DE GRUYTER OLDENBOURG Journal of Economics and Statistics 2017; 237(5): 407–452

Original Article

Christina Boll, Anja Rossen and André Wolf*

The EU Gender Earnings Gap: Job Segregation and Working Time as Driving Factors

https://doi.org/10.1515/jbnst-2017-0100
Received February 8, 2017; revised July 28, 2017; accepted September 16, 2017

Abstract: This paper estimates size and impact factors of the gender pay gap in Europe. It adds to the literature in three aspects. First, we update existing figures on the gender pay gaps in the EU based on the Structure of Earnings Survey 2010 (SES). Second, we enrich the literature by undertaking comprehensive country comparisons of the gap components based on an Oaxaca-Blinder decomposition. Overall, we analyse 21 EU countries plus Norway, which clearly exceeds the scope of existing microdata studies. Third, we examine the sources of the unexplained gap. We find that about one third of the gap can be traced back to the role of the explanatory factors included in our analysis. Human capital related factors are of minor importance. Instead, the sectoral segregation of genders is identified as the most important barrier to gender pay equality in European countries. In addition, the fact that part-time positions are more frequent among women notably contributes to the gap. Furthermore, sector premiums are generally to men's advantage, this might point to a less advanta-geous within-sector positional sorting for women compared to men. We conclude that policies aiming at closing the gender pay gap should focus more on the sector level than on the aggregate economy.

Keywords: gender wage gap, Oaxaca/Blinder decomposition, Europe, Structure of Earnings Survey, female labor participation, part-time work
JEL Classification: J31, J16, J24

***Corresponding author: André Wolf,** Hamburg Institute of International Economics (HWWI), Baumwall 7, 20459 Hamburg, Germany, E-mail: wolf@hwwi.org
Christina Boll, Hamburg Institute of International Economics (HWWI), Baumwall 7, 20459 Hamburg, Germany, E-mail: boll@hwwi.org
Anja Rossen, Institute for Employment Research (IAB), Thomas-Mann-Str. 50, 90471 Nürnberg, Germany, E-mail: anja.rossen4@iab.de

1 Introduction

During the past decades, increasing education and labour force participation rates of women have boosted female earnings and have led to a convergence of genders' employment patterns and earnings (O'Neill/Polachek 1993; Blau/Kahn 2017). Still, factors like segregation and hours of work remain important (Blau/Kahn 2016). Moreover, a substantial share of the gender wage gap remains unexplained, being subject to various theories on its roots and implications (Goldin 2014). Concerning the situation in Europe, one can pose the following questions: do current gender pay gaps in Europe and their composition match the trends sketched in the international literature? How do European countries differ in their main drivers of the gap and what are the reasons?

This article aims to answer these questions, examining the gender pay gap across a set of representative European countries based on a unique international matched employer–employee dataset, the European Structure of Earnings Survey (SES). With this dataset and its particularly detailed and reliable salary information as well as its rich set of job- and employer-related variables, we are able to extend and enrich previous national studies (Goldin 2014) and international comparative studies which are based on either national (i. e. Blau/Kahn 1992, 1996, 2003, 2006) or international harmonized household-based microdata (Fortin 2005; Arulampalam et al. 2007; Olivetti/Petrongolo 2008; Christofides et al. 2010). As a decomposition method, we apply the most well-known Oaxaca-Blinder-method (Oaxaca 1973; Blinder 1973).

Our study contributes to the literature in several ways. First, we provide an update of existing figures on the unadjusted and adjusted gender pay gaps in EU countries based on the most recent wave of the Structure of Earnings Survey (SES). Overall, we analyse 21 EU countries (plus Norway), which clearly exceeds the scope of existing microdata studies (e. g. Arulampalam et al. 2007; based on the ECHP; Simón 2012 based on the SES 2002). Second, we undertake comprehensive country comparisons of the gap components. We thereby differ from other studies in that we also examine and compare the sources of the unexplained gap, thus providing additional insights into the sources of the pay differential. Third, we discuss our decomposition results in the broader context of female labour market participation, pointing to the role of selection effects and unobserved gender segregation in industries and occupations.

Our findings confirm the persistence of gender wage discrepancies in Europe. Compared to previous cross-European studies, we find high similarities both in the relevance of unexplained residuals throughout Europe and in the regional structure of the gap's magnitude and decomposition. The estimated

unadjusted pay gap amounts to 15.0 % in our cross-country analysis. About one third of the gap can be traced back to the role of the explanatory factors included in our analysis. Human capital related factors are of minor importance. Instead, the sectoral segregation of genders is identified as the most important barrier to gender pay equality in European countries. In addition, the fact that part-time positions are more frequent among women notably contributes to the gap. Furthermore, sector premiums are generally to men's advantage, this might point to a less advantageous within-sector positional sorting for women compared to men. We conclude that policies aiming at closing the gender pay gap should focus more on the sector level than on the aggregate economy.

The outline of the study is as follows. Section 2 provides a brief literature overview from which the theses guiding our empirical analyses are derived. Section 3 describes the model setup and Section 4 the data. The results are discussed in Section 5 and Section 6 concludes.

2 Literature and research theses

As Goldin (2014: 1093) points out, the gender wage gap is a summary statistic for gender differences in work. For a long time, the gap mostly reflected human capital differences between women and men. The wage gap has been primarily seen as an indicator for productivity differentials and, referring to its unexplained part, for discrimination. Due both to women's catching up in education, resulting in a reversal of the education gap to women's advantage in many countries, and a narrowing gender gap in experience, **human capital factors** tend to take a back seat in the explanation of current gender wage differentials (Polachek 2006). Decreases in the gender experience gap help to account for the corresponding decline in the gender wage gap that we have observed in recent decades (e. g., Blau/Kahn 1997, 2006, 2016).[1]

1 Still, the available household income and the presence of a partner and children, significantly impact on women's employment patterns (Lauber et al. 2014; Boll 2011a, 2011b; Anxo et al. 2007; Geyer/Steiner 2007; Jaumotte 2003; Hersch/Stratton 1994; Bielby/Bielby 1989). Time devoted to paid and unpaid work is subject to the intra-couple bargaining processes of partners (Beblo/Boll 2014). Even though men's engagement in childcare has significantly risen in recent decades (Boll et al. 2014), women still bear the lions' share of childcare in most countries (Boll 2017; DIW 2016). A temporary absence from work can entail a devaluation of their human capital compared to men of similar age, especially with respect to experience-related knowledge (Becker 1985). Due to family related employment breaks and part-time work, women suffer severe earnings losses over their career, as a rich empirical literature demonstrates (for Germany e. g. Helberger 1984; Galler 1991; Beblo/Wolf 2002; Kunze/Ejrnaes 2004; Boll 2011a, 2011b).

However, one has to be careful with this diagnosis. First, from the life course perspective, the wage gap particularly widens during family formation. Light and Ureta (1995) found in an analysis for the US that about 12 percent of the overall wage gap could be attributed to gender differences in the accumulation of experience at the beginning of the career. Second, actual work experience is not directly observed in many data sets. As gender differences in this characteristic are wrongly assigned to the unexplained portion of the pay gap, the contribution of gendered endowments is thus underestimated. Switching to other datasets often changes the picture. For Germany, for example, a study with Socio Economic Panel data (SOEP; cf. Wagner et al. 2008) shows for the year 2011 that gender differences in employment experience answer for 5.6 percentage points out of the 22.8 % German gender pay gap (Boll/Leppin 2015). Firm tenure is not identical with work experience since firm tenure focuses on years of employment with the same employer whereas work experience is the aggregate sum of years of employment. Wage premiums of firm tenure measure returns to firm-specific human capital whereas work experience premiums measure market returns to general human capital. A study conducted by Simón (2012) based on the Structure of Earnings Survey 2002 shows that firm tenure hardly impacts on the average gender pay gap in a country-sample of nine countries, although this average effect masks some notable country differences. Women in Central and Eastern European Countries (CEEC) show often a higher tenure than men.

Gender differences in the **sorting between and within occupations and industries** remain important in explaining the gender wage gap, despite occupational upgrading of women relative to men (Blau/Kahn 2016; Estévez-Abe 2005, 2006).[2] Whatever its reason, the gendered segregation of occupations is

Further, child-related effects also disseminate through signals (Spence 1973), e. g. via 'motherhood penalties' (Hersch/Stratton 1997, 2002) or potential repercussions on education decisions. Under a traditional division of labour by gender in the family, women might foresee shorter and more discontinuous work lives as consequences of their family responsibilities; they will thus have lower incentives to invest in on-the-job training than men (Blau/Kahn 2016). This thesis strongly relates to Polachek's thesis of occupational choice, which also relies on human capital investment rationales in the context of gender roles (Polachek 1981, Goldin/Polachek 1987). Thus, the thesis of Mincer and Polachek that women's labour market attachment is central in understanding the gender wage gap (Mincer/Polachek 1974) remains relevant. For instance, Blau and Kahn (1997) in their work with US Panel data estimate full-time work experience to account for almost the complete explained gap. Waldfogel (1998) yields lower but still impressive shares of 30 % to 40 % in a sample including the US and Great Britain.

2 The pay-relevant sorting into occupations has to be seen as a matter of abilities (Roy 1951) as well as of structure and preferences. According to sociological theories, gendered behaviour is a component of identity formation following role models (Mead 1934) and societal expectations with respect to gender-specific competences and skills (Correll 2004; Busch 2013), whereas

a persistent phenomenon common to all industrialized countries.[3] According to findings of Wood et al. (1993), job setting accounted for one third of the gender pay gap. Petersen and Morgan (1995) using cross-industry data of the US identify differences across occupations to be more important than within-job wage.

Not only do men and women tend to work in different occupations, they also tend to be employed at different levels of the hierarchy within occupations (Blau/Kahn 2016; Bettio/Verashchagina 2009). Blau and Kahn (2016) who present some empirical evidence for the US argue that the roots of the low performance of women in top positions may lie in the fact that it takes time to move up through the ranks (the 'pipeline' argument), greater work-family conflicts, or simply discrimination. Whatever the sources of the women's lesser representation at the top, research suggests it can have substantial consequences for gender wage differences (Blau/Kahn 2016). This is witnessed by the higher pay gap at the top of the earnings distribution compared to median (OECD 2012: 167; Boll/Leppin 2015) or generally lower levels (Blau/Kahn 2016). According to a study with German micro data from 2011, the different occupational positioning of women and men contributed with 3.4 percentage points to the raw gap (Boll/Leppin 2015). Bettio (2002) argues that horizontal desegregation would not necessarily decrease the pay gap in Europe, but vertical desegregation would. This finding is supported by Goldin (2014: 1098), who states that earnings gaps within occupations are more important than the distribution of individuals among occupations.

Similar to occupations, the sectoral distribution of women and men adds to the pay gap. Goldin et al. (2017) suggest that men have greater preferences or abilities than women to move to higher paying firms and positions and that this factor particularly increases with women's increasing family responsibilities. Also Barth et al. (2017) with US-LEHD data highlight the importance of mobility differences between women and men between establishments for the increasing overall gap over the lifecycle, particularly for those who are married. This points to the Mincerian thesis that in traditional gender role settings, married women behave like 'tied movers' and 'tied stayers' (Mincer 1978), particularly in the

economic theories rather refer to individual costs of deviating from gender stereotyped behaviour (economics of identity – see Akerlof/Kranton 2000). Beyond individual rationales, the fact that women prevail in low-paid occupations is often seen as an outcome of a systematic underevaluation of female work (England 1992). For centuries, women undertook caring and nursing tasks outside the labour market as unpaid work. Nowadays, these tasks are marketable jobs which are for the most part characterized by a lower pay than typical 'male' jobs, thereby contributing to a gender differential in earnings (Marini 1989).

3 For a detailed discussion of gender and occupational stereotypes in the context of occupational choice see Boll et al. (2015).

presence of young children in the household. Efficiency gains via intra-household specialization further enforce the resulting gender wage differential (Becker 1981).

Moreover, women do not only work more often in less pay-attractive sectors, they also benefit less from sector affiliation than men do. Goldin et al. (2017) motivate these findings with gender mobility differentials both between and within sectors and firms. Sectors differ in occupational rewards due to different wage setting regimes at industry level. Even more important, they differ in their ability and cost to adapt to employees' needs in terms of flexibility, reduced hours and temporary breakouts in the course of family events. Depending on the firm's work organization scheme, splitting up a full-time job into several flexible part-time jobs or providing flexible hours can create different coordination costs in the cross-firm comparison. As a result, in cost-intensive firms, compensating differentials in hourly payments have emerged, which imply that jobs with reduced working schedules are associated with lower hourly wages than classic full-time work (Goldin 2014). As women and men predominantly differ in their demand for flexible working time arrangements, they are differently affected in their earnings.

This directly relates to a further important driver of the gender wage gap, women's higher prevalence in **part-time work**. In 2014, the share of part-timers on the female employed was higher than the respective share among male employees across countries, even though in some of them (mostly Eastern European countries) the female part-time employment rate was only slightly higher than the male part-time employment rate (OECD 2016). For similar findings see Blau and Kahn (2016: 22) for the US or Boll et al. (2016) for EU countries. Because part-time workers have lower hourly earnings than full-time workers (Blank 1990; Hirsch 2005), the higher incidence of part-time work among women regularly contributes to the gender pay gap. Another form of atypical work is temporary work, which is regularly related to lower earnings compared to permanent jobs (Booth et al. 2002). Simón (2012) found a slightly positive impact of temporary work on the gender pay gap for an aggregate European sample consisting of nine countries in 2002.

While a decrease in the **unexplained gender wage gap** played a role in narrowing the gender wage gap in the 1980s, the unexplained gap has remained roughly stable ever since (Blau/Kahn 2016). Apparently, productivity-related factors and other supply-sided endowments fail to fully explain the observed gap in wages. Here, labour market discrimination offers a further explanation (see Blau/ Kahn 2016: 29–35 for an overview of theories and empirics of discrimination).[4] Decomposition analyses provide further insights about the roots

4 One example is taste-based discrimination (Becker 1957; Arrow 1973). Some employers might have personal preferences to hire male workers; some workers might prefer to collaborate with

of unexplained wage residuals. Beyond the true 'blind spot' of the wage differential, they illuminate gender differences in returns to observed endowments and thereby shed light on the channels through which measurement errors and/or discrimination operates.

In this study, we want to explore (a) if and to what extent the established notions on human capital, workplace characteristics and unexplained residuals can be confirmed with our data and (b) how they impact the magnitude and composition of gendered pay in the cross-European comparison. We thereby build on previous cross-country comparisons on the European level. More specifically, we directly connect to the findings of Foster-McGregor et al. (2013) and Simón (2012), using the same data source. Foster-McGregor et al. (2013) aimed at exploring earnings inequality in a multi-faceted way, extending the gender perspective. To this end, the authors used the BO decomposition technique for splitting country-specific mean wages up into an explained and an unexplained part but refrained from further differentiation into single characteristics. Our analysis directly fills this gap. Doing so, we also supplement the study by Simón (2012), which provides a detailed decomposition of nation-specific gender pay gaps of nine European countries, in two ways. First, we exploit a larger country set based on a more recent wave of the data, drawing a more comprehensive picture of European similarities and differences in gendered pay. Second, we decompose both the explained and the unexplained gap, taking the empirical evidence on the persistence of notable unexplained wage residuals across countries into account. The following **research theses**, building on the literature, shall motivate and guide our analyses:

First, regarding human capital, we expect that a higher average education and a higher tenure of women should, where they show up, decrease the wage gap.

Second, a higher prevalence of women in atypical jobs should increase it.

Third, we suggest that a traditional gender segregation between sectors will contribute to the pay gap.

Fourth, women's less advantageous sorting compared to males with respect to occupations and occupational positions within firms and sectors should show

---

male colleagues. Another form of discrimination is highlighted in the context of information asymmetry. In situations of uncertainty, employers tend to rely on their own experiences i. e. assigning an unknown employee the characteristics of the social group it belongs to (statistical discrimination). In this case, gender discrimination refers to unequal pay resulting from assigning a woman a lower productivity, career aspiration and job commitment than she actually has (Blau/Ferber 1986). As a result, women might be systematically hindered to take on leading positions (Reskin/Roos 2009).

up in lower sector premiums for women compared to men (as part of the unexplained gap).

Fifth, a notable part of the overall pay gap cannot be explained by differences in measured endowments.

3 Models

To analyse the magnitude and causal factors of the gender wage gap, we follow the seminal work of Oaxaca (1973) and Blinder (1973) both because of its widespread use (Foster-McGregor et al. 2013) and its relative simplicity.[5] Particularly, we are able to connect our results to the official pay gap statistics issued by Eurostat, supplementing them with decomposition results based on micro data.

The classic Oaxaca-Blinder decomposition focuses on the gap in average hourly earnings between male and female workers. Formally, it consists of two estimation steps. *As a first step*, estimations of the determinants of hourly wages are carried out separately for male (m) and female (f) workers. This takes the form of separate Mincerian wage regressions (Mincer 1974). In a log-linear model, logarithmized hourly wages (W) are regressed on a set of explanatory factors, i. e. a range of worker and job-related characteristics (X) henceforth referred to as *endowments*, as they are viewed as observable indicators of productivity differences partly explaining the wage gap. Formally, the regression equations look as follows (with β^j representing the estimated coefficient of the characteristic indexed with j and ε representing a residual term):

$$\ln W_{m;i} = \beta_m^0 + \sum_j \beta_m^j X_{m;i}^j + \varepsilon_{m;i}$$

$$\ln W_{f;i} = \beta_f^0 + \sum_j \beta_f^j X_{f;i}^j + \varepsilon_{f;i}$$

5 Other decomposition techniques are suitable for different purposes. For a dynamic setting, Juhn et al. (1993) decompose changes in the wage gap over time into a portion due to gender-specific factors and a portion due to changes in the overall level of wage inequality. As this reflects another kind of research question, it is not suitable for our purposes. Moreover, several semiparametric techniques have been developed and implemented (DiNardo et al. 1996; Firpo et al. 2007). Compared to the classical Oaxaca-Blinder-decomposition, they offer a higher degree of flexibility, as they impose less rigid assumptions on the functional relationship between the variables of interest. This flexibility, however, comes at the cost of higher computational demands and a reduction in the interpretability and applicability for policy purposes, especially in cases where complex non-monotonic patterns arise. For these reasons, and also to ensure comparability with previous approaches, we stick in our multi-country framework with Oaxaca-Blinder.

As a second step, the resulting coefficient estimates are used to decompose the gender difference in the average wage levels ($\bar{W}$). This is achieved by replacing gender-specific log mean[6] wages by the right-hand side of the two equations above. Following Blinder (1973), rearranging terms leads to the following expression:

$$\ln \overline{W_m} - \ln \overline{W_f} = \sum_j \left(\overline{X_m^j} - \overline{X_f^j}\right)\beta_m^j + \sum_j \left(\beta_m^j - \beta_f^j\right)\overline{X_f^j} + \left(\beta_m^0 - \beta_f^0\right)$$

The overall gender gap in log mean wages is thus split into three components. The first component represents the part of the wage gap attributable to gender differences in observed endowments. It is therefore termed the *characteristics effect* (or *endowment effect)*. A positive (negative) characteristics effect implies that based on the distribution of endowments male workers should on average earn more (less) than female workers. The second component shows which part of the wage gap is due to the fact that the same endowment generates different market returns for male and female workers. If this component is positive (negative), it implies that male (female) workers receive a wage advantage over female (male) workers because they yield higher returns for the same endowments. Finally, the third component represents a constant term. It captures the influence of all unobserved wage determinants on the gender wage gap, such as personal ability, negotiating skills and institutional setting. If this component is positive (negative), it implies that male (female) workers are better equipped with and/or receive higher returns for these unobserved endowments. The sum of second and third component is termed *the coefficients effect or the adjusted wage gap*. It represents the unexplained part of the gender wage gap, as it cannot be traced back to observed endowment differences. The adjusted wage gap must not be equated with discrimination as is sometimes referred to (e. g. Del Rio et al. 2011).

The fact that the unexplained part comprises also the influence of endowment differences in unobserved characteristics between male and female workers could lead to an overestimation of the real level of discrimination (Boll/Leppin 2015; Federal Statistical Office 2006: 10). On the other hand, it may not be ruled out that discriminatory practices restrict women's access to pay-attractive endowments as they are measured in the characteristics effect. In this regard, the unexplained part will tend to underestimate the real extent of gender discrimination. Hence, the power of the statistical approach relates more to its capacity to quantify key issues related to gendered pay than to identify distinct actors' responsibilities.

6 In this study, we refrain from quantile regressions computing and decomposing the gap in distinct segments of the wage distribution; see e. g. Albrecht et al. (2003) or Boll and Leppin (2015).

4 Data

4.1 Sample

For our analyses, we use the (2010) wave of the European Structure of Earnings Survey (hereafter SES). The SES is a large-scale European matched employer-employee dataset. It consists of inter-country harmonized microdata, as the survey is conducted in all the countries according to a common methodology. Thus, cross-country comparisons are developed on a strictly comparable basis with a rich set of harmonized information. This data set is particularly suited for our purposes for two reasons. First, it provides highly reliable and extensive salary information which is a clear advantage over household survey data, which provide comparatively coarse wage information which further bears a high risk of measurement error. Second, the SES data offers a wealth of workplace and employer-related variables whereas this sort of information is regularly rather limited in household survey data. The SES is conducted every four years through questionnaires sent to a representative sample of enterprises. The sample is drawn through a two-stage random sampling. First, a random sample of companies is drawn, and thereafter, a random sample of employees is drawn within each selected company. The national statistical institutes are responsible for selecting the sample, preparing the questionnaires, conducting the survey and forwarding the results to Eurostat. The SES provides detailed information on the relationships between the level of remuneration and individual characteristics of employees (sex, age, occupation, length of service, highest educational level attained, etc.) and those of their employer (economic activity, size and location of the enterprise). As mentioned earlier, the large set of explanatory variables is a plus of this dataset. In comparison to other data, it allows us to include details on temporary contracts and firm characteristics.

The sample regularly covers workplaces with at least ten employees in sections C (Manufacturing) to S (Other services) of the Statistical Classification of Economic Activities in the European Community (NACE rev. 2). Public administration, defence and compulsory social security (section O) is not available for some of the countries in our analysis. This induces us to drop employees from this sector in all countries for the sake of consistency.[7] Note that also in the official statistics from Eurostat addressing the gender pay gap in the public versus private sector and drawing on the Structure of Earnings Survey, section O is excluded (Eurostat 2017). However, section P (education) which together

7 Cf. Simón (2012) for the same approach.

with section O is normally referred to as the 'public sector' (e. g. BMFSFJ 2009), is included. The partial exclusion of the public sector in our analysis will probably impact our results, as we know from the literature, that employment in the public sector plays a considerable role in explaining gender pay gap differences between countries (Mandel/Semyonov 2014;BMFSFJ 2009; Estévez-Abe 2005, 2006). One reason is that wage differentials tend to be lower in the public sector than in the private sector (Arulampalam et al. 2007). However, the likely impact of the exclusion of section O on our results is not straightforward to tell, as the relative magnitude of the gender pay gap in the public vs. the private sector varies between countries.[8] As further restrictions, self-employed are excluded from our analyses and information on sectors and occupational groups are only available at a limited level of disaggregation.

Given that data availability concerning individual and job-related characteristics differs to some extent between countries, we had to weigh the aim of accounting for as many insightful characteristics as possible against the need to preserve a sufficient number of countries for our analysis. In the end, we were left with 22 countries (21 EU countries plus Norway).[9] The total number of observations in our aggregated sample is 8,829,191. Note that the estimation results for the country-pooled sample are particularly shaped by large countries (Czech Republic, Norway, and Germany). For example, the Czech Republic (845,009 observations) is 48 times as large as Lithuania (17,491 observations). To account for the heterogeneity of gender wage gaps within Europe, country-specific estimations are indispensable.

4.2 Variables

The dependent variable is the log average gross hourly wage (in euro). In addition to regular payments, the wage includes overtime payments, shift premiums, bonuses, commissions, allowances for teamwork, night work, weekend work, family allowances, payments to employees' savings scheme and other gratuities in cash fixed by collective agreements or voluntarily agreed. Not included are advances or pay for holiday, periodic bonuses and gratuities not paid regularly at each pay date, statutory family allowances, allowances for

8 Eurostat (2017), relying on sections B-S, excluding O, reports for the year 2015 lower gender pay gaps in the public than in the private sector for most EU countries, with Latvia, Romania, Bulgaria, Finland marking the exceptions and parity in Hungary.

9 Missing EU countries are Austria, Cyprus, Denmark, Ireland, Luxembourg, Malta, Slovenia.

work clothes or tools, reimbursements or payments for travel, subsistence etc., and expenses incurred in carrying out the employer's business.

As individual worker characteristics, age and education were included. Age proxies experience, i. e. work experience (which as such is not available in our data at hand) and is therefore a broader measure of human capital, including also general, non-firm-specific components (contrary to firm tenure). Age is given in terms of six categories, where the youngest group comprises the 20–29 years old workers and the oldest group the more than 60 years old. The measure of education is derived from an aggregation of ISCED levels into three categories (ISCED 0-2, ISCED 3-4, ISCED 5-6). As job-related characteristics, contract type, firm tenure, hours of work, occupational group as well as industry, ownership and size of the enterprise were taken into account. Contract type is captured by a dummy variable that is equal to one for temporary and zero for permanent contracts. Firm tenure is split into four time spans (0–1 years, 2–4 years, 15–24 years, > 24 years) and is based on the self-reported length of service in the enterprise. As noted earlier, firm tenure is not identical with work experience since firm tenure focuses on years of employment with the same employer whereas work experience is the aggregate sum of years of employment. Wage premiums of firm tenure measure returns to firm-specific human capital whereas work experience premiums measure market returns to general human capital. Work experience is not available in the dataset (cf. Foster-McGregor et al. 2013).[10] This data shortcoming will not distort the aggregate level of (unadjusted) pay gaps since unobserved gender differences in characteristics are captured by the unexplained part of the gap, but the latter will be higher (and the explained part will be lower) as it would be the case if actual work experience was observable in the data.

Information on hours of work is available with respect to the share of a full-timer's normal hours. We differentiate between two dummy variables indicating that workers work 60–99 % (large part-time) and those who work less than 60 % of a full-time worker's normal workload (small part-time). This measurement restriction is not imposed by us, but by SES itself. Hence, we are unable to detect any potential non-monotonicity properties in the marginal effect of working time

10 Although a potential experience (defined as age minus years in education minus 6) might be computed, we refrain from doing so as this indicator would hardly capture the gender difference in actual work experience, due to women's higher number of (family-related) employment breaks. Simón (2012) uses age as a proxy for work experience which is certainly more suitable for men than for women, for the above named reasons. Therefore, we use age as a control in our wage estimations, but refrain from assigning it a meaningful interpretation in our hypotheses and empirical results with respect to human capital.

within these groups. Nevertheless, as our argumentation (and also the discussion within the literature) is focused on the general dichotomy between part-time and full-time work rather than on modelling a comprehensive functional relationship between wages and work hours, we consider this delimitation useful for our purposes. Moreover, in existing studies, information on precise working hours are commonly generated based on workers subjective self-assessment and are therefore prone to measurement error. Occupational groups are identified based on the ISCO-08 classification at the two-digit-level, discriminating between 42 different groups.

The industry of the enterprise is assigned based on an own aggregation of the NACE-Rev.2- classification, motivated by the need for cross-country harmonization. It allows us to distinguish between 16 different sectors. Concerning the impact of ownership, we include a dummy variable that is set equal to one if the firm is under public control. This is defined to be the case if a share of more than 50 % is in public ownership.

Finally, the size of the enterprise is measured by its number of employees, broadly categorized into enterprises with less than 50 and others with at least 50 employees. As aforementioned, firms with less than 10 employees (very small firms) are not included in the SES 2010. Since women are overrepresented in those firms and at the same time, these firms regularly pay less, this sample restriction is likely to underestimate the role of firm size for the gender pay gap. Analyses that build on the EU-SILC data including very small firms show that this is indeed the case (Boll et al. 2016).

For a detailed description of all variables, see Table 2 in the Annex.

5 Results

5.1 Descriptive statistics

Table 3 based on the aggregate sample, in the Annex depicts summary statistics for men and women, observation numbers by country and gender are reported in Table 4. Average nominal wages of women differ between 1.86 Euros in Bulgaria and 26.19 Euros in Norway. For men, the range is between 2.15 Euros in Bulgaria and 31.50 Euros in Norway. In 16 out of 22 countries, the share of persons with tertiary education is higher among female workers than among males. Among the exceptions, Germany stands out with the highest lead of men over women. Furthermore, the share of employees that exhibit firm tenure from 5 up to 14 years is higher among women than among men in 18 out of 22

countries (with Bulgaria and Hungary marking the most important exceptions), and the same holds true for the share of employees with 15 years and more in 12 countries (with Norway, Slovakia and Finland as the most prominent exceptions). In general, the share of workers aged 50 or older is higher among males than among females.[11]

More than 20 % of employees work in temporary jobs in Portugal, Poland and Spain and this also holds true for Czech female workers. Generally, temporary jobs are more frequent among women than among men (among the 7 exceptions, Latvia, Poland and Estonia stand out with the highest lead of men over women). Percentage shares of part-timers are higher among female workers than among male workers. This holds true for both types of part-time and throughout Europe. However, country differences in magnitude become apparent.[12]

Concerning horizontal segregation, everywhere in Europe the female share exceeds the male share on employees in health and social work activities and education (with the sole exception of Hungary in the latter case), whereas men dominate throughout Europe in the chemical and metal industry as well as in the field of construction. However, the magnitude of segregation varies by sector and country. Furthermore, women work more often in enterprises under major public control than men do. Publicly controlled firms hold a share of more than 30 % on male employees only in Hungary, Croatia, Norway and Poland, whereas in the named countries plus Norway and Sweden, publicly controlled firms hold shares of more than 50 % on female workers.

To sum up, it becomes evident that women's formal and also firm-specific human capital outperforms men's in most countries. On the other hand, traditional patterns of segregation prevail all over Europe. However, from the perspective of mean wages, women are still unable to reap the full returns in terms of earnings. Several reasons might account for this finding.

---

11 In more detail, the share among men ranges below 25 % in 4 countries only and nowhere below 20 %. Among women, the share is below 25 % in 7 countries and below 20 % in 2 countries (Spain and Greece).

12 Whereas more than 20 % of female employees in Norway, Sweden, Belgium and the Netherlands work in large-scale part-time jobs and the same holds true for low-scale part-time jobs in Norway, the Netherlands and the UK, part-time work is of minor importance for women in Central and East European countries (CEEC) and anywhere for men. In the Netherlands, 43.1 % of working women assume a part-time job of low scale. Germany ranks second in this regard, with a share of 37.3 %. The respective shares for large-scale part-time in the two countries are 35.6 % and 18.6 %.

5.2 Wage regression results

In what follows, we present selected results on wage regressions. As mentioned above, the nation- and gender-specific wage regressions inform us about the wage returns that men and women achieve for single characteristics. Table 5 in the Annex depicts the full results.

For females, part-time work, disregarding its scope, is associated with significant[13] hourly wage penalties compared to full-time work in all countries except France, Hungary, Poland and Croatia, where both types of part-time yield wage premiums. Remarkably, in the Netherlands, where part-time is most widespread in the European context, penalties are restricted to low-scale part-time. In Spain, Portugal and Finland, low-scale part-time even yields a wage premium. Similar to females, part-time premiums are observed for males in France and Hungary irrespective of its scope, but with partially insignificant effects in Poland and Croatia. Male patterns resemble female ones also for the remaining countries. Note however, that for both types of part-time, wage penalties tend to be more pronounced for men than for women (with the UK marking the sole exception for low-scale and Slovakia for large-scale part-time), whereas wage premiums are mostly in favour of men (with Hungary marking the sole exception).[14]

Working with an enterprise under major public control is related to a wage bonus in roughly one half of countries and to a malus in the other half for females. By contrast, male workers receive a premium in 16 out of 22 countries. Holding a temporary contract (compared to a permanent contract) and working in a small firm with less than 50 employees is both related to wage penalties for women and men in all countries (except for Latvian men in case of temporary work). More years of firm tenure are associated with a wage reward, this holds true for both women and men. At the same time, women benefit from higher premiums for staying 15 years or longer with the same firm than men in Germany, Spain, France, Italy, Belgium and the United Kingdom. Similar to tenure, a higher educational level is associated with higher earnings. This holds for both genders, although educational premiums are differently distributed across genders and countries.[15]

---

13 Significance is reported for the 1%-, 5%- and 10%-level in what follows.

14 Part-time penalties can be rationalized by several explanations, for instance related to the existence of coordination costs and restrictions in the access to internal training. Indeed, Manning and Petrongolo (2008) document the discrepancy in hourly earnings of full-time and part-time working women in Great Britain.

15 For example, the wage premium of tertiary compared to medium education is higher for women than for men in Germany, Spain, Poland, Latvia and Lithuania, and the same holds true for the wage premium of medium education compared to low education in Greece, Finland and Belgium. Furthermore, compared to age group 40–49, being age 50 or older is associated with

5.3 Decomposition in explained and unexplained gender pay gap

Before addressing the level of single endowments, we split the overall gender pay gap (subsequently termed the unadjusted gap) in an explained and an unexplained part. For our cross-country sample, the unadjusted gap is 15.0 % (2010). About one third of the gap can be traced back to the role of the explanatory factors included in our analysis. A wage difference of 11.0 % remains as the unexplained (adjusted) gap. Hence, the source of the largest part of the gap is not a difference in measured worker attributes but in unobservables. At country level, the picture however varies drastically, as shown in Table 1.

Concerning the unadjusted gap, figures range from 3.6 % for Poland to 25.1 % for Estonia. From a geographical perspective, it is noticeable that most Central and Eastern European states are exhibiting gaps clearly below average, with the Czech Republic, Slovakia and Estonia marking the exceptions. Among the West European countries, only Italy is exhibiting a very small gap (4.5 %). Further country variation is revealed by the decomposition results. First, the country ranking with respect to the adjusted gap changes substantially compared to the unadjusted gap. Second, the role of gender differences in average worker features is in some countries not only more pronounced than in others, it also works in opposite directions. For instance, it is striking that the two countries with the smallest raw gap (Poland and Italy) both exhibit negative explained gaps.[16] Hence, the average female worker in these countries is endowed with better characteristics than her male counterpart, at least concerning those characteristics included in our dataset. The reason why also in Poland and Italy female workers nevertheless have lower average earnings is exclusively to be found in the unexplained residual.

Moreover, this unexplained part is nowhere identified to be negative. It doesn't even get lower than five percent. In most countries, it is thus this term that comprises the bulk of factors that prevent women from catching-up. The

wage penalties for women and men in Germany, Estonia, Norway and the UK and with wage premiums for women and men in Belgium, Spain, France, Greece, Hungary, Croatia, Italy, Portugal and Romania.

16 With respect to negative explained gaps, the study by Foster-McGregor et al. (2013), which is also based on wave 2010 of the SES data, comes up with similar results. The authors find significantly negative explained pay gaps for Greece, Hungary, Latvia, Luxembourg and Poland. Also Lithuania displays a negative explained gap, but lacks significance. Italy and Portugal exhibit positive explained gaps close to zero.

Table 1: Unadjusted, explained and unexplained gender pay gap based on SES 2010 data, in %.

Country	Unadjusted gap	Explained gap	Unexplained gap (adj.)	Country	Unadjusted gap	Explained gap	Unexplained gap (adj.)
Belgium	8.6	2.8	5.8	Latvia	7.5	–3.1	10.6
Bulgaria	8.6	1.3	7.3	Lithuania	5.9	–7.9	13.8
Croatia	5.9	–5.9	11.7	Netherlands	15.5	7.1	8.4
Czech Republic	16.7	3.5	13.2	Norway	14.0	7.2	6.9
Estonia	25.1	10.3	14.9	Poland	3.6	–7.8	11.4
Finland	20.8	9.3	11.5	Portugal	11.6	–0.9	12.5
France	13.5	4.9	8.7	Romania	7.1	0.8	6.2
Germany	22.3	14.5	7.8	Slovakia	16.7	2.3	14.4
Greece	13.1	5.5	7.6	Spain	17.5	5.4	12.0
Hungary	8.4	0.5	7.9	Sweden	14.0	6.2	7.8
Italy	4.5	–6.2	10.7	UK	20.6	6.2	14.4
				Total	*15.0*	*4.0*	*11.0*

Sources: SES (2010), own calculations (see Boll et al. 2016).

only two countries where the explained gap exceeds the unexplained part are Germany and Norway (see for the same result Foster-McGregor et al. 2013; Simón 2012[17]). As explained above, it consists of two different kinds of effects. First, it accounts for the fact that the same endowment could be evaluated differently by the market, depending on whether the person is male or female. Second, it includes the impact of gender differences in those market-relevant characteristics which are not controlled for in our model. This second aspect is of special relevance, as our dataset does not allow us to assess potentially important gender differences related to e. g. actual work experience (as mentioned in Section 4.2). It is interesting to see that some of the countries with negative explained gaps like Poland and Portugal perform worse than the country average when it comes to the unexplained gap. Apparently, from the fact that women outperform men in attributes like education one cannot conclude on a lower pay gap. This provides justification for a more disaggregated analysis of the sources of the gender pay gap.

5.4 Decomposition of the explained gender pay gap

Figure 1 documents which share of the explained part of the gender pay gap can be attributed to which measured characteristic. Precise numbers can be found in Table 6 in the Annex.[18] While some features show similar effects across countries, the role of others is highly heterogeneous.

Starting with **education**, the role of schooling tends to contribute to wage convergence, *confirming the first part of our first research hypothesis*. Female workers in most countries exhibit a higher average level of education than their male counterparts, at least when measured on our three-level scale.

Combined with the fact that higher educational levels are associated with higher earnings (see Section 5.2), the consequence is a diminution of the cross-country gender gap by 1.0 %, in its magnitude clearly exceeding previous results by Simón (2012)[19] and a diminution of national gender pay gaps where men have

17 Simón (2012) analyses a sample with 9 countries (Lithuania, Latvia, Italy, Norway, Portugal, Spain, the Netherlands, the Czech Republic and Slovakia), thereby Norway is the only country where the explained gap exceeds the adjusted gap. The author uses the wave 2002 of the SES and finds somewhat higher unadjusted gaps, but also here, Lithuania, Latvia and Italy exhibit the lowest ones. Moreover, Lithuania presents a negative explained gap which accords with our results.

18 As aforementioned, results of the wage regressions underlying our decompositions are available in the electronical appendix.

19 In the earlier SES wave 2002 which is analysed by Simón (2012), education still contributes to the gap in Norway Slovakia, the Czech Republic and the Netherlands.

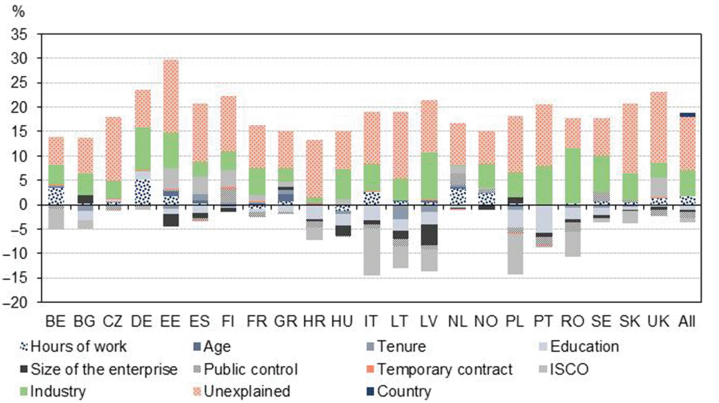

Figure 1: Decomposition of the gender pay gap (in %), 2010.
Sources: SES (2010), own calculations (see Boll et al. 2016).

higher educational endowments. In two countries, Poland and Portugal, the diminution even exceeds 3%, foremost due to large gender differences in the shares of college graduates. On the other hand, we witness with Germany a case where differences in schooling further nourish the wage gap by 1.6%. This is due to German men's lead over women with respect to the employee share with tertiary education which is most pronounced in the European comparison.

As discussed earlier, **firm tenure** is another predictor for human capital, focusing on firm-specific skills and knowledge, acquired by training-on-the job via staying with the same firm for years. In the aggregate sample, differences in tenure raise the gender pay gap by merely 0.1 pp., which is significantly lower than the 0.5 pp. estimated by Simón (2012) for his dataset of nine European countries. This positive relationship between wages and tenure is confirmed at the country level.[20] In line with basic intuition, literature findings (Brown 1989) and descriptive statistics (Section 5.1), longer job tenure is associated with higher earnings in the cross-country regression. This can both be explained by a mechanism of self-selection (higher wages imply higher job satisfaction, thus workers stay longer) and the productivity-enhancing accumulation of job-specific human capital over time (Topel 1991). In our cross-country sample, women

20 The positive relationship between tenure and wage manifests in our data in a lower conditional wage for lower tenure compared to the benchmark category "5–14 years" and a higher conditional wage for higher tenure. Moreover, the wage penalty for tenure 0–1 year is more pronounced than the wage penalty for tenure 2–4 years. The only exception is marked for Norway, with a comparatively higher conditional wage for tenure amounting to 2–4 years.

exhibit a slightly larger average tenure than men, contradicting the finding of Macpherson and Hirsch (1995) who identify average tenure to be lower in female-dominated occupations. However, we find that gendered endowments vary at country level. The data *confirm the second half of our first hypothesis*, stating that a lead of women with respect to firm tenure should manifest in a decreasing effect of this characteristic on the gender pay gap for the respective country. An example is Bulgaria, where the impact of tenure on the wage gap is measured to be – 1.2 pp., reflecting a high local share of female workers (43.3 %) with very long tenure of more than 15 years which is particularly pay-attractive. Only 9.4 % of Bulgarian men display such a long firm tenure. An even higher wage decreasing effect of tenure is observed for Lithuania with -3.1 pp. and Latvia with -1.5 pp., supporting the findings of Simón (2012). On the other hand, firm tenure contributes to the overall wage gap with 0.4 pp. in Finland, where 28.7 % of males but only 8.6 % of females exhibit a firm tenure of more than 15 years. A general finding that accords with Simón (2012) is that in CEEC countries, tenure is more likely to be to women's advantage than in the rest of Europe.

Our second hypothesis addresses the role of atypical work for gendered pay. From Section 5.1 we know that women are more prevalent among part-time workers and also among workers with temporary jobs. From Section 5.2 we learned that **part-time work** is associated with wage penalties (compared to full-time) in most countries, and the same holds true for temporary compared to permanent jobs. Therefore, it does not come as a surprise that the factor 'hours of work' predominantly raises the wage gap, *supporting the first part of our second research hypothesis*. According to our findings, women's higher frequency of part-time work contributes to a widening of the cross-country gender pay gap by 1.6 %. This fits recent evidence by Goldin (2014) for the US, who assigns working time arrangements a key role for explaining the incomplete gender convergence on the US labour market. An outlier in our study concerning the magnitude of this effect is Germany, where the part-time effect reaches a level of 5.1 %, the second largest of all measured characteristics effects in this country. This result originates from a dominance of low-scale part-time (as shown in Section 5.1, 37.3 % of German female part-timers assume a job of low-scale part-time), combined with a severe wage penalty of 8.5 % (compared to full-time). Moreover, German women's part-time affiliation is severely persistent over the life course. 58.3 % of working women with a youngest child at teen age (12 +) holds a part-time job, whereas the EU-28 average is 32.1 % (Eurostat 2015). This results in a 34.0 % contribution of part-time work to the German gender gap in accumulated earnings even at age 50 (Boll et al. 2017). If we look at the Netherlands for comparison, the share of female workers in low-scale part-time is even higher (43.1 %), but the wage penalty is much lower (2.6 %) and is

not even significant for large-scale part-time, whereas German female workers suffer a 4.9 % penalty in this case. As a result, part-time adds to the Dutch gender pay gap with 3.1 pp.[21] By contrast, In Hungary and France, where we observed part-time premiums for both genders, part-time work is to the advantage of women, decreasing the pay gap, since more women than men benefit from the premium. Throughout Europe and also in these two countries, women are more likely to work part-time than men. But, as our data show, a more widespread use of part-time does not necessarily correspond to a lower penalty, as the examples for Germany and Latvia show (see for the same result Foster-McGregor et al. 2013: 50). However, in a geographical perspective, CEEC countries stand out with a negative or close to zero contribution of part-time work to the pay gap, what is in line with the findings of Simón (2012) with the same data source eight years earlier. In this context, the sectoral structure of part-time employment also matters. Publicly-controlled sectors sometimes display high shares of part-time employment and rather low part-time penalties, e. g. Education in Poland or Health Services in Sweden (Foster-McGregor et al. 2013: 51).

Another aspect of atypical work is **temporary contracts**. Like part-time work, temporary work tends to widen the gender gap, *confirming the second part of our second research hypothesis*. Working in a temporary position reduces the expected earnings (compared to permanent work) in all countries and for both genders except for Latvian men (see Section 5.1). This is consistent with general findings of the literature (Booth et al. 2002). Temporary workers have less incentives to accumulate job-specific human capital, as they face the risk of depreciation when the contract is not prolonged. For the same reason, employers are also less inclined to give them access to internal training. At the same time, temporary jobs are more frequent among women than among men (see Section 5.1). This seems intuitive in the presence of self-selection: facing a higher risk of career interruptions through child birth, women on average are less inclined to commit to a certain career path and employers are for the same reason less willing to offer them permanent positions. Nevertheless, the overall effect remains of low magnitude. In our cross-country sample, temporary work widens the wage gap by only 0.1 pp. (which is identical with the finding by Simón 2012). At country level, the maximum contribution is 0.5 pp. (Finland). Cases where the effect goes in the other direction comprise those countries where the gender distribution of temporary work is reversed. In Poland and Portugal, this implicates a modest reduction in the gender pay gap by 0.2 pp.

21 Among the nine countries analyzed by Simón (2012), Norway and the Netherlands exhibit the highest contributions of part-time work to the gender pay gap.

Something that can be noticed for all countries is that the selection of male and female workers into different **industries** contributes to the existence of wage differences, *supporting our third research hypothesis*. Hence, a significant part of the gender gap is due to the fact that women are over-represented in industries with low pay levels (and accordingly under-represented in well-paid industries). Sector affiliation contributes to the gap in the cross-country sample with 5.2%. Sector represents the factor with the greatest effect size for the cross-country sample, a finding that is consistent with recent results by Simón (2012) for a smaller sample of the 2002 wave of the same dataset. As shown in the descriptive statistics in Section 5.1, women are particularly over-represented in Education as well as in Health and Social Work Activities. At the same time, they are highly under-represented in Construction and in manufacturing sectors such as Chemical Products, Metal Products or Electric and Transport Equipment.

In a country comparison, the largest effects of sectoral distribution are measured for Romania and Latvia, where its contribution to the overall gender gap amounts to 11.3 pp. and 9.7 pp., respectively. In both countries, the comparatively small presence of women in well-paid jobs in the area of Manufacturing and Construction is again responsible for this result. At the other extreme, there are two countries where the industry effect remains fairly marginal: the Netherlands (0.3 pp.) and Croatia (1.1 pp.). In the Netherlands, manufacturing sectors as well as wholesale trade are an important part of the explanation. Dutch women show a lower participation in these sectors than in the cross-country average. At the same time, these sectors offered, all else being equal, a comparatively low remuneration compared to other sectors in the Dutch economy, a fact that primarily concerned men.[22] Related to industry is **firm size**. The fact that the gender distribution of workers differs with firm size mitigates the wage gap which is consistent with the results by Simón (2012). As descriptive statistics reveal, the share of workers working in firms with more than 50 employees is higher among female than among male workers (except in Bulgaria, Poland and the Czech Republic). From wage regressions, we further know that the payment level in large firms is ceteris paribus higher throughout Europe, a result that is well documented in the labour economics literature (Oi and Idson 1999). Explanations could be the occurrence of productivity gains through a higher division of labour or the need to pay compensating differentials due to the unpleasantness of working in an impersonal atmosphere (Masters 1969). As a consequence, the gender pay gap is reduced by 0.6 pp. in the cross-country estimation. The only conflicting evidence at country level is

22 Also in the country sample of Simón (2012), the Netherlands display the lowest effect of sector affiliation to the gender pay gap.

obtained for Bulgaria, Poland and Greece. However, we have to bear in mind that the negative effect of firm size most likely accrues from the fact that firms with less than ten employees are excluded. Since women are over-represented in very small firms, the effect sign of firm size could reverse if very small firms are taken into account. Analyses based on the EU-SILC data (2013) confirm this suggestion (Boll et al. 2016).

Public control over the firm (which is, by definition, the case when a share of more than 50 % is in public ownership) is another factor that predominantly reduces the gender wage differential, confirming previous results from Arulampalam et al. (2007) and Simón (2012). In all observed countries in our dataset at hand, female workers were over-represented in publicly controlled firms. This result accords with findings of Gornick and Jacobs (1998) and may be explained with attractive employment conditions the public sector offers for mothers, due to the high degrees of protection, time flexibility and tolerance towards periods of absence (Kolberg 1991). At the same time, we find in the majority of countries a higher conditional remuneration in publicly than in privately controlled firms, implying a reduction of the wage gap by 1.1 pp. in the aggregate and up to 2 pp. (Romania) at country level. Gregory and Borland (1999) argue that these differences in wage structure are not surprising given that wage setting in the public sector occurs in a political environment, whereas private-sector decision making occurs in a market environment. Moreover, anti-discrimination legislation may be more aggressively enforced in the public sector. However, the public control premium applies more for men than for women: Whereas male workers receive a premium in 16 out of 22 countries, on the side of women this holds true for around half of all countries. Moreover, countries with a public control penalty for both genders exist. In Finland and the Netherlands, working in a publicly controlled firm implies a wage penalty for both genders, yielding an increase in the gender gap by 2.7 pp. and 2.3 pp., respectively.[23]

Workers' **age distribution** does hardly impact on the aggregate wage gap, the net effect of age differences is practically zero (–0.1 %). Effects of the single age groups are of a similar magnitude. A look at the wage regressions shows that this is not due to an irrelevance of the factor age in wage setting. Compared to the reference group of 40–49 years old workers, workers in most other age groups are estimated to earn significantly less in the cross-country regression for male workers, reproducing the typical inversely U-shaped wage evolution from the literature (Skirbekk 2004) for the aggregate sample. Rather, differences in

23 Foster-McGregor et al. (2013: 61) find a public control wage premium in about half of all countries, although not differentiating by gender.

the age distribution of male and female workers are simply too small to let this affect the wage gap. However, the practically zero effect for the aggregate sample masks somewhat higher effects in single countries (in line with Simón 2012). The highest contribution of age to the pay gap is observed for Greece and Estonia.[24]

Finally, the characteristic causing the most heterogeneous effects is **occupation**. Its contribution to the gender gay gap in the aggregate sample is –0.9 %. Hence, at the time of observation, women tended to cluster in the better paid occupational groups (from a male perspective). At a first sight, this seems to reject the theories linking occupational segregation to gender pay differences laid out previous Section 2. However, we need to remain cautious with our interpretation, due to several data limitations. First, we merely distinguish between 43 occupational groups, thereby not capturing the full extent of gender heterogeneity in occupational sorting. Second, we can expect a high degree of correlation between occupational choice and sector, up to the point that some occupations are only observed within some sectors. Thirdly, with the occupational classification at hand, it is not possible to adequately control for vertical hierarchy. This is an important point since the different allocation of women and men to hierarchical positions within occupations (and sectors) is a robust finding in the literature (e. g. Bettio/Verashchagina 2009). Last but not least, employment selection matters: in some countries, tasks associated with a female image are still largely executed outside the formal labour market (Bettio 2002).

Referring to these particularities, the moderate effect measured for occupational endowment achieved from the aggregate sample appears a bit less striking, especially since it does not stand out in the literature (cf. Bettio/Verashchagina 2009; Ministère du travail, de l'emploi, de la formation professionelle et du dialogue social 2015 for France). Moreover, the overall effect hides tremendous heterogeneity across countries. In Spain, Estonia and the UK, occupational differences are measured to contribute more than 3.5 pp. to the overall wage gap, implying this to be the prime factor responsible for the existence of a positive explained gap in these countries. Also for Finland, France, Greece, Hungary, the Netherlands and Norway a positive impact is observed. By

24 Within the group of female workers, countries where workers aged 50 or older earn significantly less than the 40–49 years old represent a clear majority. The above mentioned "inverse U"-shaped pattern is thus the common case. Only in a minority of countries (Estonia, Finland, Hungary) the marginal effect remains positive until age 60. Among male workers, inverse U-shaped patterns are observed (in different forms) for each single country. As a consequence, the endowment effect of age tends to be negative (i. e. gap-decreasing) in those countries, in which female workers are over-represented (in relation to the total working population) in the middle age-groups 30–39 and 40–49, while it is in positive in the others.

contrast, we witness a massive negative impact e. g. in Italy and Poland, reaching levels of – 9.6 pp. and – 8.3 pp., respectively, nourishing the result that endowment differences in total work in favour of women. Lithuania displays a negative impact of occupation as well, advantaging women (consistent with the finding of Simón 2012). A detailed analysis of the contributions of the single occupational groups reveals that this is mainly the outcome of a strong concentration of female workers in the group of teaching professionals. In both Italy and Poland, the wage bonus of teaching professionals compared to the reference category is much higher than in the cross-country sample. At the same time, the degree to which women are over-represented in this occupational group is higher than in other countries.

Occupational affiliation has to be interpreted in the context of employment selection. Figure 2 depicts gender gaps in employment rates (employment rate males – employment rate females) together with unadjusted pay gaps in the observed European countries.

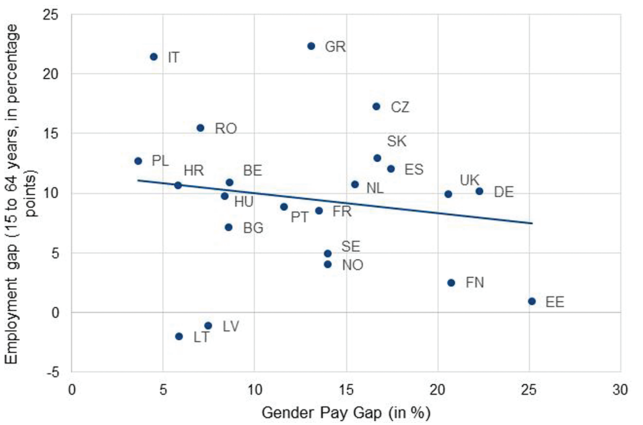

Figure 2: Relationship between gender pay gap and gender employment gap in SES. Sources: Eurostat (2015), SES (2010), own calculations (see Boll et al. 2016).

The pattern documents a clear negative relationship between the two measures: countries with high employment gaps tend to exhibit low pay gaps and vice versa. Poland and Italy obviously belong to the group of European countries with low wage gaps and at the same time comparatively large employment gaps due to low female labour market participation. Apparently, this is a reflection of the fact that some typically low-paid service tasks like nursing and cleaning,

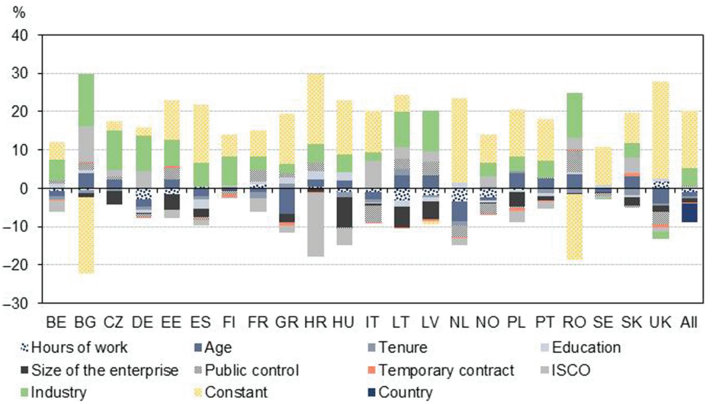

Figure 3: Decomposition of the unexplained part of the gender pay gap (in %), 2010. Sources: SES (2010), own calculations (see Boll et al. 2016).

which have traditionally been viewed as women's work, are in these countries to a large part still not delegated through formal work contracts, but mostly executed within households. More generally, the picture supports the notion of a non-random selection of women into the labour market, in the form that women with low returns to paid jobs choose to stay out, thus narrowing the gender gap in average wages (Olivetti/Petrongolo 2008).

5.5 Factors behind the unexplained gender pay gap

Results in Table 1 have shown that the unexplained gap is everywhere positive. Furthermore, it makes up the largest part of the overall gender wage gap in almost all countries under observation (with Germany and Norway marking the exceptions). Given the unavoidable data limitations, this does not come as a surprise. Foremost, this should result from the lack of a measure for actual work experience.[25] Endowment effects resulting from these differences are implicitly included in the constant as part of the residual (adjusted) gap. A study with German data shows that gender differences in actual experience account for 5.6 percentage points of the overall gap (Boll/Leppin 2015). As we hypothesize in

25 An approximation by potential experience as measured by a worker's age and years of education would have had to remain highly imperfect, as it does not account for gender differences in labour market absence, especially related to birth and child caring. We therefore refrained from generating such a proxy.

the beginning of the paper (thesis 5), the constant should be of notable extent for this reason in all countries under investigation. Similar unobserved effects captured by the constant could stem from factors like personal abilities and negotiating skills.

Moreover, the adjusted pay gap might encompass effects of hierarchical and occupational sorting, which cannot be captured by the precision and aggregation level of an occupation measure like ours. As our fourth research hypothesis postulates, we expect that these gender differences show up at the sectoral level, i. e. in different sector premiums of women and men. In what follows, we split up the unexplained part of the gender pay gap to verify our hypotheses. Figure 3 plots the contributions to the unexplained gap at country level. Precise numbers can be found in Table 7 in the Annex.

As it is the case for the characteristics effect, also sources of the coefficients effect differ substantially between countries. Nevertheless, some major patterns can be identified. First, industry is estimated to exert a sizeable positive coefficients effect in almost all countries (except Sweden and UK), *confirming our fourth research hypothesis*. For the aggregate sample, this effect equals 4.8 %. In Belgium, the Czech Republic, Latvia and Romania, the magnitude even exceeds 10 %. That is, in all countries except the two named above, male wage premiums are particularly pronounced in those sectors where female workers are over-represented. This indeed hints at considerable intra-sectoral gender heterogeneity with respect to the sorting into occupations and hierarchical positions. Apparently, much of the sorting takes place within rather than between industries.

The second consistent pattern is the negative sign of the age composition coefficient. It reduces the gender pay gap by 1.0 pp. in the aggregate sample. It is also negative throughout the single country estimations, but not always significant. The negative effect of part-time premiums (decreasing the pay gap) hints to the fact that men suffer higher wage penalties from part-time work than women (see Section 5.2). An exception (for low-scale part-time) is the United Kingdom, resulting in an increasing effect of this factor on the UK gender pay gap. France and Hungary are among the few countries displaying wage premiums for part-time work compared to full-time. Whereas the premiums are higher for men in France (resulting in a positive impact on the French gender pay gap), they are higher for women in Hungary (resulting in a negative impact on the Hungarian gender pay gap).

Finally, the constant term represents a major contributing factor in the majority of countries, which *partly confirms our fifth research hypothesis* (Bulgaria and Romania are exceptional in this context). With a contribution of 14.8 pp. in the cross-country sample, the constant is almost exclusively responsible for the existence of an unexplained wage variation. It captures the

influence of unobserved variables. As discussed earlier, we assume that gender differences in actual work experience over the lifecycle make up the bulk of this amount. The wage-reducing effect of a temporary labour market absence of women due to birth and childcare is nowhere explicitly accounted for in our approach. Moreover, Becker (1985) and Fuchs (1989) speculate that most of the wage gap not attributable to experience is due to unmeasured differences between men and women in their commitment to parenting which points to the importance of gender roles.

However, the striking performance of Bulgaria and Romania as still quite recently acceded EU member states asks for a detailed institutional analysis. This points to the natural limits that large-scale cross-country studies like ours face in disentangling the socioeconomic interrelations behind a certain observation.

6 Conclusion

Based on the 2010 wave of the Structure of Earnings Survey, this study has investigated size and sources of gender wage gaps in European countries.

Our first result was already a crucial one: a significant wage gap between male and female workers is still an undeniable reality in every single EU country under observation. However, magnitude and composition notably varies between countries. While endowments operate in some countries like Germany and Estonia decisively in favour of men, in others like Poland and Italy they advantage women. By contrast, the unexplained part of the gap is nowhere identified to be negative, it advantages men throughout Europe. Regarding endowments in more detail, gender differences in human capital play only a moderate role for gendered pay in Europe, in accordance with the international literature. Taken education, tenure and age together, the contribution is positive in only 7 out of 22 countries. Only in Germany, the positive impact exceeds 1 percentage point of the overall German gap. In more detail, schooling works predominantly in favour of women, and regional differences with respect to firm tenure, though a bit more prominent, barely impact on the overall gap. However, this does not generally mean that training-on-the-job loses importance. The data at hand does not allow us to control for actual work experience, although this factor significantly adds to the pay gap, as many studies show. The effect is captured by the constant term within the adjusted gap in our study.

More strongly than human capital differences, women's over-representation in atypical employment impacts the overall pay gap. Our findings reveal that part-time is less an issue for CEEC than for Western and European

countries. On the one hand, this eases employment re-entry of women after childbirth, but, on the other hand, it leads to an increase in pay differentials. Across European countries, we find a notable trade-off between low gender wage divides and low gender employment gaps. Temporary work disadvantages women in terms of equal pay. The most important factors for gendered pay across Europe are sectoral segregation on the one hand and the high constant as the true 'blind spot' of the pay differential on the other hand. Not only do women still work in less pay-attractive sectors than men, they seem to be further characterized by a less advantageous sorting within sectors (with respect to occupations and occupational positions) which shows up in lower sector premiums compared to men.

We conclude that policies aiming at closing the gender pay gap should focus more on the sector level than on the aggregate economy. The constant mirrors the importance of unobserved drivers, i. e. gender differences in labour market intermittencies, preferences for job amenities, abilities, or bargaining skills. Compared to previous cross-European studies (Foster-McGregor et al. 2013; Simón 2012; Arulampalam et al. 2007), we find high similarities both in the persistent relevance of unexplained residuals throughout Europe and in the regional structure of the gap's magnitude and decomposition.

There are several limitations of our study. First, it is unable to isolate the effect of institutions (e. g. family conciliation policies, social beliefs and norms, wage-setting institutions). Illuminating these particularities requires further detailed research incorporating the interplay of individual decision-making and institutional backgrounds. Second, due to data restrictions, we were not able to model selection issues. As women's labour market participation likely depends on potential earnings, the calculated gap may be biased (Olivetti/Petrongolo 2008). Recently, in analysing US census data, Jacobsen et al. (2015) find evidence for a switch to a positive selection during the last fifty years, but there is also counter evidence (e. g. Beblo et al. 2003 for Germany). Third, an increase in explanatory power could be achieved by including additional characteristics in the decomposition which was also impossible with the given dataset.

References

Akerlof, G.A., R.E. Kranton (2000), Economics and Identity. Quarterly Journal of Economics 115: 715–753.

Albrecht, J., A. Bjorklund, S. Vroman (2003), Is There a Glass Ceiling in Sweden?. Journal of Labor Economics 21: 145–177.

Anxo, D., I. Cebrián, C. Fagan, G. Moreno (2007), Patterns of Labour Market Integration in Europe – A Life Course Perspective on Time Policies. Socio-Economic Review 5: 233–260.
Arrow, K. (1973), The Theory of Discrimination. pp. 3–33 in: O. Ashenfelter, A. Rees (eds.), Discrimination in Labor Market. Princeton/NJ.
Arulampalam, W., A.L. Booth, M.L. Bryan (2007), Is There a Glass Ceiling over Europe? Exploring the Gender Pay Gap across the Wage Distribution. Industrial & Labor Relations Review 60 (2): 163–186.
Barth, E., S.P. Kerr, C. Olivetti (2017), The Dynamics of Gender Earnings Differentials: Evidence from Establishment Data. NBER Working Paper No. 23381, May 2017.
Beblo, M., D. Behninger, A. Heinze, F. Laisney (2003), Measuring Selectivity-Corrected Gender Wage Gaps in the EU. ZEW Discussion Paper: 3–74.
Beblo, M., C. Boll (2014), Ökonomische Analysen Des Paarverhaltens Aus Der Lebensverlaufsper-Spektive Und Politische Implikationen. Vierteljahrshefte zur Wirtschaftsforschung 83, Familien-politische Maßnahmen in Deutschland – Evaluationen und Bewertungen: 121–144.
Beblo, M., E. Wolf (2002), Die Folgekosten Von Erwerbsunterbrechungen. DIW-Vierteljahreshefte Zur Wirtschaftsforschung 71 (1): 83–94.
Becker, G.S. (1957), The Economics of Discrimination. Chicago, IL: The University of Chicago Press.
Becker, G.S. (1981), A Treatise on the Family. Cambridge, MA: Harvard University Press.
Becker, G.S. (1985), Human Capital, Effort, and the Sexual Division of Labor. Journal of Labor Economics 3 (1): 33–58.
Bettio, F. (2002), The Pros and Cons of Occupational Gender Segregation in Europe. Canadian Public Policy/Analyse De Politiques 28: 65–84.
Bettio, F., A. Verashchagina (2009), Gender Segregation in the Labour Market: Root Causes, Implications and Policy Responses in Europe. European Commission's Expert Group on Gender and Employment (EGGE), European Commission, Directorate General for Employment, Social Affairs and Equal Opportunities, Unit G, 1.
Bielby, W.T., D.D. Bielby (1989), Family Ties: Balancing Commitments to Work and Family in Dual-Earner Households. American Sociological Review 54 (5): 776–789.
Blank, R.M. (1990), Are Part-Time Jobs Bad Jobs?. pp. 123–155 in: G. Burtless (ed.), A Future of Lousy Jobs? the Changing Structure of U.S. Wages. Washington, DC.
Blau, F.D., M.A. Ferber (1986), The Economies of Women, Men and Work. Upper Saddle River, NJ: Pearson Education.
Blau, F.D., L.M. Kahn (1992), The Gender Earnings Gap: Learning from International Comparisons. American Economic Review 82: 533–538.
Blau, F.D., L.M. Kahn (1996), Wage Structure and Gender Earnings Differentials: An International Comparison. Economica 63: 29–62.
Blau, F.D., L.M. Kahn (1997), Swimming Upstream: Trends in the Gender Wage Differential in the 1980s. Journal of Labor Economics 15 (1): 1–42.
Blau, F.D., L.M. Kahn (2003), Understanding International Differences in the Gender Pay Gap. Journal of Labor Economics 21: 106–144.
Blau, F.D., L.M. Kahn (2006), The U.S. Gender Pay Gap in the 1990s: Slowing Convergence. Industrial & Labor Relations Review 60 (1): 45–66.

Blau, F.D., L.M. Kahn (2016): The Gender Wage Gap: Extent, Trends, and Explanations. IZA Discussion Paper No. 9656, January 2016.

Blau, F.D., L.M. Kahn (2017), The Gender Wage Gap: Extent, Trends, and Explanations. Journal of Economic Literature 55 (3): 789–865.

Blinder, A.S. (1973), Wage Discrimination: Reduced Form and Structural Estimates. Journal of Human Resources 8 (4): 436–455.

BMFSFJ–Federal Ministry for Family Affairs, Senior Citizens, Women and Youth (ed.) (2009), Der Verdienstunterschied Zwischen Frauen Und Männern Im Öffentlichen Bereich Und in Der Privatwirtschaft. Berlin: BMFSFJ.

Boll, C. (2011a), Mind the Gap – German Motherhood Risks in Figures and Game Theory Issues. International Economics and Economic Policy 4 (8): 363–382.

Boll, C. (2011b), Lohneinbußen Von Frauen Durch Geburtsbedingte Erwerbsunterbrechungen. Der Schattenpreis von Kindern und dessen mögliche Auswirkungen auf weibliche Spezialisierungsentscheidungen im Haushaltszusammenhang, Eine quantitative Analyse auf Basis von SOEP-Daten, Monografische Dissertationsschrift, Reihe "Sozialökonomische Schriften" (Hrsg.: Prof. Dr. B. Rürup und Prof. Dr. W. Sesselmeier), Verlag Peter Lang, Frankfurt am Main et al., 2011.

Boll, C. (2017), Die Arbeitsteilung im Paar – Theorien, Wirkungszusammenhänge, Einflussfaktoren und exemplarische empirische Evidenz [Expertise im Rahmen des Zweiten Gleichstellungsberichts der Bundesregierung]. Available under: www.gleichstellungsbericht.de.

Boll, C., E. Bublitz, M. Hoffmann (2015), Geschlechtsspezifische Berufswahl: Literatur- Und Datenüberblick Zu Einflussfaktoren, Anhaltspunkten Struktureller Benachteiligung Und Abbruchkosten. HWWI Policy Paper 90. Hamburg.

Boll, C., M. Jahn, A. Lagemann (2017), The Gender Lifetime Earnings Gap – Exploring Gendered Pay from the Life Course Perspective. HWWI Research Paper 179. Hamburg.

Boll, C., J.S. Leppin (2015), Die Geschlechtsspezifische Lohnlücke in Deutschland: Umfang, Ursachen Und Interpretation. Wirtschaftsdienst 95 (4): 249–254.

Boll, C., J.S. Leppin, N. Reich (2014), Paternal Childcare and Parental Leave Policies: Evidence from Industrialized Countries. Review of Economics of the Household 12 (1): 129–158.

Boll, C., J.S. Leppin, A. Rossen, A. Wolf (2016), Magnitude and Impact Factors of the Gender Pay Gap in EU Countries, Report prepared for and financed by the European Commission – Directorate-General for Justice, European Union (Hrsg.), Hamburg.

Booth, A.L., M. Francesconi, M.,.J. Frank (2002), Temporary Jobs: Stepping Stones or Dead Ends?. The Economic Journal 112 (480): 189–213.

Brown, J.N. (1989), Why Do Wages Increase with Tenure? On-The-Job Training and Life-Cycle Wage Growth Observed within Firms. The American Economic Review 97 (5): 971–991.

Busch, A. (2013), Der Einfluss Der Beruflichen Geschlechtersegregation Auf Den „Gender Pay Gap ". Kölner Zeitschrift Für Soziologie Und Sozialpsychologie 65 (2): 301–338.

Christofides, L.N., W. Polycarpou, K. Vrachimis (2010), The Gender Wage Gaps, 'Sticky Floors' and 'Glass Ceilings' of the European Union. IZA Discussion Paper No. 5044. Institute for the Study of Labor.

Correll, S.J. (2004), Constraints into Preferences: Gender, Status, and Emerging Career Aspirations. American Sociological Review 69 (1): 93–113.

Del Río, C., C. Gradín, O. Cantó (2011), The Measurement of Gender Wage Discrimination: The Distributional Approach Revisited. The Journal of Economic Inequality 9 (1): 57–86.
Deutsches Institut für Wirtschaftsforschung (DIW) (2016), Auch in Doppelverdiensthaushalten: Vollzeiterwerbstätige Frauen leisten deutlich mehr Hausarbeit als Männer – Unterschiede verringern sich kaum, Pressemitteilung vom 02. 03.2016, Berlin.
DiNardo, J., N.M. Fortin, T. Lemieux (1996), Labour Market Institutions and the Distribution of Wages, 1973-1992: A Semiparametric Approach. Econometrica 64 (5): 1001–1044.
England, P. (1992), Comparable Worth: Theories and Evidence. New York: Walter de Gruyter.
Estévez-Abe, M. (2005), Gender Bias in Skills and Social Policies: The Varieties of Capitalism Perspective on Sex Segregation. Social Politics 12 (2): 180–215.
Estévez-Abe, M. (2006), Gendering the Varieties of Capitalism – A Study of Occupational Segregation by Sex in Advanced Industrial Societies. World Politics 59 (1): 142–175.
Eurostat (2017), The unadjusted gender pay gap by economic control (%), 2015 (Source: Eurostat (earn_gr_gpgr2ct), Table 3, Available under: http://ec.europa.eu/eurostat/statistics-explained/index.php/Gender_pay_gap_statistics- (Download on 9.7.2017).
Eurostat-Data Explorer (2015), Part-time employment as percentage of the total employment, by sex and age (%) (lfsa_eppga). Available under: http://appsso.eurostat.ec.europa.eu/nui/show.do. (Last update 31. 08.2015, extracted 23. 09.2015).
Federal Statistical Office (2006), Verdienstunterschiede Zwischen Männern Und Frauen. Studie im Auftrag des Bundesministeriums für Familie, Senioren, Frauen und Jugend. Wiesbaden.
Firpo, S., N.M. Fortin, T. Lemieux (2007), Unconditional Quantile Regressions. Technical Working Paper 339. National Bureau of Economic Research.
Fortin, N. (2005), Gender Role Attitudes and Women's Labour Market Outcomes across OECD Countries. Oxford Review of Economic Policy 21: 416–438.
Foster-McGregor, N., S. Leitner, J. Pöschl, R. Stehrer (2013), Study on Various Aspects of Earnings Distribution Using Micro-Data from the European Structure of Earnings Survey VC/2013/0019. Final report, Commissioned by the European Union Programme for Employment and Social Solidarity – PROGRESS (2007-2013). The Vienna Institute for International Economic Studies (wiiw).
Fuchs, V.R. (1989), Women's Quest for Economic Equality. The Journal of Economic Perspectives 3 (1): 25–41.
Galler, H.P. (1991), Opportunitätskosten Der Entscheidung Für Familie Und Haushalt. in: S. Gräbe (ed.), Der Private Haushalt Als Wirtschaftsfaktor. Frankfurt am Main/New York.
Geyer, J., V. Steiner (2007), Short-Run and Long-Term Effects of Childbirth on Mothers' Employment and Working Hours across Institutional Regimes. An Empirical Analysis Based on the European Community Household Panel. DIW Berlin. Discussion Papers No. 682.
Goldin, C. (2014), A Grand Gender Convergence: Its Last Chapter. The American Economic Review 104 (4): 1091–1119.
Goldin, C., S.P. Kerr, C. Olivetti, E. Barth (2017), The Expanding Gender Earnings Gap: Evidence from the LEHD-2000 Census. American Economic Review: Papers and Proceedings 107 (5): 110–114.
Goldin, C., S. Polachek (1987), Residual Differences by Sex: Perspectives on the Gender Gap in Earnings. The American Economic Review 77 (2): 143–151.
Gornick, J.C., J.A. Jacobs (1998), Gender, the Welfare State, and Public Employment: A Comparative Study of Seven Industrialized Countries. American Sociological Review 63 (5): 688–710.

Gregory, R.G., J. Borland (1999), Recent Developments in Public Sector Labor Markets. pp. 3573–3630 in: O.C. Ashenfelter, D.E. Card (ed.), Handbook of Labor Economics, 3(C). Amsterdam: Elsevier.

Helberger, C. (1984), Humankapital, Berufsbiographie Und Die Einkommen Von Männern Und Frauen, Arbeitspapiere des SFB 3 „Mikroanalytische Grundlagen der Gesellschaftspolitik", Nr. 129, J. W. Goethe-Universität Frankfurt und Universität Mannheim, Frankfurt am Main/ Mannheim.

Hersch, J., L.S. Stratton (1994), Housework, Wages, and the Division of Housework Time for Employed Spouses. American Economic Review 84 (2): 120–125.

Hersch, J., L.S. Stratton (1997), Housework, Fixed Effects and Wages of Married Workers. Journal of Human Resources 32 (2): 285–307.

Hersch, J., L.S. Stratton (2002), Housework and Wages. Journal of Human Resources 37 (1): 217–229.

Hirsch, B.T. (2005), Why Do Part-Time Workers Earn Less? the Role of Worker and Job Skills. Industrial & Labor Relations Review 58 (4): 525–551.

Jacobsen, J., M. Khamis, M. Yuksel (2015), Convergences in Men's and Women's Life Patterns: Lifetime Work, Lifetime Earnings, and Human Capital Investment. Gender Convergence in the Labor Market. Research in Labor Economics 41: 1–33.

Jaumotte, F. (2003), Female Labour Force Participation: Past Trends and Main Determinants in OECD Countries. OECD Economics Department Working Papers. No. 376.

Juhn, C., K.M. Murphy, B. Pierce (1993), Wage Inequality and the Rise in Returns to Skill. Journal of Political Economy 101 (3): 410–442.

Kolberg, J.E. (1991), The Welfare State as Employer. London/NY.

Kunze, A., M. Ejrnæs (2004), Wage Dips and Drops around First Birth. IZA Discussion Paper No. 1011.

Lauber, V., J. Storck, C.K. Spieß (2014), Vereinbarkeit Von Beruf Und Familie Von Paaren Mit Nicht Schulpflichtigen Kindern – Unter Spezifischer Berücksichtigung Der Erwerbskonstellation Beider Partner. Ausgewählte Ergebnisse auf Basis der FiD-Daten („Familien in Deutschland"). Politikberatung kompakt Nr. 88/2014. DIW Berlin.

Light, A., M. Ureta (1995), Early-Career Work Experience and Gender Wage Differentials. Journal of Labor Economics 13 (1): 121–154.

Macpherson, D.A., B.T. Hirsch (1995), Wages and Gender Composition: Why Do Women's Jobs Pay Less?. Journal of Labor Economics 13 (3): 426–471.

Mandel, H., M. Semyonov (2014), Gender Pay Gap and Employment Sector: Sources of Earnings Disparities in the United States, 1970-2010. Demography 51: 1597–1618.

Manning, A., B. Petrongolo (2008), The Part-Time Pay Penalty for Women in Britain. The Economic Journal 118 (526): 28–51.

Marini, M.M. (1989), Sex Differences in Earnings in the United States. Annual Review of Sociology 15: 343–380.

Masters, S.H. (1969), An Interindustry Analysis of Wages and Plant Size. The Review of Economics and Statistics 51 (3): 341–345.

Mead, G.H. (1934), Mind, Self & Society. Chicago, IL: University of Chicago Press.

Mincer, J. (1974), Schooling, Experience, and Earnings. New York: National Bureau of Economic Research.

Mincer, J. (1978), Family Migration Decisions. Journal of Political Economy 86 (5): 749–773.

Mincer, J., S. Polachek (1974), Family Investments in Human Capital: Earnings of Women. Journal of Political Economy 82 (2): 76–108.
Ministère du travail, de l´emploi, de la formation professionelle et du dialogue social (2015), Ségrégation professionelle et écarts de salaires femmes-hommes. DARES analyses. No. 082.
O'Neill, J., S. Polachek (1993), Why the Gender Gap in Wages Narrowed in the 1980s. Journal of Labor Economics 11 (1): 205–228.
Oaxaca, R. (1973), Male-Female Wage Differentials in Urban Labor Markets. International Economic Review 14 (3): 693–709.
Oi, W.Y., T.I. Idson (1999), Firm Size and Wages. Handbook of Labor Economics 3 (Part B): 2165–2214.
Olivetti, C., B. Petrongolo (2008), Unequal Pay or Unequal Employment? A Cross-Country Analysis of Gender Gaps. Journal of Labor Economics 26: 621–654.
Organisation for Economic Co-operation and Devolopment (OECD) (2012), Closing the Gender Gap: Act Now. Paris: OECD Publishing.
Organisation for Economic Co-operation and Devolopment (OECD) (2016), OECD Family Database, Chart LMF1.6.B. Proportion of employed in part-time employment, by sex, 2014, https://www.oecd.org/els/LMF_1_6_Gender_differences_in_employment_outcomes.pdf
Petersen, T., L.A. Morgan (1995), Separate and Unequal: Occupation-Establishment Sex Segregation and the Gender Wage Gap. American Journal of Sociology 101 (2): 329–365.
Polachek, S.W. (1981), Occupational Self-Selection: A Human Capital Approach to Sex Differences in Occupational Structure. The Review of Economics and Statistics 63 (1): 60–69.
Polachek, S.W. (2006), How the Life-Cycle Human Capital Model Explains Why the Gender Wage Gap Narrowed. pp. 102–124 in: F. Blau, M. Brinton, D. Grusky (eds.), The Declining Significance of Gender. New York.
Reskin, B.F., P.A. Roos (2009), Job Queues, Gender Queues: Explaining Women's Inroads into Male Occupations. Philadelphia, PA: Temple University Press.
Roy, A.D. (1951), Some thoughts on the distribution of earnings. [S.l.]: [s.n.] (University of Cambridge. Department of applied economics. Reprint series, no 49).
SES (2010), EU Structure of Earnings Survey – wave 2010. Luxembourg: Eurostat.
Simón, H. (2012), The Gender Gap in Earnings: An International Comparison with European Matched Employer–Employee Data. Applied Economics 44 (15): 1985–1999.
Skirbekk, V. (2004), Age and Individual Productivity: A Literature Survey. Vienna Year Book of Population Research 2: 133–153.
Spence, M. (1973), Job Market Signalling. Quarterly Journal of Economics 87 (3): 355–374.
Topel, R. (1991), Specific Capital, Mobility and Wages: Wages Rise with Job Seniority. The Journal of Political Economy 99 (1): 145–176.
Wagner, G.G., J. Göbel, P. Krause, R. Pischner, I. Sieber (2008), Das Sozio-Oekonomische Panel (SOEP): Multidisziplinäres Haushaltspanel Und Kohortenstudie Für Deutschland – Eine Einführung (Für Neue Datennutzer) Mit Einem Ausblick (Für Erfahrene Anwender). AStA Wirtschafts- Und Sozialstatistisches Archiv 2 (4): 301–328.
Waldfogel, J. (1998), The Family Gap for Young Women in the United States and Britain: Can Maternity Leave Make a Difference?. Journal of Labor Economics 16 (3): 505–545.
Wood, R.G., M.E. Corcoran, P.N. Courant (1993), Pay Differences among the Highly Paid: The Male-Female Earnings Gap in Lawyers' Salaries. Journal of Labor Economics 11 (3): 417–441.

Annex

Table 2: List of variables.

Dependent variable	
Log wage	**Average gross hourly earnings in the reference month (to 2 decimal places), in Euro**
Explanatory variables	
Individual worker characteristics	
Age	Dummy variables for age groups: 1) 20–29 years 2) 30–39 years 3) 40–49 years (reference) 4) 50–59 years 5) 60 years and older
Education	Dummy variables for highest successfully completed level of education and training, derived from the International Standard Classification of Education, level 97 (ISCED-97): 1) Low-skilled: Early childhood education, primary education, lower secondary education 2) Medium-skilled: Upper secondary education, post-secondary non-tertiary education (reference) 3) High-skilled: Short-cycle tertiary education, bachelor or equivalent, master or equivalent, doctoral or equivalent
Job-related characteristics	
Temporary contract	Dummy variable that is equal to one for temporary and zero for permanent contracts.
Tenure	Dummy variables for length of service in enterprise (in years): 1) Less than 2 years 2) From 2 up to 4 years 3) From 5 up to 14 years (reference) 4) 14 years and more
Hours of work	1) Low-scale: Share of a full-timer's normal hours between 0 and 59 % 2) Large-scale: Share of a full-timer's normal hours between 60 and 99 %
Firm size	Size of the enterprise to which the local unit belongs
Public control (> 50 %)	Form of economic and financial control: Equal to one if public ownership is more than 50 % or private ownership is more than 50 %

(*continued*)

Table 2: (*continued*)

Occupation	Dummy variables for occupation (ISCO – 08): 1) Commissioned armed forces officers 2) Non-commissioned armed forces officers 3) Armed forces occupations, other ranks 4) Chief executives, senior officials and legislators 5) Administrative and commercial managers 6) Production and specialised services managers 7) Hospitality, retail and other services managers 8) Science and engineering professionals 9) Health professionals 10) Teaching professionals 11) Business and administration professionals 12) Information and communications technology professionals 13) Legal, social and cultural professionals 14) Science and engineering associate professionals 15) Health associate professionals 16) Business and administration associate professionals 17) Legal, social, cultural and related associate professionals 18) Information and communications technicians 19) General and keyboard clerks 20) Customer services clerks 21) Numerical and material recording clerks 22) Other clerical support workers 23) Personal service workers 24) Sales workers 25) Personal care workers 26) Protective services workers 27) Market-oriented skilled agricultural workers 28) Market-oriented skilled forestry, fishery and hunting workers 29) Subsistence farmers, fishers, hunters and gatherers 30) Building and related trades workers, excluding electricians 31) Metal, machinery and related trades workers 32) Handicraft and printing workers 33) Electrical and electronic trades worker 34) Food processing, wood working, garment and other craft and related trades workers 35) Stationary plant and machine operators 36) Assemblers 37) Drivers and mobile plant operators 38) Cleaners and helpers 39) Agricultural, forestry and fishery labourers 40) Labourers in mining, construction, manufacturing and transport (reference)

(*continued*)

Table 2: (*continued*)

	41) Food preparation assistants 42) Street and related sales and service workers 43) Refuse workers and other elementary workers
Industry	Dummy variables for the economic sector of the current enterprise in NACE Rev. 2: 1) 10_to_13 + 14_15 – Food industry and textiles 2) 16_to_18 + 58_to_60 – Paper, Printing and publishing 3) 26_to_27_33 + 19_to_22 + 23 + 29_30 + 31_32 – Chemical products, electric and transport equipment 4) 24_25 + 28 – Basic metals and metal products 5) 45_46 – Wholesale trade 6) 47 – Retail Trade 7) 49_to_52 – Transportation and storage 8) 70_71_78_81_82 + 64_to_66_69_80 + 53_61_to_63_79 – Business services 9) 75_86_to_88 – Health and social work activities 10) 68_72_to_74_77_95 + 90_to_93_96 – Professional, scientific and creative services 11) B + 35_36 + 37_to_39 – Mining, energy and water supply 12) F – Construction 13) I – Accommodation and food services 14) P – Education (reference) 15) 94 – Activities of membership organisations

Sources: SES (2010), Boll et al. (2016).

Table 3: Summary statistics, all countries (aggregate sample).

	Female	**Male**
Dependent variable		
Log Wage	2.047	2.224
Wage	11.383	13.962
Explanatory variables		
Hours of work		
Part-time low	0.141	0.066
Part-time high	0.125	0.034
Public control (> 50 %)	0.455	0.242
Temporary Contract	0.122	0.117
Firm size	0.198	0.179
Age		

(*continued*)

Table 3: (*continued*)

	Female	Male
20–29 years	0.166	0.180
30–39 years	0.248	0.266
40–49 years	0.288	0.260
50–59 years	0.246	0.226
60 years and older	0.052	0.067
Tenure		
Less than 2 years	0.212	0.199
From 2 up to 4 years	0.232	0.237
From 5 up to 14 years	0.341	0.351
15 years and more	0.215	0.214
Education		
Low-skilled	0.139	0.144
Medium-skilled	0.638	0.664
High-skilled	0.223	0.192
Occupation		
Commissioned armed forces officers	0.000	0.000
Non-commissioned armed forces officers	0.000	0.000
Armed forces occupations, other ranks	0.000	0.000
Chief executives, senior officials and legislators	0.004	0.009
Administrative and commercial managers	0.014	0.022
Production and specialised services managers	0.019	0.032
Hospitality, retail and other services managers	0.008	0.008
Science and engineering professionals	0.013	0.039
Health professionals	0.049	0.015
Teaching professionals	0.127	0.050
Business and administration professionals	0.034	0.027
Information and communications technology professionals	0.007	0.023
Legal, social and cultural professionals	0.020	0.015
Science and engineering associate professionals	0.019	0.080
Health associate professionals	0.054	0.009
Business and administration associate professionals	0.080	0.051
Legal, social, cultural and related associate professionals	0.018	0.010
Information and communications technicians	0.004	0.015
General and keyboard clerks	0.061	0.023
Customer services clerks	0.027	0.009
Numerical and material recording clerks	0.027	0.030
Other clerical support workers	0.021	0.011
Personal service workers	0.040	0.024
Sales workers	0.077	0.029
Personal care workers	0.079	0.012
Protective services workers	0.004	0.019

(*continued*)

Table 3: (*continued*)

	Female	Male
Market-oriented skilled agricultural workers	0.001	0.003
Market-oriented skilled forestry, fishery and hunting workers	0.000	0.000
Subsistence farmers, fishers, hunters and gatherers	0.000	0.000
Building and related trades workers, excluding electricians	0.001	0.041
Metal, machinery and related trades workers	0.006	0.089
Handicraft and printing workers	0.004	0.007
Electrical and electronic trades worker	0.004	0.033
Food processing, wood working, garment and other craft and related trades work.	0.020	0.018
Stationary plant and machine operators	0.031	0.069
Assemblers	0.023	0.020
Drivers and mobile plant operators	0.006	0.088
Cleaners and helpers	0.057	0.010
Agricultural, forestry and fishery labourers	0.001	0.001
Labourers in mining, construction, manufacturing and transport	0.020	0.040
Food preparation assistants	0.008	0.002
Street and related sales and service workers	0.000	0.000
Refuse workers and other elementary workers	0.012	0.017
Industry (reference: Education)		
Food industry and textiles	0.045	0.041
Paper, Printing and publishing	0.019	0.035
Chemical products, electric and transport equipment	0.079	0.159
Basic metals and metal products	0.019	0.074
Wholesale trade	0.027	0.054
Retail Trade	0.102	0.105
Transportation and storage	0.006	0.020
Business services	0.143	0.154
Health and social work activities	0.239	0.058
Professional, scientific and creative services	0.055	0.053
Mining, energy and water supply	0.012	0.008
Construction	0.018	0.070
Accommodation and food services	0.010	0.073
Education	0.026	0.016

Table 4: Sample sizes.

	Sex			Sex	
Country	**Female**	**Male**	**Country**	**Female**	**Male**
Belgium	50,436	66,322	Italy	108,617	152,098
Bulgaria	87,823	91,401	Lithuania	17,456	16,875
Czech Republic	840,282	873,889	Latvia	112,425	91,087
Germany	543,178	627,520	Netherlands	74,787	75,991
Estonia	59,476	46,296	Norway	723,194	631,134
Spain	63,950	95,336	Poland	311,522	317,184
Finland	160,419	121,648	Portugal	54,696	65,143
France	87,496	98,208	Romania	104,470	130,147
Greece	17,163	21,671	Sweden	146,881	121,427
Croatia	22,620	23,588	Slovak Rep.	335,863	364,484
Hungary	340,298	164,153	United Kingdom	74,128	71,436
			Total	4,337,180	4,267,038

Table 5: Wage regression results, all countries (aggregate sample).

	Female		Male	
Hours of work (reference: full-time)				
Part-time low	−0.040***	(0.002)	−0.074***	(0.003)
Part-time high	−0.035***	(0.002)	−0.059***	(0.003)
Public control (>50 %)	0.056***	(0.002)	0.066***	(0.002)
Temporary Contract	−0.065***	(0.004)	−0.086***	(0.003)
Firm size	−0.105***	(0.001)	−0.147***	(0.001)
Age (reference: 50–59 years)				
20–29 years	−0.119***	(0.002)	−0.170***	(0.003)
30–39 years	−0.037***	(0.002)	−0.050***	(0.002)
40–49 years	−0.006***	(0.001)	0.003*	(0.002)
60 years and older	0.002	(0.003)	−0.008***	(0.003)
Tenure (reference: from 5 up to 14 years)				
Less than 2 years	−0.079***	(0.002)	−0.115***	(0.002)
From 2 up to 4 years	−0.054***	(0.002)	−0.061***	(0.002)
15 years and more	0.086***	(0.002)	0.095***	(0.002)
Education (reference: medium-skilled)				
Low-skilled	−0.070***	(0.002)	−0.080***	(0.002)
High-skilled	0.147***	(0.002)	0.160***	(0.002)
Occupation (reference: Labourers in mining, construction, manufac. and transport)				
Commissioned armed forces officers	1.049***	(0.172)	0.997***	(0.127)
Non-commissioned armed forces officers	0.028	(0.122)	0.262***	(0.064)
Armed forces occupations, other ranks	0.677***	(0.187)	0.399***	(0.047)

(*continued*)

Table 5: (*continued*)

		Female		Male
Chief executives, senior officials and legislators	0.939***	(0.012)	1.013***	(0.010)
Administrative and commercial managers	0.787***	(0.006)	0.870***	(0.005)
Production and specialised services managers	0.707***	(0.006)	0.707***	(0.005)
Hospitality, retail and other services managers	0.397***	(0.007)	0.492***	(0.008)
Science and engineering professionals	0.556***	(0.005)	0.515***	(0.004)
Health professionals	0.629***	(0.008)	0.807***	(0.019)
Teaching professionals	0.620***	(0.004)	0.615***	(0.005)
Business and administration professionals	0.582***	(0.004)	0.623***	(0.004)
Information and communications technology professionals	0.655***	(0.007)	0.591***	(0.004)
Legal, social and cultural professionals	0.535***	(0.006)	0.536***	(0.007)
Science and engineering associate professionals	0.330***	(0.005)	0.363***	(0.003)
Health associate professionals	0.391***	(0.004)	0.326***	(0.006)
Business and administration associate professionals	0.408***	(0.003)	0.444***	(0.003)
Legal, social, cultural and related associate professionals	0.323***	(0.004)	0.312***	(0.007)
Information and communications technicians	0.406***	(0.007)	0.355***	(0.004)
General and keyboard clerks	0.230***	(0.003)	0.193***	(0.004)
Customer services clerks	0.166***	(0.004)	0.124***	(0.005)
Numerical and material recording clerks	0.242***	(0.004)	0.187***	(0.003)
Other clerical support workers	0.148***	(0.004)	0.044***	(0.005)
Personal service workers	0.098***	(0.004)	0.124***	(0.005)
Sales workers	0.094***	(0.003)	0.093***	(0.003)
Personal care workers	0.169***	(0.004)	0.126***	(0.005)
Protective services workers	0.046***	(0.009)	−0.071***	(0.004)
Market-oriented skilled agricultural workers	0.022**	(0.011)	−0.009	(0.006)
Market-oriented skilled forestry, fishery and hunting workers	−0.083***	(0.029)	0.041*	(0.022)
Subsistence farmers, fishers, hunters and gatherers	−0.203	(0.168)	−0.098	(0.139)
Building and related trades workers, excluding electricians	0.138***	(0.011)	0.136***	(0.003)
Metal, machinery and related trades workers	0.121***	(0.006)	0.177***	(0.002)
Handicraft and printing workers	0.040***	(0.006)	0.143***	(0.006)
Electrical and electronic trades worker	0.160***	(0.007)	0.204***	(0.003)
Food processing, wood working, garment and other craft and related trades work.	−0.032***	(0.004)	0.036***	(0.003)
Stationary plant and machine operators	0.057***	(0.003)	0.149***	(0.002)
Assemblers	0.076***	(0.004)	0.129***	(0.004)
Drivers and mobile plant operators	0.185***	(0.008)	0.104***	(0.002)
Cleaners and helpers	−0.030***	(0.003)	−0.079***	(0.005)

(*continued*)

Table 5: (*continued*)

	Female		Male	
Agricultural, forestry and fishery labourers	−0.26**	(0.013)	−0.112***	(0.022)
Food preparation assistants	0.012**	(0.005)	0.041***	(0.009)
Street and related sales and service workers	−0.044*	(0.023)	−0.048**	(0.022)
Refuse workers and other elementary workers	−0.056***	(0.004)	−0.045***	(0.004)
Industry (reference: Education)				
Food industry and textiles	0.032***	(0.003)	0.131***	(0.004)
Paper, Printing and publishing	0.125***	(0.004)	0.169***	(0.005)
Chemical products, electric and transport equipment	0.150***	(0.003)	0.219***	(0.004)
Basic metals and metal products	0.089***	(0.004)	0.169***	(0.004)
Wholesale trade	0.114***	(0.004)	0.162***	(0.004)
Retail Trade	0.033***	(0.003)	0.140***	(0.004)
Transportation and storage	0.122***	(0.004)	0.105***	(0.004)
Business services	0.135***	(0.002)	0.209***	(0.004)
Health and social work activities	0.016***	(0.002)	0.024***	(0.004)
Professional, scientific and creative services	0.052***	(0.003)	0.121***	(0.004)
Mining, energy and water supply	0.073***	(0.004)	0.067***	(0.006)
Construction	0.218***	(0.004)	0.289***	(0.004)
Accommodation and food services	0.071***	(0.005)	0.197***	(0.004)
Education	0.024***	(0.004)	0.053***	(0.005)
Constant	2.341***	(0.004)	2.488***	(0.005)

Notes: 1: university region; * significance at the 0.1 level, ** significance at the 0.05 level, *** significance at the 0.01 level; standard errors in parenthesis; both regressions include country dummies.Sources: SES (2010), HWWI (2015).

Table 6: Composition of the explained gender pay gaps at country level (in %), 2010.

	Belgium	Bulgaria	Czech Rep.	Germany	Estonia
Hours of work	3.25	0.12	0.33	5.07	1.54
Public control (> 50 %)	−0.61	0.05	−0.95	−0.26	0.33
Temporary contract	0.15	−0.01	0.25	0.17	0.11
Firm size	−0.30	1.67	0.03	−0.29	−2.58
Age	0.31	−0.15	−0.08	0.02	1.12
Tenure	0.25	−1.22	0.22	0.03	−0.87
Education	0.03	−1.93	0.39	1.62	−1.04
Occupation	−4.36	−1.76	−0.22	−0.61	4.37
Industry	4.10	4.52	3.54	8.74	7.29
Total explained gap	*2.83*	*1.29*	*3.50*	*14.49*	*10.27*

(*continued*)

Table 6: (*continued*)

	Spain	Finland	France	Greece	Croatia
Hours of work	0.16	0.00	−0.92	0.49	−0.14
Public control (> 50 %)	−0.39	2.70	−1.02	−0.50	−1.40
Temporary contract	0.00	0.48	0.25	0.12	0.33
Firm size	−1.14	−0.74	−0.09	0.54	−0.31
Age	0.68	−0.53	0.19	1.64	−0.16
Tenure	1.33	0.44	0.06	0.79	0.07
Education	−1.73	−0.24	−0.56	−1.49	−2.83
Occupation	3.61	3.33	1.30	1.07	−2.50
Industry	2.92	3.86	5.68	2.78	1.05
Total explained gap	*5.43*	*9.30*	*4.88*	*5.45*	*−5.89*
	Hungary	**Italy**	**Lithuania**	**Latvia**	**Netherlands**
Hours of work	−1.39	2.47	0.68	0.43	3.07
Public control (> 50 %)	−0.27	−0.78	−1.56	−0.75	2.34
Temporary contract	0.02	0.16	0.01	0.04	−0.09
Firm size	−2.08	−0.99	−1.70	−4.34	−0.32
Age	−0.04	0.00	0.02	0.46	0.50
Tenure	−0.57	−0.17	−3.09	−1.47	0.36
Education	−2.44	−3.04	−2.28	−2.62	−0.60
Occupation	0.96	−9.55	−4.49	−4.59	1.50
Industry	6.27	5.71	4.56	9.69	0.34
Total explained gap	*0.47*	*−6.20*	*−7.87*	*−3.15*	*7.11*
	Norway	**Poland**	**Portugal**	**Romania**	**Sweden**
Hours of work	2.24	0.09	−0.16	0.06	0.47
Public control (> 50 %)	0.71	−1.10	−1.79	−1.96	1.98
Temporary contract	0.02	−0.25	−0.21	0.00	0.00
Firm size	−0.79	1.45	−0.95	−0.70	−0.63
Age	−0.02	−0.52	−0.10	0.11	−0.34
Tenure	0.20	−0.53	0.00	−0.78	−0.30
Education	−0.28	−3.72	−5.48	−2.19	−1.52
Occupation	0.16	−8.29	−0.12	−5.05	−0.94
Industry	4.92	5.11	7.95	11.33	7.44
Total explained gap	*7.15*	*−7.76*	*−0.85*	*0.84*	*6.17*

(*continued*)

Table 6: (*continued*)

	Slovak Rep.	United Kingdom	All countries
Hours of work	0.38	1.12	1.58
Public control (> 50 %)	0.34	−1.24	−1.10
Temporary contract	0.00	0.21	0.10
Firm size	−0.20	−0.66	−0.63
Age	−0.36	−0.28	−0.06
Tenure	−0.22	0.18	0.06
Education	−0.59	−0.14	−0.98
Occupation	−2.63	4.04	−0.94
Industry	5.60	3.00	5.21
Country			0.71
Total explained gap	*2.31*	*6.23*	3.95

Sources: SES (2010), HWWI (2015).

Table 7: Composition of the unexplained gender pay gaps at country level (in %), 2010.

	Belgium	Bulgaria	Czech Rep.	Germany	Estonia
Hours of work	−0.90	−0.66	−0.09	−3.13	−1.56
Public control (> 50 %)	0.82	1.82	0.66	−0.71	3.02
Temporary contract	−0.26	0.22	0.04	−0.44	0.50
Firm size	−0.09	−1.04	−3.43	−0.21	−4.20
Age	−1.27	−3.87	−2.30	−1.73	2.11
Tenure	−0.69	−0.74	−0.76	−0.85	0.10
Education	1.02	0.81	−0.11	−0.92	−0.05
Occupation	−3.02	9.34	1.71	4.31	−2.19
Industry	5.53	13.65	10.37	9.26	6.91
Constant	4.66	−19.94	2.47	2.23	10.23
Total unexplained gap	*5.80*	*7.33*	*13.16*	*7.81*	*14.88*
	Spain	**Finland**	**France**	**Greece**	**Croatia**
Hours of work	0.34	−0.09	0.77	−0.41	0.21
Public control (> 50 %)	−0.40	−0.89	2.86	1.08	2.25
Temporary contract	−0.27	−0.74	0.01	−0.69	−0.22
Firm size	−2.21	−0.32	0.02	−2.18	−0.85
Age	−2.16	−0.45	−1.11	−6.42	1.86

(*continued*)

Table 7: (*continued*)

Tenure	−0.90	0.31	−1.63	0.97	−0.20
Education	−2.41	0.26	0.91	1.72	2.15
Occupation	−1.35	−0.04	−3.52	−2.08	−16.66
Industry	6.22	7.49	3.66	2.38	4.88
Constant	15.18	5.92	6.69	13.26	18.32
Total unexplained gap	*12.03*	*11.45*	*8.66*	*7.63*	*11.75*
	Hungary	**Italy**	**Lithuania**	**Latvia**	**Netherlands**
Hours of work	−1.03	−1.11	−3.30	−1.98	−3.65
Public control (> 50 %)	−0.18	−4.29	2.79	3.59	−2.83
Temporary contract	−0.10	−0.44	−0.13	−0.33	−0.39
Firm size	−7.97	−0.64	−5.48	−4.85	0.08
Age	1.96	−1.83	3.35	3.28	−5.06
Tenure	−1.40	−0.99	1.43	−0.38	−1.12
Education	2.14	−0.09	−1.54	−1.07	1.29
Occupation	−4.26	6.99	3.12	2.55	−1.95
Industry	4.54	2.34	9.18	10.83	0.09
Constant	14.20	10.78	4.35	−1.03	21.92
Total unexplained gap	*7.90*	*10.72*	*13.76*	*10.60*	*8.39*
	Norway	**Poland**	**Portugal**	**Romania**	**Sweden**
Hours of work	−2.54	−0.58	−0.25	−0.09	−0.20
Public control (> 50 %)	−2.66	−0.22	0.37	5.73	−0.88
Temporary contract	−0.11	−0.76	−0.13	0.23	0.00
Firm size	−0.35	−3.97	−1.24	−0.24	−0.19
Age	−0.73	3.91	2.48	3.57	−0.99
Tenure	0.16	0.49	−1.20	−1.28	−0.02
Education	−0.58	−0.41	−0.66	0.41	0.84
Occupation	2.83	−2.95	−2.04	3.24	−0.35
Industry	3.52	3.83	4.25	11.69	−0.03
Constant	7.34	12.05	10.89	−17.04	9.64
Total unexplained gap	*6.88*	*11.39*	*12.46*	*6.23*	*7.82*
	Slovak Rep.	**United Kingdom**	**All countries**		
Hours of work	−0.25	1.58	−1.03		
Public control (> 50 %)	−0.60	−3.21	0.32		
Temporary contract	0.81	−0.79	−0.23		
Firm size	−2.17	−1.66	−1.07		

(*continued*)

Table 7: (*continued*)

Age	3.08	−4.18	−1.05
Tenure	−1.69	−0.51	−0.73
Education	−0.42	0.91	0.14
Occupation	3.89	−1.16	−0.05
Industry	4.01	−1.93	4.77
Constant	7.77	25.35	14.77
Country			*−4.81*
Total unexplained gap	*14.43*	*14.39*	*11.04*

Sources: SES (2010), HWWI (2015).

Book Review

Don Harding and Adrian Pagan. *The Econometric Analysis of Recurrent Events in Macroeconomics and Finance*. Princeton University Press, Princeton, New Jersey, 2016. 232 pp., $49.50, £41.95. ISBN: 9780691167084

Reviewed by **Sylvia Kaufmann,** Study Center Gerzensee, Dorfstrasse 2, CH-3115 Gerzensee, Switzerland, E-mail: sylvia.kaufmann@szgerzensee.ch

https://doi.org/10.1515/jbnst-2017-1111

The book is based on lecture material that Harding and Pagan taught in various short courses on advanced econometric methods for dating and forecasting turning points in macroeconomic and financial time series. The material is well structured in nine chapters and provides a good reference point to start into the topic. The book contains quite a few references to relevant literature in business cycle analysis.

In the first chapter, Harding and Pagan set out the stage for the theme of the book, which consists in describing the procedure of dating turning points by prescribed and model-based rules and comparing the forecasting performance of these two approaches. Chapter two and three discuss the application of prescribed rules for dating recurring events in univariate series and based on multivariate information, respectively. Harding and Pagan discriminate between oscillations, fluctuations and cycles to describe recurrent events in time series and discuss non-stochastic and stochastic models to capture these features. Chapter two neatly describes simple (like the calculus and the two quarters) and more sophisticated (like the Bry-Boschan) rules to identify cycles, i.e. to determine the phases of a cycle and its turning points. Chapter three proposes to aggregate univariate cycles by phases or turning points to obtain a reference cycle of interest. Some shortcomings of prescribed rules, which are not really worked out in the book, become obvious after reading this chapter. Prior to aggregation, contemporaneously correlated series need to be identified and counter-cyclically co-moving series need to be sign-adjusted. Harding and Pagan do not give (systematic) advice on how to deal with these two issues and therefore, the application of the methods needs prior expert knowledge about the (possibly time-varying) cyclical correlation of series with the reference cycle of interest. Chapter four outlines various time series models which can be used to obtain model-based dates of recurring events. Basic characteristics of Markov regime switching models and how they compare to the Bry-Boschan prescribed rule are discussed in more details, given that they have become a workhorse model in business cycle analysis. Multivariate

econometric models like factor and panel data models are briefly referenced at the end of the chapter, too.

Chapters five and six are again more substantial in that they define features which characterize recurrent events and provide statistical measures and tests to assess synchronization of cycles across multiple series. Cycles may be characterized by the fraction of time spent in expansion and contraction, amplitudes, the duration and shape of phases, and whether phases are diverse or not. All these measures are expressed in terms of the cycle indicator and related to moments of the underlying series. The discussion of tests for duration dependence completes the chapter. Chapter six outlines how to assess synchronization of cycle indicators by bivariate statistical tests, regression analysis and the concordance index. These methods are also useful to evaluate model-based state indicators. Unfortunately, Harding and Pagan do not mention this. Except when discussing the regression-based approach, Harding and Pagan omit recognizing that rejecting the null of synchronization does in fact not rule out negative synchronization. On the other hand, the parameter estimates, in particular the phase-specific conditional or unconditional means, of an econometric model in which states are restricted to be equal across series yield a direct inference on positive or negative synchronization.

Chapters seven and eight are interesting to read because they analyze common econometric and quantitative business cycle models from an unconventional viewpoint. Business cycle models are assessed by what would be called prior predictive analysis in Bayesian econometrics. In chapter seven, the ability of linear and nonlinear econometric models in reproducing cyclical features of Bry-Boschan "filtered" series is evaluated by simulations. It turns out that nonlinear models capture phase-specific features like duration, amplitude and excess growth quite well. For the rest of the chapter and at the beginning of chapter eight, Harding and Pagan highlight issues to mind when using the cycle indicator in multivariate systems. Finally, Harding and Pagan argue that in quantitative macroeconomic analysis, short-term horizons are relevant when variance decompositions are used to assess whether the models succeed in capturing business cycle features. As in chapter seven, Harding and Pagan evaluate the importance of structural shocks for business cycle features by simulating model-specific data series. It turns out that aggregate supply shocks are determining the business cycle, whereas monetary policy shocks provide only a minor contribution. Looking more closely to a model including a financial acceleration effect, they show that crisis effects do not add much to capture business cycle features. Moreover, the term premium only weakly affects the probability of a recession.

Final chapter nine turns towards predicting turning points and recessions. Essentially, the discussion shows that, even if various variables like GDP growth and the interest rate spread are included into a model, predicting a recession (or in other words a peak) is hopeless given that the probability of a recession ex ante never reaches .5. This last chapter appears the least useful for researchers interested in forecasting. It lacks valuable guidance on how to remedy the deficiencies of the presented models and does not recognize that models performing well in-sample are often not the ones which perform well in forecasting.

What is unique to the book is the precise description of the modified Bry-Boschan business cycle dating procedure and the formal analysis of the procedure. For example, Harding and Pagan show that the Bry-Boschan procedure for quarterly series results in a fifth-order process for the cycle indicator. The neat description of characterizing features of cycles in single series and measuring synchronization of recurring events across multiple series is valuable also for researchers using model-based methods to date cycles. The book falls a bit short of a fair evaluation of model-based against prescribed rules to date cycles. Harding and Pagan take a critical (if not tough) stance and mainly highlight shortcomings (sometimes perceived as flaws) of the model-based approaches without putting into perspective the problems of prescribed rules. The reader will recognize that prescribed rules are two-sided, which means that turning points will always be delivered with a lag (i.e. no now-casting procedure is available); multivariate analysis must rely on prior expert knowledge to classify time series into leading, co-moving or lagging variables and whether they are counter-cyclical (i.e. the methods are hardly amenable to big data analysis). Nevertheless, the reader will also recognize that cycles determined by prescribed rules may represent a valuable benchmark against which econometric business cycle models may be evaluated.