^2	0.000	0.000	-0.000***	-0.000**	0.000***	-0.000***	0.000***	-0.000***	0.000***	-0.000***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
PT	-0.053***	-0.009***	-0.158***	-0.087***	0.124***	-0.217***	0.025***	-0.083***	0.112	-0.021***
	[0.004]	[0.002]	[0.009]	[0.014]	[0.019]	[0.011]	[0.007]	[0.002]	[0.080]	[0.006]
Corr(h,lnw)	-0.309***	-0.090***	-0.153***	-0.144***	0.026***	-0.162***	-0.066***	-0.374***	0.018	0.253***
	[0.009]	[0.004]	[0.001]	[0.015]	[0.001]	[0.019]	[0.010]	[0.004]	[0.026]	[0.010]
N	447,219	908,695	113,952	121,295	123,898	100,166	68,301	1,077,700	46,777	106,759

Females	DE	DK	ES	FI	FR	IT	NL	NO	PT	SE
Hours	-0.014***	-0.022***	-0.059***	-0.018**	-0.031***	-0.080***	0.014***	-0.154***	0.042***	-0.161***
	[0.002]	[0.002]	[0.006]	[0.007]	[0.003]	[0.001]	[0.004]	[0.002]	[0.007]	[0.004]
$Hours^2$	-0.000***	0.000***	0.000***	0.000	0.001***	0.001***	-0.000***	0.002***	-0.001***	0.002***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
FTE	0.005***	0.001	0.015***	0.004	-0.009***	0.025***	-0.007***	0.055***	-0.019***	0.060***
	[0.001]	[0.000]	[0.002]	[0.003]	[0.001]	[0.001]	[0.002]	[0.001]	[0.004]	[0.001]
FTE^2	0.000	0.000	-0.000*	0.000+	0.000***	-0.000***	0.000***	-0.000***	0.000***	-0.000***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
PT	-0.046***	0.012***	-0.148***	-0.040***	0.123***	-0.090***	0.025***	-0.046***	0.067	-0.006*
	[0.002]	[0.001]	[0.007]	[0.008]	[0.010]	[0.008]	[0.005]	[0.001]	[0.058]	[0.003]
Corr(h,lnw)	0.373***	0.368***	0.135***	-0.02	-0.319***	-0.189***	0.046+	0.149***	-0.043+	0.061***
	[0.001]	[0.004]	[0.001]	[0.013]	[0.010]	[0.004]	[0.026]	[0.004]	[0.024]	[0.010]
N	405,194	975,645	88,598	158,106	106,746	115,585	68,179	975,959	41,313	129,979

Note: Standard errors into parenthesis. $^{+}p < 0.1$, $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$. We control for individual, job and firm characteristics as in the main specification.

Table A.3: **Estimation results (Age)**

20-29 y.o.	DE	DK	ES	FI	FR	IT	NL	NO	PT	SE
Hours	-0.003	-0.089***	-0.061***	0.014	-0.087***	-0.087***	0.007	-0.158***	0.01	-0.136***
	[0.002]	[0.002]	[0.007]	[0.009]	[0.010]	[0.005]	[0.005]	[0.003]	[0.008]	[0.009]
$Hours^2$	-0.000***	0.001***	0.000***	-0.000***	0.001***	0.001***	-0.000**	0.002***	-0.001***	0.001***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
FTE	0.002**	0.026***	0.015***	-0.009**	-0.001	0.026***	-0.004*	0.053***	-0.015**	0.052***
	[0.001]	[0.001]	[0.003]	[0.003]	[0.004]	[0.003]	[0.002]	[0.001]	[0.005]	[0.004]
FTE^2	0.000***	-0.000***	0.000	0.000***	0.000***	-0.000***	0.000***	-0.000***	0.000***	-0.000***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
PT	-0.029***	-0.032***	-0.134***	-0.055***	0.168***	0.876***	0.022*	-0.038***	0.033	-0.021**
	[0.005]	[0.002]	[0.014]	[0.010]	[0.041]	[0.129]	[0.010]	[0.002]	[0.082]	[0.007]
Corr(h,lnw)	0.034***	0.244	0.014	0.068**	0.167***	0.030***	-0.029***	0.313***	0.112*	0.041
	[0.006]	.	[0.042]	[0.023]	[0.004]	[0.005]	[0.001]	[0.002]	[0.046]	.
N	153,153	387,141	22,566	41,862	27,331	20,743	25,317	410,082	12,784	42,696

30-39 y.o.	DE	DK	ES	FI	FR	IT	NL	NO	PT	SE
Hours	-0.001	-0.003	-0.062***	-0.022*	-0.049***	-0.086***	0.006	-0.152***	0.013	-0.132***
	[0.003]	[0.002]	[0.007]	[0.010]	[0.007]	[0.003]	[0.007]	[0.004]	[0.013]	[0.009]
$Hours^2$	-0.000*	0.000**	0.000***	0	0.000***	0.001***	-0.000*	0.002***	-0.000*	0.001***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
FTE	0.006***	-0.001	0.017***	0.009*	-0.020***	0.022***	-0.007*	0.057***	-0.013*	0.051***
	[0.001]	[0.001]	[0.003]	[0.004]	[0.003]	[0.002]	[0.003]	[0.001]	[0.006]	[0.004]

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Table A.3: Estimation results (Age (Cont.)

	DE	DK	ES	FI	FR	IT	NL	NO	PT	SE
FTE^2	0.000	0.000***	-0.000*	0	0.000***	-0.000***	0.000***	-0.000***	0.000***	-0.000***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
PT	-0.068***	0.004*	-0.168***	-0.076***	0.170***	0.525***	0.060***	-0.068***	0.084	-0.022***
	[0.005]	[0.002]	[0.012]	[0.013]	[0.026]	[0.089]	[0.012]	[0.002]	[0.076]	[0.007]
Corr(h,lnw)	-0.168***	-0.132***	-0.002	-0.095***	0.056*	0.017	0.004	-0.103***	-0.173***	-0.022***
	[0.016]	[0.006]	[0.022]	[0.018]	[0.027]	[0.040]	[0.042]	[0.006]	[0.028]	[0.006]
N	199,133	470,386	53,194	73,160	63,150	45,255	29,932	556,032	24,887	59,919
40-49 y.o.	DE	DK	ES	FI	FR	IT	NL	NO	PT	SE
Hours	-0.004	0.018***	-0.089***	-0.056***	-0.050***	-0.068***	0.017*	-0.157***	0.042***	-0.137***
	[0.003]	[0.003]	[0.008]	[0.011]	[0.006]	[0.002]	[0.007]	[0.004]	[0.011]	[0.009]
$Hours^2$	0	-0.000**	0.001***	0.000***	0.001***	0.001***	-0.000***	0.002***	-0.001***	0.001***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
FTE	0.006***	-0.006***	0.029***	0.020***	-0.014***	0.026***	-0.010***	0.062***	-0.018**	0.053***
	[0.001]	[0.001]	[0.003]	[0.005]	[0.003]	[0.001]	[0.003]	[0.001]	[0.005]	[0.004]
FTE^2	0	0.000***	-0.000***	-0.000*	0.000***	-0.000***	0.000***	-0.000***	0.000***	-0.000***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
PT	-0.062***	0.027***	-0.155***	-0.049*	0.081***	0.392***	-0.001	-0.087***	0.054	-0.025***
	[0.006]	[0.002]	[0.011]	[0.019]	[0.021]	[0.073]	[0.012]	[0.003]	[0.083]	[0.007]
Corr(h,lnw)	-0.134***	-0.218***	-0.043*	-0.111***	0.038+	-0.145***	0.003	-0.171***	-0.285***	-0.110***
	[0.006]	[0.005]	[0.021]	[0.021]	[0.022]	[0.011]	[0.008]	[0.007]	[0.028]	[0.001]
N	216,867	522,137	72,585	78,432	73,136	72,382	36,355	577,592	29,213	67,352
50-59 y.o.	DE	DK	ES	FI	FR	IT	NL	NO	PT	SE
Hours	-0.023***	0.017***	-0.082***	-0.078***	-0.032***	-0.067***	0.021***	-0.162***	0.026**	-0.151***
	[0.004]	[0.002]	[0.008]	[0.011]	[0.006]	[0.002]	[0.005]	[0.004]	[0.008]	[0.008]
$Hours^2$	0.000***	-0.000**	0.001***	0.001***	0.000**	0.001***	-0.000***	0.002***	-0.001***	0.002***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
FTE	0.015***	-0.004***	0.028***	0.032***	-0.015***	0.028***	-0.010***	0.063***	-0.025***	0.059***
	[0.002]	[0.001]	[0.003]	[0.005]	[0.003]	[0.001]	[0.002]	[0.001]	[0.006]	[0.003]
FTE^2	-0.000***	0.000***	-0.000***	-0.000***	0.000***	-0.000***	0.000***	-0.000***	0.000***	-0.000***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
PT	-0.059***	0.040***	-0.128***	-0.074***	0.102***	0.316***	0.018	-0.083***	0.153	-0.012
	[0.005]	[0.002]	[0.014]	[0.018]	[0.018]	[0.076]	[0.012]	[0.003]	[0.149]	[0.008]
Corr(h,lnw)	-0.085***	-0.245***	-0.109***	-0.194***	0.077***	-0.228***	-0.026***	-0.133	0.243***	-0.147***
	[0.011]	[0.013]	[0.023]	[0.024]	[0.018]	[0.022]	[0.004]	.	[0.041]	[0.016]
N	283,260	504,676	54,205	85,947	67,027	77,371	44,876	509,953	21,206	66,771

Note: Standard errors into parenthesis. $^{+}p < 0.1$, $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$. We control for individual, job and firm characteristics as in the main specification.

Table A.4: **Estimation results (Education)**

Primary	DE	DK	ES	FI	FR	IT	NL	NO	PT	SE
Hours	-0.004*	-0.044***	-0.072***	0.035+	-0.076***	-0.082***	0.013+	-0.156***	0.025***	-0.124***
	[0.002]	[0.002]	[0.005]	[0.020]	[0.007]	[0.005]	[0.007]	[0.003]	[0.008]	[0.014]
$Hours^2$	-0.000+	0.000***	0.000***	-0.001***	0.001***	0.001***	-0.000**	0.002***	-0.001***	0.001***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
FTE	0.003**	0.011***	0.016***	-0.013	-0.003	0.037***	-0.009**	0.055***	-0.013**	0.049***
	[0.001]	[0.001]	[0.002]	[0.008]	[0.003]	[0.002]	[0.003]	[0.001]	[0.004]	[0.005]
FTE^2	0.000*	-0.000***	0.000	0.000*	0.000***	-0.000***	0.000***	-0.000***	0.000***	-0.000***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
PT	-0.049***	0.012***	-0.074***	-0.189***	0.138***	-0.177***	0.040*	-0.055***	-0.072	-0.004

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Table A.4: Estimation results (Education (Cont.)

	DE	DK	ES	FI	FR	IT	NL	NO	PT	SE
	[0.006]	[0.002]	[0.008]	[0.015]	[0.025]	[0.012]	[0.016]	[0.002]	[0.064]	[0.011]
Corr(h,lnw)	-0.071***	0.343***	0.267***	0.198***	0.107***	-0.198***	-0.042***	0.246***	-0.047	-0.106
	[0.004]	[0.009]	[0.024]	[0.040]	[0.030]	[0.033]	[0.004]	[0.004]	[0.032]	[0.827]
N	83,108	196,046	79,308	17,055	25,077	43,264	16,455	448,430	35,500	14,614
Secondary	DE	DK	ES	FI	FR	IT	NL	NO	PT	SE
Hours	-0.014***	-0.042***	-0.074***	-0.024**	-0.065***	-0.080***	-0.005	-0.165***	0.037***	-0.163***
	[0.002]	[0.001]	[0.007]	[0.009]	[0.006]	[0.003]	[0.005]	[0.003]	[0.007]	[0.006]
$Hours^2$	0	0.000***	0.000***	-0.000**	0.001***	0.001***	0.000	0.002***	-0.001***	0.002***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
FTE	0.007***	0.008***	0.015***	0.000	-0.014***	0.029***	-0.002	0.057***	-0.021***	0.062***
	[0.001]	[0.000]	[0.003]	[0.003]	[0.003]	[0.002]	[0.002]	[0.001]	[0.005]	[0.002]
FTE^2	0	-0.000***	0	0.000***	0.000***	-0.000***	0.000***	-0.000***	0.000***	-0.000***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
PT	-0.030***	0.023***	-0.166***	-0.056***	0.212***	-0.119***	0.045***	-0.061***	0.024	-0.018***
	[0.003]	[0.001]	[0.013]	[0.010]	[0.022]	[0.011]	[0.009]	[0.002]	[0.120]	[0.005]
Corr(h,lnw)	-0.024*	0.433***	0.276***	0.421***	-0.033	-0.223***	-0.005	0.318***	0.113**	0.003
	[0.010]	[0.003]	[0.003]	[0.013]	[0.022]	[0.024]	[0.038]	[0.005]	[0.037]	[0.012]
N	512,598	800,779	42,481	115,232	62,117	96,994	57,422	701,461	25,871	109,802
Tertiary	DE	DK	ES	FI	FR	IT	NL	NO	PT	SE
Hours	-0.003	-0.009***	-0.089***	-0.003	-0.043***	-0.094***	0.028***	-0.161***	0.052***	-0.127***
	[0.005]	[0.002]	[0.007]	[0.008]	[0.005]	[0.002]	[0.004]	[0.003]	[0.016]	[0.007]
$Hours^2$	0.000	0.000***	0.001***	0.000	0.000***	0.001***	-0.000***	0.002***	-0.001***	0.001***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
FTE	0.012***	0.001+	0.032***	0.002	-0.014***	0.024***	-0.013***	0.063***	-0.035***	0.048***
	[0.002]	[0.001]	[0.003]	[0.003]	[0.002]	[0.002]	[0.002]	[0.001]	[0.007]	[0.003]
FTE^2	-0.000***	-0.000***	-0.000***	0.000	0.000***	-0.000***	0.000***	-0.000***	0.000***	-0.000***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
PT	-0.094***	0.009***	-0.232***	-0.047***	0.089***	-0.139***	0.000	-0.091***	0.353***	-0.011+
	[0.005]	[0.002]	[0.015]	[0.013]	[0.016]	[0.014]	[0.009]	[0.003]	[0.092]	[0.006]
Corr(h,lnw)	-0.210***	-0.164***	-0.096***	-0.221***	0.085***	-0.118***	-0.037***	-0.203***	-0.169	-0.095***
	[0.025]	[0.005]	[0.019]	[0.005]	[0.014]	[0.024]	[0.002]	[0.005]	[0.108]	[0.010]
N	256,707	887,515	80,761	147,114	143,450	75,493	62,603	903,768	26,719	112,322

Note: Standard errors into parenthesis. $^{+}p < 0.1$, $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$. We control for individual, job and firm characteristics as in the main specification.

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