# Earnings Premiums in Academia: Evidence from Personnel Data

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## ABSTRACT

This study examines the existence of a gender earnings gap in the academic labour market with well-defined pay scales with panel data from the personnel records of a large university. We find that women earn approximately 10% less than men but that adjusting for different background characteristics and research performance decreases the gap to 2%. Our results suggest that the level of gender pay inequality is greater among older employees and lower for more productive employees. The results also imply that the gender gap is more pronounced in female-led departments than in male-led departments.

Key words: Salary wage differentials, Teacher salaries

JEL classification: I23, J16, J24, J31, J44

# 1 INTRODUCTION

There is an extensive previous literature examining the gap between the mean earnings of men and women in different nations, industries, sectors and occupations[1]. One strand of this literature has focused on earnings differentials in academic labour markets, relying both on nationally representative data (Barbezat, 1987, 1991; Monks & Robinson, 2000; Toutkoushian, 1998, 1999) and on personnel data from single universities (Binder, Krause, Chermak, Thacher & Gilroy, 2010; Lindley, Fish & Jackson, 1992; Raymond, Sesnowitz & Williams, 1988; Strathman, 2000)[2]. The majority of these studies have been conducted in the US, with very few studies undertaken in other countries. The exceptions include Canada (Brown, Troutt & Prentice, 2011; Schrank, 1977; Warman, Woolley & Worswick, 2010), the UK (Blackaby, Booth & Frank, 2005; McNabb & Wass, 1997; Ward, 2001b) and Japan (Takahashi & Takahashi, 2011).

The previous literature provides a strong indication that female academics earn less than male academics with similar characteristics, such as tenure, educational attainment, academic discipline and research performance[3]. The most recent estimates from the US indicate that female faculty members earn approximately 4–5% less than their equally qualified male counterparts (Porter, Toutkoushian & Moore, 2008; Umbach, 2008)[4]. Outside the US, Warman et al. (2010) studied a sample of Canadian academics and found that men received an earnings premium that was approximately 3% of the average earnings of women.

1 For surveys and meta-analyses, see, e.g., Altonji and Blank (1999), Blau and Kahn (2000), Jarrell and Stanley (2004), Weichselbaumer and Winter-Ebmer (2005) and Kunze (2008).

2 Early studies on the academic gender pay gap include Katz (1973), Gordon, Morton and Braden (1974), Johnson and Stafford (1974), Hoffman (1976) and Ferber, Loeb and Lowry (1978). For surveys of this literature, see Ransom and Megdal (1993), Barbezat (2002) and Becker and Toukoushian (2003).

3 Some (single-institution) studies have found only limited evidence for the existence of a gender pay gap (Raymond et al., 1988; Swartzman, Seligman & McClelland, 1992; Ferber & Loeb, 2002).

4 These results are based on models with academic rank as an independent variable. By omitting the rank variable, Umbach (2008) found a gender gap of roughly 6%.

Ward (2001b) discovered a gender salary gap of around 3% in Scottish universities, which, however, proved not to be statistically significant[5]. Blackaby et al. (2005) and Takahashi and Takahashi (2011) analysed gender pay differences among academic economists in the UK and in Japan, respectively. According to the results, the male earnings premium was nearly 6% in the UK, whereas in Japan, female economists earned approximately 7% less than their male colleagues[6]. Although the gender pay gap appears to be a relatively permanent feature of academic labour markets, there is some evidence suggesting that the gap has decreased in the US and in Canada (Barbezat, 1987, 1991; Ransom & Megdal, 1993; Toutkoushian, 1998; Warman et al., 2010)[7].

A major advantage of using data for academic labour markets is that they typically include detailed information on individual performance measures, such as research performance and teaching merits. A large body of evidence illustrates that increased academic performance is related to higher salaries (e.g., Bratsberg, Ragan & Warren, 2010; Ferber & Green, 1982; Katz, 1973; Monks & Robinson, 2000; Moore, Newman & Turnbull, 1998). Furthermore, studies show that adjusting for individual performance narrows the gender pay gap, implying that performance differentials between men and women partly explain the observed gender difference in average salaries (Barbezat, 1991; Ransom & Megdal, 1993).

This paper studies the gender earnings differences using data drawn from the personnel records of a Finnish university from 2006–2010. The Finnish academic labour market provides an interesting institutional setting for an analysis of earnings differences because the earnings are based on collectively bargained, well-defined pay scales. The rigid pay scales

5 Exclusion of academic rank yielded a statistically significant male premium of nearly 8%.
6 With rank excluded, Blackaby et al. (2005) discovered a male premium of over 9%.
7 Again, McNabb and Wass (1997) found no evidence of a narrowing gender gap in their sample of UK universities, nor did Brown et al. (2011) using data from a single Canadian university.

typically have a feature of specifying the main attributes (e.g., job tenure) on which the earnings are based and may therefore limit the earnings differences between individuals with similar attributes but with different performance levels. In fact, Takahashi and Takahashi (2011) found that pay scales for Japanese economists reward not for increased performance but for experience and age. On the other hand, this restrictive feature of pay scales may reduce gender inequality in earnings, as men and women with similar attributes should receive similar earnings.

Although we recognise that the use of single-institution data may limit the external validity of our results, we believe that these concerns are mitigated by the fact that the earnings determination process is uniform across all Finnish universities. Moreover, there are several reasons why it is beneficial to use single-institutional data in the study of earnings differences. First, we are able to examine the earnings-setting process in an internal labour market for which personnel policies, earnings-setting criteria and earnings determinants are likely to be very similar for all workers. Second, as opposed to a multi-institutional study, we can ignore the unobserved heterogeneity in institution-specific characteristics. Third, as Binder et al. (2010) note, using institution-level data allows us to hold constant different compensating differentials – such as location, benefits and working conditions – while estimating an earnings equation. Fourth, variables such as individual performance and occupational group, which are often subject to measurement error, are now accurately measured.

In our analysis, we observe a gender earnings gap of approximately 10% in favour of men. According to the results, this male premium mainly reflects gender differences in human capital variables (age, tenure and education) and in individual performance. After adjusting for human capital variables, academic discipline and individual performance, there remains a

gender gap of approximately 2%. However, this unexplained gap is not stable across different employee groups: the results show that the gap is greater among older employees and lower at higher levels of research performance. Furthermore, the gap is more distinct in departments with a female head than in departments with a male head. This finding conflicts with other studies showing that gender pay inequality is reduced under female leadership (Cardoso & Winter-Ebmer, 2010; Hensvik, 2011; Hultin & Szulkin, 2003).

The paper proceeds as follows. Section 2 outlines the single-institution data set and estimation methodology. Section 3 describes the earnings determination process for the Finnish academic labour market. Section 4 provides the main results and robustness checks. Section 5 concludes with a discussion of the results.

# 2 DATA AND METHODS

The data employed are drawn from the personnel records of a Finnish university in the period 2006–2010. This unbalanced panel data include all full-time faculty members, with a total of 4645 observations on 1582 individuals[8]. The data contain the following information for each individual[9]: personal id number, monthly earnings, gender, age, tenure, highest degree, department, occupational group (academic rank), job complexity level and yearly number of publications. Our data differ from those of earlier studies in two important ways. First, the panel structure of the data allows us to track individuals over time; with few exceptions (Binder et al., 2010; Bratsberg et al., 2010), the majority of the previous research on academic pay gaps has relied on cross-sectional data. Second, the data are well-balanced by gender, with the proportion of women being nearly 48 per cent[10].

Using our single-institution panel data, we examine the earnings determination by estimating an earnings equation of the following form:

$$\log(e_{it}) = \alpha + \beta G_i + \gamma \boldsymbol{x}_{it} + \varepsilon_{it} \qquad (1)$$

where $e_{it}$ represents the earnings of individual $i$ in period $t$, $G_i$ is a gender dummy, $\boldsymbol{x}_{it}$ is a vector of individual characteristics (including age, tenure, highest degree, department and three different publication variables) and $\varepsilon_{it}$ is an error term. The coefficient $\beta$ represents the

8 The initial data set consists of 5718 observations, but 830 observations were lost due to the exclusion of observations with missing values. In most cases, data were missing on educational attainment, especially for recently hired employees working at low ranks. We also excluded individuals with concurrent administrative duties for two reasons: 1) their earnings determination may diverge from that of non-administrative personnel and 2) the assignment of administrative duties may contain gender bias. As a result, 243 observations were removed.

9 For detailed description of the variables, see the Appendix.

10 The high percentage of women in the data reflects the fact that in comparison to many other countries, women constitute a relatively large fraction of academic employees in Finland (see, e.g., Enders & Musselin, 2008).

unexplained gender gap in earnings after controlling for characteristics in $\boldsymbol{x}_{it}$. To account for the possible correlation in the error term $\varepsilon_{it}$ within individual *i*, we use cluster-robust standard errors[11]. Additionally, to exploit the panel properties of the data, we estimate the model using a random effects model. That is, we replace the fixed intercept $\alpha$ in (1) with an individual-specific intercept $\alpha_i$

$$\log(e_{it}) = \alpha_i + \beta G_i + \gamma \boldsymbol{x}_{it} + \varepsilon_{it} \qquad (2)$$

The random effects model assumes that the unobservable individual effect $\alpha_i$ is uncorrelated with each regressor.

We now provide a more detailed discussion of the explanatory variables used in the earnings model. To control for the individual's previous work experience, we use two different variables, namely, age and job tenure. Due to a lack of adequate information on work history outside the university, we use age as a proxy for potential prior experience. The job tenure measures the time since an employee entered the university. For employees missing this information, the tenure measures the length of time since the latest labour contract was negotiated; the variable will therefore underestimate the actual job tenure for some employees. Furthermore, in some cases, the tenure is likely to be an overestimate of the actual work experience because it is measured in full years after a specified reference date and possible career breaks are not considered.

[11] Focusing on a single institution will introduce some challenges to the statistical inference of the estimated regression coefficients. Because our data consist of an entire population, one might argue that we do not have to rely on sampling theory to make statistical inferences. According to this view, estimated regression coefficients are the true values of population coefficients and calculated standard errors thus cannot be used to assess the statistical significance of the estimated coefficients. As an alternative, the single-institution data may be viewed as a sample drawn from a "superpopulation", in which case the statistical inference could be based on estimated standard errors. In our analysis, we rely on this latter concept and use cluster-robust standard errors in assessing statistical significance. For further discussion on statistical inference of single-institution data sets, see Balzer, Boudreau, Hutchinson, Ryan, Thorsteinson, Sullivan et al. (1996), Binder et al. (2010), McCloskey and Ziliak (1996) and Moore (1993).

To account for possible earnings differences between academic disciplines, we use dummy variables for departments as proxy variables. These controls are important because the disciplines may differ significantly with respect to outside wage offers and rates of research performance and because academic earnings may be inversely related to the proportion of women in the discipline (Barbezat, 1991; Bellas, 1997; Umbach, 2007).

To study the earnings effects of individual performance, we use three different research variables: the number of refereed international articles, the number of refereed national articles and the number of other publications (e.g., working papers, book chapters)[12]. These performance variables are measured separately for each year and do not distinguish between single-authored and co-authored publications[13]. The use of contemporary publications to explain variation in earnings is controversial: earnings are clearly not a function of current performance but rather a product of past performance. Therefore, we implicitly assume that the individual research performance is fairly stable over time; or alternatively, if the amount of individual research output does not vary substantially in the short run, contemporary publications may act as a proxy for recent research performance. Because these assumptions may fail to hold in practice, we assess the robustness of the results by using cumulative publications in the period 2005–2009 to explain the variation in earnings in 2010.[14]

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12 Räty and Bondas (2008) illustrate the importance of distinguishing between different types of publications: some academic disciplines (e.g., medicine and natural sciences) primarily focus on international publications, whereas others (e.g., law and education, humanities and social sciences) also emphasise the importance of national publications.

13 There is some evidence suggesting that single-authored articles have a larger positive effect on academic salaries compared to co-authored articles (Hilmer & Hilmer, 2005; Sauer, 1988).

14 Ideally, we would use career publications to explain earnings differences. In the absence of this information, we use cumulative publications as proxies for the career publications. However, these cumulative variables may be subject to measurement error: individual publication data consist only of those publications produced while working in this particular university and therefore lack previous information for employees who entered the university during the investigation period. Consequently, the cumulative publications may underestimate the actual research performance of recently hired employees.

One problem with using publication counts as a measure of research performance is that the quality of the research output is not considered. Nonetheless, the distinction between different types of publications provides one (indirect) way to assess the earnings effects of publication quality: international articles are likely to carry more weight in the assessment of an employee's performance than other publications (see the next section), which, in turn, should yield a higher rate of return for international articles. Therefore, we expect the coefficient for international publications to be larger than those for other publications.

To examine whether the gender earnings gap exists within occupational groups (academic ranks), we include occupational dummy variables in the earnings equation. These variables are expected to have considerable explanatory power in predicting earnings, as earnings are intrinsically related to occupational hierarchy. However, if the university's promotion decisions have been influenced by gender bias, including occupations may introduce endogeneity into the model[15]. This would cause the estimated gender earnings gap to be biased downward. To overcome this endogeneity problem, we estimate the model both with and without occupations. Earlier studies have repeatedly shown that the inclusion of occupations (ranks) reduces the gender pay gap, indicating that the gap is more pronounced between, rather than within, occupations (Binder et al., 2010; Blackaby et al., 2005; Toutkoushian & Conley, 2005; Umbach, 2007)[16].

[15] The endogeneity arises from the fact that earnings and occupational level are partially determined by the same underlying factors (including gender). Therefore, the occupation variable is a 'bad control' (see e.g., Neal & Johnson, 1996). However, the omission of gender-biased occupations may cause the error term to be correlated with the gender variable, leading to a biased estimate of the gender earnings gap. See Becker and Toutkoushian (2003) and Boudreau, Sullivan, Balzer, Ryan, Yonker, Thorsteinson et al. (1997) for an extensive discussion of the endogeneity of occupations (ranks).

[16] There have been attempts to consider the potential endogeneity of rank using simultaneous equation model (Strathman, 2000) and the Heckit estimation method (Becker & Toutkoushian, 2003). In these studies, alternative estimation techniques yield similar gender pay gaps to those obtained using rank as an additional explanatory variable.

**Descriptive evidence on gender earnings differences**

The personnel data for the year 2010 are summarised in Table 1. As illustrated in the table, the average monthly earnings of women were lower than those of men (approximately 9% lower). The table also reveals that women were younger, less tenured and less educated than men. Furthermore, compared to men, women had a lower number of publications (at least in terms of international publications) and worked in lower occupational groups. According to human capital theory (Becker, 1975), these differences in individual characteristics may reflect the lower productivity of women, which may in turn explain the lower earnings.

[*Table 1 here*]

# 3 DETERMINATION OF EARNINGS, JOB COMPLEXITY, AND PERFORMANCE LEVEL

In this section, we will provide a description of the main features of earnings policy at Finnish universities[17]. The academic earnings are set by a collective bargaining agreement, which applies to all university employees. Consequently, single universities have only a limited opportunity to pay institution-specific bonuses. The period of analysis begins in 2006, when Finnish universities implemented a new earnings system. In contrast to the prior system, which placed considerable emphasis on job tenure, the new scheme related earnings more closely to job complexity and personal performance. In the new system, earnings comprise two main components:

$$Monthly\ earnings = Occupation\text{-}specific\ component + Performance\ component$$

The occupation-specific component is based on an individual's job complexity level, whereas the performance component is based on the personal performance level; there are 11 different complexity levels and 9 different performance levels. The occupational group (academic rank) and the job complexity level are intrinsically related: early-stage researchers (e.g., teaching assistants) operate at complexity levels 1–4, postdoctoral researchers and lecturers operate at levels 5–7 and professors operate at levels 8–11. The occupation-specific component determines the minimum earnings of an individual and is adjusted regularly for collectively bargained pay increases. The performance component is calculated as a percentage of the occupation-specific component.

[17] For an extensive description, see "*Manual for the new UPJ salary system for universities*" (downloadable at www.tieteentekijoidenliitto.fi/239, viewed 27 March 2013).

The connection between the job complexity level, the personal performance level and earnings is illustrated in Table 2. For example, a researcher who works at complexity level 6 and at performance level 5 has monthly earnings of approximately 3840 euros (≈ 3145 + 0.221*3145). Furthermore, some employees receive additional remuneration for supplementary assignments, such as for administrative duties. In the initial phase of the new pay scheme, some of the senior employees were also entitled to an additional bonus (called a guaranteed earnings component), which was intended to prevent a reduction in earnings at the time of the system change[18].

[*Table 2 here*]

The job complexity and performance levels are evaluated – independently of each other – in an assessment discussion between the employee and an immediate supervisor[19]. The assessment of the job complexity level is made on the basis of a job description, which includes all the essential tasks and duties of the employee. The assessment discussion is held once every two years, but the employee is entitled to request a reassessment if there have been significant changes in his or her job description.

The assessment of performance level is based on three different merits: 1) teaching merits, 2) research merits and 3) merits of societal engagement and contributions to the university community. Each of these merits is rated on a scale from 1 (very low) to 9 (excellent) based on an evaluation of the accomplishment of assigned tasks and duties. The overall performance

[18] In addition, some employees were eligible for further allowances granted under the previous system.

[19] At the time of the recruitment, each employee is assigned an immediate supervisor. The immediate supervisor is typically a head of department or a deputy head.

rate is obtained as a weighted sum of rates on different merits, weighted by the share of working time devoted to each activity[20].

After the earnings are agreed upon between the employee and the immediate supervisor, the central administration of the university evaluates the consistency of performance components of earnings. These evaluations are intended to ensure that the personal performance is assessed consistently across employees within the same discipline, occupational group and job complexity level. The evaluation for professors differs from that of other employees: in the case of professors, the consistency of performance levels is evaluated by the rector of the university.

Because the earnings are mainly based on job complexity and performance assessment, there are primarily two potential sources of gender bias. First of all, women may face barriers in reaching higher levels of job complexity. This is equivalent to stating that women may encounter difficulties in achieving higher occupations or higher complexity levels within occupations or both. Second, the possible undervaluation of women's merits and achievements may constrain their opportunities to achieve higher performance levels.

The distribution of employees by job complexity level is illustrated in Figure 1. As the figure shows, a higher proportion of men compared to women were working at the highest levels of job complexity. The difference is particularly pronounced at complexity level 8, which is the entry level of complexity for professors. Table 3 demonstrates the covariation between job complexity and performance levels. The two important observations from this table are as

[20] For example, suppose that an employee spends 70% of his or her working time on research, 20% on teaching and 10% on societal and university community engagement. If the employee's performance in these activities is rated as 7, 6 and 5, respectively, the overall performance rate is 6.6 (= 0.7*7 + 0.2*6 + 0.1*5).

follows: 1) there was a positive relationship between job complexity and performance level; that is, the performance level was generally higher for those working at higher complexity levels and 2) within each complexity level, men were likely to work at higher performance levels than women.

[*Figure 1 here*]

[*Table 3 here*]

Combining the findings from Figure 1 and Table 3 suggests that men were more likely than women to attain higher levels of job complexity and performance[21]. However, the observed gender differences in job complexity levels (performance levels) do not necessarily represent evidence of discrimination; these differences may be explained by differences in background characteristics (individual performance). To assess this hypothesis, we will next analyse the determinants of the job complexity level. Our interest is in evaluating the role of gender in assigning complexity levels.

## 3.1 Determinants of job complexity level

Using an ordered probit model on job complexity level, we now analyse the factors affecting the promotion decisions in the university[22]. Empirical evidence from the US and the UK academic labour markets suggest that, even after controlling for differences in individual characteristics and performance, women are less likely to be promoted (Ginther & Hayes,

[21] Although the data reported in Figure 1 and Table 3 are only for one year, 2010, gender differences in job complexity and performance levels were similar across all years of the investigation period.

[22] Pekkarinen and Vartiainen (2006) also use job complexity levels to evaluate the gender bias in promotions of Finnish metal workers.

2003; Ward, 2001a) and more likely to work in lower ranks (Ransom & Megdal, 1993; Toutkoushian, 1999) than comparable men.

The findings are reported in Table 4. Signs of the human capital and performance coefficients are as anticipated: the probability of working at higher levels of job complexity increased with age, tenure, educational level and research performance. The estimated gender coefficient indicates that women were less likely than equally qualified men to work at higher complexity levels. Because there is a well-established relationship between job complexity and occupational levels, this result stems from the fact that women were more likely than men to work in lower occupations, at lower complexity levels within occupations, or both. However, the effect of gender was rather small when compared, for example, to the age effect.

[*Table 4 here*]

Based on the marginal effects, the gender difference was particularly evident at complexity level 6. Considering the fact that most of the postdoctoral employees worked at complexity levels 5 and 6 (see Figure 1), the obstacle faced by women of being promoted to complexity level 6 may help to explain a substantial part of the observed gender gap in earnings (see Table 1 and the next section).

# 4 THE MALE EARNINGS PREMIUM IN ACADEMIA

In this section, we examine the extent to which the prevailing gender gap in earnings may be explained by differences in traditional human capital variables (age, tenure and education), academic disciplines (as proxied by departments), individual research performance and occupational groups (academic ranks). Following this, we conduct a number of robustness checks to test the sensitivity of the main results to different model specifications.

## 4.1 Main results

Table 5 summarises the main results of the earnings equations. The first column reports the 'raw gender gap': without adjusting for differences in control variables, women earned roughly 10% less than men[23]. The results in the second column reveal that differences in individual characteristics explain much of the gender gap in earnings: controlling for age, tenure, educational attainment and department reduces the gap to approximately 3%[24]. The coefficients on different characteristics are rather conventional: earnings increased with age and tenure (at a diminishing rate), as well as with educational attainment[25].

[*Table 5 here*]

[23] Calculated as $\exp(0.091) - 1 \approx 0.095$.

[24] The age, tenure and educational level play a particularly important role in explaining earnings differences: adjusting for these variables, the value of $R^2$ increases from 0.02 to 0.74 and the gender gap in earnings decreases from 9.1% to 4.2%. Because 1) age and job tenure were highly correlated ($r \approx 0.68$) and 2) tenure was subject to some measurement error, we also estimated the model without the tenure variable. Excluding tenure inflated the estimated coefficient for age, whereas the other coefficients remained essentially unchanged.

[25] The positive coefficient on tenure is contradictory to the findings of some US studies (Binder et al., 2010; Bratsberg et al., 2003, 2010; Ransom, 1993), in which tenure was found to have a negative effect on academic salaries. In addition to theoretical explanations proposed to account for the negative salary effect of tenure (e.g., Ransom, 1993), several studies have shown that this negative effect might be due to an inadequate set of control variables (Hallock, 1995; Monks & Robinson, 2001; Moore et al., 1998). For example, Moore et al. (1998) found that the negative effect of tenure disappeared after including controls for the quantity and quality of publications, teaching and administrative tasks.

In the third column, we augment the model with research performance variables. As a result, the gender gap decreases even further (from 3% to 2%), implying that there were performance differences between males and females and that controlling for these differences mitigates the unexplained earnings gap between the two genders. The coefficients on publication variables are relatively large, suggesting that the university has offered fairly substantial rewards for research output. In addition, there is some indirect evidence indicating that the remuneration was partially based on quality of publications: the coefficient on international publications is almost twice as large as the two other publication coefficients, implying that international publications were more generously rewarded than other publications.

The model in the fourth column includes occupational variables. The coefficient on the female variable indicates a gender gap of approximately 1%, showing that the gender difference in earnings was lower within occupations than between occupations. However, as discussed in Section 2, gender bias in promotion decisions may cause occupational variables to be endogenous, resulting in an underestimation of the true gender pay gap. Based on the results in Table 4, there are reasons to believe that female employees have been at a disadvantage in the promotion process. Consequently, the inclusion of occupations will most likely lead to the undervaluation of the gender earnings gap.

A shortcoming of the preceding results is that they do not control for unobserved individual heterogeneity. To adjust for this unmeasured heterogeneity, we re-estimate the model in column 3 using a random effects model. The results in column 5 show that controlling for random effects increases the gender gap to above 5% and substantially reduces the coefficients on research performance variables. However, these results are restricted by the random effects assumption that the individual-specific component is not allowed to correlate

with explanatory variables. If the correlation between individual components and regressors is in fact nonzero, the random effects estimator is inconsistent and we should use a fixed effects estimator (e.g., Cameron & Trivedi, 2005). However, as is well known, we cannot use a fixed effects estimator to estimate the coefficients of time-invariant variables such as gender[26].

Our analysis uses publication counts to measure individual performance. However, other performance measures such as the quality of publications and teaching merits could improve the predictive power of our models and help to explain the remaining unexplained gender gap. Earlier studies have repeatedly found that publication quality, as measured by number of citations (Bratsberg et al., 2010; Diamond, 1986; Moore et al., 1998) or by the number of articles in top-tier journals (Bratsberg et al., 2010; Broder, 1993a; Hilmer & Hilmer, 2005), has a positive effect on academic salaries. There is also evidence suggesting that teaching merits may play a role in the salary determination of academic employees. However, this evidence is inconclusive as to whether the teaching merits have a positive or a negative effect on salaries. For example, Ward (2000) discovered a positive relationship between salaries and student evaluations of teaching ability. On the other hand, several recent studies have concluded that a higher amount of teaching is associated with lower earnings (Binder et al., 2010; Fairweather, 2005; Graves, Marchand & Sexton, 2002; Umbach, 2007). Finally, several studies have found no evidence on the salary effects of different teaching merits (Katz, 1973; Tuckman & Hagemann, 1976).

[26] As an alternative, an estimator proposed by Hausman and Taylor (1981) allows for the estimation of time-invariant variables when some of the explanatory variables are correlated with the individual-specific component. Applying this estimator to our data yields gender earnings gap estimates of around 3%. However, these estimates are statistically insignificant.

## 4.2 Robustness checks

We now assess the robustness of the previous results to alternative earnings equation specifications. First, we study whether the gender earnings gap varied with age, tenure, educational attainment or research performance. Second, we assess whether there were differences in gender pay equity between female- and male-led departments. Finally, we evaluate the independent effects of concurrent and past performance on the estimated gender gap.

### 4.2.1 Gender differences in rewards

In the previous analysis, only the intercept of the earnings equation was allowed to vary across gender. This approach ignores the fact that the slopes may also differ across gender, implying that men and women may have been rewarded differently for the same human capital and performance variables. To allow for the gender differences in slopes, we add interaction terms between a female dummy variable and other regressors[27].

Table 6 reports the statistically significant interaction terms[28]. The results show that the gender gap in earnings increased with age and decreased with the number of international publications. For example, other things being equal, an increase in age of ten years was associated with an increase of approximately 1 percentage point in the gender earnings gap.

[27] Only a few previous studies on academic pay determination have reported results for the interaction effects between gender and other control variables (Johnson & Stafford, 1974; Lindley et al., 1992; Schrank, 1977).

[28] The interaction terms between gender and other explanatory variables (tenure, educational attainment and other publication variables) turned out to be statistically insignificant and, in many cases, were quite close to zero. We obtained similar results when we estimated separate earnings equations for men and women; the Chow test rejected the equality of regression coefficients across genders, and the gender difference in coefficients was most pronounced for age and international publication variables.

Similarly, an additional international publication reduced the gender earnings gap by approximately 1.1 percentage points.

[*Table 6 here*]

### 4.2.2 Supervisory effects

Theoretically, various explanations have been proposed for the beneficial effect of female leadership on gender pay equality (Cardoso & Winter-Ebmer, 2010; Penner & Toro-Tulla, 2010; Penner, Toro-Tulla & Huffman, 2012). Female leaders may, for example, act as mentors for subordinate females, helping them to advance their careers and thus to achieve higher salary levels. Female leaders may also pay more attention to gender pay equity among employees due to their more egalitarian preferences; alternatively, they may favour other women, which may lead to higher wages for women.

Empirical support for these theoretical considerations has to date been scarce and somewhat ambiguous. For example, Cardoso and Winter-Ebmer (2010) examined female-led firms in Portugal, finding support for the hypothesis that the gender pay gap is reduced under female leadership: women-led firms, when compared to male-led firms, paid higher wages for females and lower wages for males. Hultin and Szulkin (2003) and Hensvik (2011) analysed the wage effects of female leadership in Sweden and showed that the establishment-level gender wage gap decreased as the proportion of female managers and supervisors increased. Conversely, Penner and Toro-Tulla (2010) were unable to discover a significant effect of female superiors on the gender wage gap using data from US small business owners, as were Penner et al. (2012) in their study on female managers at a large-sized US grocery retailer.

To examine the earnings differences between female- and male-led departments, we add a dummy variable that equals one if the department head was female and zero otherwise[29]. In addition, we include an interaction term between the gender of the employee and the gender of the department head to allow for differences in the gender pay gap between female- and male-led departments. According to the results in Table 7, column 2, women working in female-led departments had lower earnings relative to comparable women working in male-led departments[30]. Consequently, and in contrast to earlier studies, the gender earnings gap was more pronounced in female-led departments than in male-led departments: the gap was approximately 5.4% (= 1.7% + 3.7%) in departments with a female head compared to 1.7% in departments with a male head. To account for the fact that the earnings determination of professors differs from that of other employees (see Section 2), we also estimate a model that excludes the professors. The results in column 4 once again suggest that the gender pay inequality was higher in female-led departments than in male-led departments.

[*Table 7 here*]

Although our results are inconsistent with previous empirical evidence, there are theoretical reasons why we might not observe reduced gender pay gaps under female leadership. Females working in management positions may, for example, be inclined to adopt similar discriminatory practices than male managers or may undervalue the work performed by female employees (Hensvik, 2011; Penner et al., 2012). In support of these theoretical reasons,

[29] A current department head may only have a limited effect on contemporaneous earnings, as earnings are primarily a product of past wage negotiations. However, if female-led departments are more likely to have had female heads also in the past, the dummy variable for the department head's gender captures this tendency towards female administration.

[30] Similar results were obtained using a random-effects model. The results were also robust to the inclusion of controls for occupations and female shares of the departments' academic employees. The coefficient on the female share variable was close to zero and statistically insignificant. This finding stands in contrast to studies by Barbezat (1991), Bellas (1993, 1994, 1997) and Umbach (2007), who found academic disciplines with a higher proportion of females to have lower average salaries compared to other disciplines.

there is some empirical evidence showing that females may discriminate against other females in different labour market-related decisions, such as in hiring decisions (Bagues & Esteve-Volart, 2010; Steinpreis, Anders & Ritzke, 1999) and in the evaluation of research grant applicants (Broder, 1993b).

### 4.2.3 The earnings effects of contemporaneous and past performance

Throughout the above analysis, we have used concurrent research performance to explain the variation in earnings. However, it is likely to be past research performance, rather than contemporaneous performance, that has an effect on earnings. We now test the robustness of the previous results by regressing monthly earnings in 2010 on the total numbers of publications in the period 2005–2009. These cumulative publication counts serve as (incomplete) proxies for career publications and enable us to examine the earnings effects of recent research activity[31].

The comparison of the effects of concurrent and past performance on earnings is shown in columns 2 and 3 of Table 8. The results confirm our earlier finding that adjusting for individual performance leads to a reduction in the size of the gender earnings gap. The gap is reduced to approximately 3% regardless of whether we use concurrent or past research performance. Therefore, the results imply that concurrent performance may serve as an adequate proxy for past performance, at least in the short run. Although the effects of simultaneous and cumulative performance on the gender gap are very similar, the earnings effects differ markedly: using cumulative publications instead of simultaneous publications

[31] According to the instructions, the evaluation of an employee's personal performance is based on performance over the last three years (and at job complexity levels 1–4, over the past year). Consequently, the publication counts from the preceding five years should explain a substantial share of the individual variation in the performance components of earnings.

leads to a notable reduction in performance coefficients (the only exception is the coefficient on national publications, which remains largely unchanged). This finding is consistent with other studies showing that rewards for additional career publications are typically modest.

[*Table 8 here*]

In addition, to examine the effect of past performance on the assignment of job complexity levels, we re-estimate the ordered probit model in Table 4 using data for the year 2010. The results in columns 4 and 5 show that using cumulative performance instead of simultaneous performance leads to a minor reduction in the estimated gender coefficient. The publication coefficients imply that the past research output increased the probability of working at higher levels of job complexity. Again, as in the case of the earnings equations, the publication coefficients are smaller when cumulative publications are used.

# 5 CONCLUSIONS

This study employs personnel data from a large-size Finnish university to examine gender differences in earnings. Because the Finnish academic earnings are based on well-defined pay scales that are common to all universities, we expect that our results will generalize to other universities. We observe a 'raw gender earnings gap' of nearly 10%. Once we control for human capital variables (age, tenure and educational level) and academic disciplines (as proxied by departments), the gap is reduced to 3%.

A further examination of the data implies that the observed gender pay gap is partly attributable to gender differences in research performance: the average numbers of publications are generally higher for men than for women. The pay scales for Finnish academics are tied to individual performance; therefore, these gender performance differences should translate into differences in earnings. The male-female gap in publication counts may be due to the concentration of women in disciplines with lower publication activity or due to the differences in personal characteristics, preferences and time use. Furthermore, if publication activity increases with co-authorship, as shown by Hollis (2001) and Maske, Durden and Gaynor (2003), the gender difference in research output may stem from the willingness to co-author. Earlier findings of Ferber and Teiman (1980) and McDowell and Smith (1992) indeed suggest that researchers tend to co-author with researchers of the same sex, which, in turn, may diminish the output of females in male-dominated disciplines. Based on the results of Ferber and Teiman (1980), the gender gap in publications may also be a result of discrimination by journal editors and publishers against female researchers.

Controlling for individual research performance reduces the unexplained gender pay gap from 3% to 2%, indicating that there were performance differences between men and women that partly explain the observed gender gap in earnings. The coefficients on publication variables are positive and statistically significant, showing that the earnings were an increasing function of publication activity. Furthermore, different types of publications yielded different rewards: the earnings premium was higher for international refereed publications than for other publications.

Once we allow for differences in occupations, the gender gap is further reduced to close to 1%. However, this estimate may underestimate the true gender earnings gap due to possible gender bias in the university's promotion procedures. Analysing the determinants of job complexity level, we find evidence suggesting that promotion decisions have not been gender-neutral: women were more likely to work at lower job complexity levels than men with similar background characteristics. Therefore, controlling for occupations may result in biased estimates of the gender earnings gap.

Our findings, in conjunction with the results of Takahashi and Takahashi (2011) in the context of Japanese academic economists, suggest that academic earnings for women also lag behind those of comparable men in labour markets where earnings are based on well-defined pay scales. However, the observed gender gap of approximately 1–2% is substantially lower than those found in most of the other countries studied (the US, the UK and Japan) but fairly similar to that observed in Canada (Brown et al., 2011; Warman et al., 2010).

In a further analysis, we show that the rewards for different background characteristics (e.g., tenure and educational level) and individual performance were similar across gender with two

exceptions: a positive effect of an additional year of age was higher for men than for women, whereas an additional international publication yielded higher rewards for women than for men. Therefore, the results imply that a male earnings premium increased with age and decreased with publication activity.

The previous literature provides theoretical arguments and empirical evidence suggesting that the gender pay gap may be lower under female leadership. Our analysis on university departments suggests the opposite: the gender earnings gap was more pronounced in departments with female heads than in departments with male heads. However, this finding should be interpreted with caution because the department head has only a limited effect on earnings: earnings are an outcome of a sequence of past negotiations and the department-level earnings determination is bound by the central administration of the university. Nevertheless, when considered in conjunction with the results in Penner and Toro-Tulla (2010) and Penner et al. (2012), our results yet again imply that female leaders do not necessarily have a beneficial effect on gender pay equality.

# TABLES AND FIGURES

TABLE 1 Descriptive statistics (year 2010)

| | Male | Female | Gender difference |
|---|---|---|---|
| | **Mean (std.dev)** | **Mean (std.dev)** | |
| Monthly earnings (euros) | 3741 (1405) | 3394 (1198) | +347 |
| Age (years) | 41.8 (11.7) | 40.7 (10.6) | +1.1 |
| Tenure (years) | 9.3 (9.3) | 7.6 (7.6) | +1.7 |
| International publications (per year) | 1.9 (3.3) | 0.9 (1.7) | +1.0 |
| National publications (per year) | 0.1 (0.6) | 0.3 (0.9) | −0.2 |
| Other publications (per year) | 0.8 (1.8) | 0.9 (1.7) | −0.1 |
| Education (%) | | | |
| Master's degree | 38.2 | 42.5 | −4.3 |
| Licentiate's degree | 6.4 | 7 | −0.6 |
| Doctor's degree | 55.4 | 50.5 | +4.9 |
| Occupational group (%) | | | |
| Teaching assistants | 4.5 | 7.9 | −3.4 |
| Researchers | 55.1 | 57.2 | −2.1 |
| Lecturers | 15.6 | 17.7 | −2.1 |
| Senior Assistants | 8.1 | 7.2 | +0.9 |
| Professors | 16.7 | 10 | +6.7 |
| Observations | 532 | 442 | |

TABLE 2 Occupation-specific and performance components of earnings in 2010

| Complexity level | Occupation-specific component | Performance level | Performance component (% of occ.-specific component) |
|---|---|---|---|
| 1 | 1687 € | 1 | 0% |
| 2 | 1826 € | 2 | 4% |
| 3 | 2009 € | 3 | 10.1% |
| 4 | 2312 € | 4 | 16.1% |
| 5 | 2682 € | 5 | 22.1% |
| 6 | 3145 € | 6 | 28.2% |
| 7 | 3619 € | 7 | 34.2% |
| 8 | 4382 € | 8 | 40.3% |
| 9 | 4939 € | 9 | 46.3% |
| 10 | 5596 € | | |
| 11 | 6407 € | | |

Notes: Occupation-specific components are based on a pay scale in December 2010 and are rounded to the nearest integer. At the beginning of 2009, there was a minor increase in performance components; prior components were 0%, 4%, 10%, 16%, 22%, 28%, 34%, 40% and 46%, respectively.

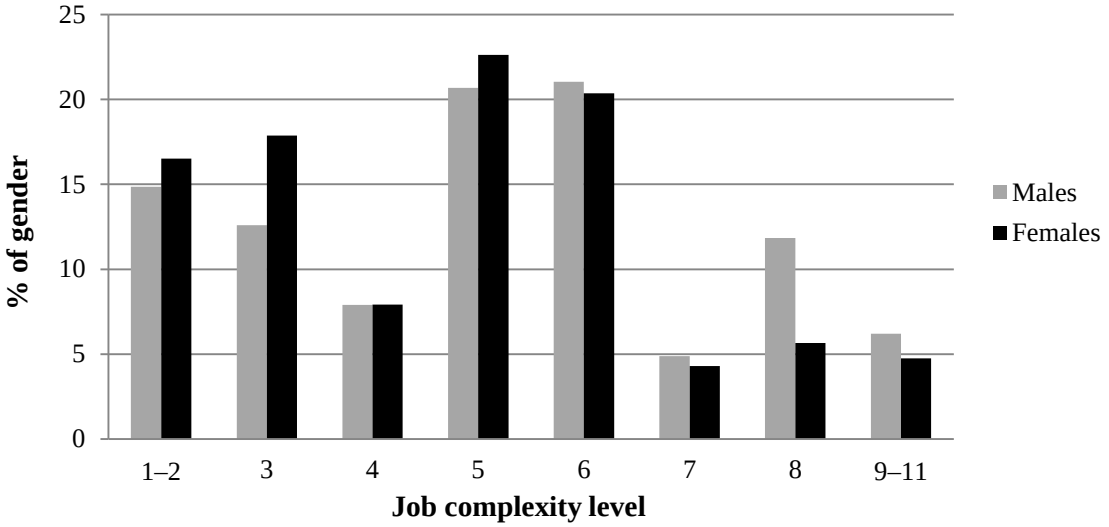


FIGURE 1 Job complexity levels by gender in 2010

TABLE 3 Job complexity and performance levels (in 2010)

| Performance level | Complexity level | | | | | | | | | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1–2 | | 3–4 | | 5–6 | | 7–8 | | 9–11 | | | |
| | M | F | M | F | M | F | M | F | M | F | M | F |
| **2–3** | 20.3 | 32.9 | 16.5 | 23.7 | 5 | 7.9 | 4.5 | 2.3 | 0 | 0 | 9.2 | 15.2 |
| **4–5** | 58.2 | 56.1 | 48.6 | 53.5 | 38.7 | 43.1 | 27 | 15.9 | 18.2 | 19 | 40.4 | 44.1 |
| **6–7** | 21.5 | 11 | 32.1 | 21 | 48.2 | 41.6 | 59.5 | 77.3 | 42.4 | 66.7 | 42.5 | 36 |
| **8–9** | 0 | 0 | 2.8 | 1.8 | 8.1 | 7.4 | 9 | 4.5 | 39.4 | 14.3 | 7.9 | 4.7 |
| **Total** | 100 | | 100 | | 100 | | 100 | | 100 | | 100 | |

Notes: M = males, F = females

TABLE 4 Ordered probit on job complexity level

| | Ordered probit | Marginal effects | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 1–3 | 4 | 5 | 6 | 7 | 8 | 9–11 |
| **Female** | −0.124<br>(1.90)* | 0.025 | 0.015 | −0.0004 | −0.033 | −0.003 | −0.003 | −0.0002 |
| **Age** | 0.257<br>(9.21)*** | −0.052 | −0.030 | 0.0004 | 0.068 | 0.006 | 0.007 | 0.0005 |
| **Age$^2$** | −0.002<br>(6.42)*** | 0.0004 | 0.0002 | −0.000 | −0.0005 | −0.000 | −0.0001 | −0.000 |
| **Tenure** | 0.059<br>(5.19)*** | −0.012 | −0.007 | 0.0001 | 0.016 | 0.001 | 0.001 | 0.0001 |
| **Tenure$^2$** | −0.001<br>(3.87)*** | 0.0003 | 0.0002 | −0.000 | −0.0003 | −0.000 | −0.000 | −0.000 |
| **Education** | | | | | | | | |
| **Licentiate** | 0.745<br>(7.25)*** | −0.262 | −0.028 | 0.172 | 0.110 | 0.005 | 0.003 | 0.0001 |
| **Doctor** | 1.923<br>(21.15)*** | −0.441 | −0.156 | 0.066 | 0.413 | 0.048 | 0.062 | 0.007 |
| **Publications** | | | | | | | | |
| **International** | 0.119<br>(10.04)*** | −0.024 | −0.014 | 0.0002 | 0.032 | 0.003 | 0.003 | 0.0002 |
| **National** | 0.043<br>(2.07)** | −0.009 | −0.005 | 0.0001 | 0.012 | 0.001 | 0.001 | 0.0001 |
| **Other** | 0.063<br>(5.79)*** | −0.013 | −0.008 | 0.0001 | 0.017 | 0.002 | 0.002 | 0.0001 |
| Observations | 4645 | | | | | | | |
| Pseudo $R^2$ | 0.38 | | | | | | | |
| Log pseudolikelihood | −4988.3 | | | | | | | |

Notes: Absolute values of z-statistics in parentheses (calculated on the basis of cluster-robust standard errors). The model also includes department dummies. Marginal effects – evaluated at sample means – were computed using the *margeff* package in STATA (Bartus, 2005). Significant at the * 10% level; ** 5% level; *** 1% level.

TABLE 5 Earnings equations (logarithm of monthly earnings)

| | OLS | | | | RE |
|---|---|---|---|---|---|
| | **(1)** | **(2)** | **(3)** | **(4)** | **(5)** |
| **Female** | −0.091 | −0.029 | −0.022 | −0.012 | −0.051 |
| | (0.019)*** | (0.010)*** | (0.009)** | (0.007)* | (0.010)*** |
| **Age** | | 0.028 | 0.027 | 0.031 | 0.043 |
| | | (0.004)*** | (0.004)*** | (0.003)*** | (0.003)*** |
| **Age$^2$** | | −0.0002 | −0.0001 | −0.0003 | −0.0003 |
| | | (0.000)*** | (0.000)*** | (0.000)*** | (0.000)*** |
| **Tenure** | | 0.018 | 0.016 | 0.012 | 0.014 |
| | | (0.002)*** | (0.002)*** | (0.001)*** | (0.002)*** |
| **Tenure$^2$** | | −0.0004 | −0.0004 | −0.0003 | −0.0003 |
| | | (0.000)*** | (0.000)*** | (0.000)*** | (0.000) |
| **Education** | | | | | |
| **Licentiate** | | 0.096 | 0.093 | 0.085 | 0.073 |
| | | (0.015)*** | (0.015)*** | (0.012)*** | (0.019)*** |
| **Doctor** | | 0.308 | 0.275 | 0.225 | 0.201 |
| | | (0.011)*** | (0.011)*** | (0.009)*** | (0.014)*** |
| **Publications** | | | | | |
| **International** | | | 0.021 | 0.013 | 0.004 |
| | | | (0.002)*** | (0.001)*** | (0.001)*** |
| **National** | | | 0.010 | 0.004 | 0.002 |
| | | | (0.004)*** | (0.003) | (0.002) |
| **Other** | | | 0.012 | 0.005 | 0.003 |
| | | | (0.002)*** | (0.001)*** | (0.001)*** |
| **Constant** | 8.09 | 6.91 | 6.93 | 6.97 | 6.65 |
| | (0.015)*** | (0.087)*** | (0.083)*** | (0.064)*** | (0.073)*** |
| **Dummy variables** | | | | | |
| **Year** | Yes | Yes | Yes | Yes | Yes |
| **Department** | No | Yes | Yes | Yes | Yes |
| **Occupation** | No | No | No | Yes | No |
| **Observations** | 4645 | 4645 | 4645 | 4645 | 4645 |
| **$R^2$ (overall)** | 0.02 | 0.75 | 0.78 | 0.86 | 0.74 |
| **$R^2$ (between)** | | | | | 0.75 |
| **$R^2$ (within)** | | | | | 0.54 |

Notes: Cluster-robust standard errors in parentheses. Significant at the * 10% level; ** 5% level; *** 1% level.

TABLE 6 Interaction between gender, age and research performance

| | **Gender–Age** | **Gender–Internat. publications** | **Both interaction terms** |
|---|---|---|---|
| **Female** | 0.024 | −0.032 | 0.020 |
| | (0.030) | (0.009)*** | (0.030) |
| **Age** | 0.028 | 0.027 | 0.028 |
| | (0.004)*** | (0.004) | (0.004)*** |
| **International publications** | 0.021 | 0.019 | 0.019 |
| | (0.002)*** | (0.002)*** | (0.002)*** |
| **Female*Age** | −0.001 | | −0.001 |
| | (0.0008) | | (0.0008)* |
| **Female*International publications** | | 0.010 | 0.011 |
| | | (0.004)*** | (0.004)*** |
| Observations | 4645 | 4645 | 4645 |
| $R^2_{adjusted}$ | 0.78 | 0.78 | 0.78 |
| F-test: interaction terms = 0 | | | F(2, 1581) = 4.55 |
| p-value | | | 0.011 |

Notes: Cluster-robust standard errors in parentheses. Only statistically significant interaction terms are reported (significant at the 15% level). The models also include the constant term and the following control variables: age, age squared, tenure, tenure squared, licentiate dummy, doctor dummy, three publication variables (international, national and others), year dummies and department dummies. Significant at the * 10% level; ** 5% level; *** 1% level.

TABLE 7 Effect of female department heads on earnings

| | **Full sample** | | **Restricted sample (professors excluded)** | |
|---|---|---|---|---|
| **Female** | −0.022 | −0.017 | −0.017 | −0.011 |
| | (0.009)** | (0.010)* | (0.008)** | (0.008) |
| **Female head** | | −0.0001 | | 0.019 |
| | | (0.016) | | (0.014) |
| **Female*Female head** | | −0.037 | | −0.050 |
| | | (0.020)* | | (0.017)*** |
| **Observation** | 4645 | 4645 | 3996 | 3996 |
| $\mathbf{R^2_{adjusted}}$ | 0.78 | 0.78 | 0.77 | 0.77 |

Notes: Cluster-robust standard errors in parentheses. The estimated earnings equations also included the control variables reported in the footnote to Table 6. Significant at the * 10% level; ** 5% level; *** 1% level.

TABLE 8 Comparison between yearly performance and cumulative performance in 2010

| | Earnings equations | | | Ordered probit on job complexity level | |
|---|---|---|---|---|---|
| | **(1)** | **(2)** | **(3)** | **(4)** | **(5)** |
| **Female** | −0.036 | −0.030 | −0.028 | −0.191 | −0.177 |
| | (0.012)*** | (0.012)*** | (0.011)** | (0.086)** | (0.086)** |
| **Yearly publications** | | | | | |
| **International** | | 0.020 | | 0.109 | |
| | | (0.002)*** | | (0.016)*** | |
| **National** | | 0.010 | | 0.056 | |
| | | (0.008) | | (0.051) | |
| **Other** | | 0.012 | | 0.054 | |
| | | (0.003)*** | | (0.023)** | |
| **Cumulative publications** | | | | | |
| **International** | | | 0.006 | | 0.039 |
| | | | (0.001)*** | | (0.005)*** |
| **National** | | | 0.010 | | 0.051 |
| | | | (0.003)*** | | (0.019)*** |
| **Other** | | | 0.004 | | 0.018 |
| | | | (0.001)*** | | (0.007)*** |
| **Observations** | 974 | 974 | 974 | 974 | 974 |
| **$R^2_{adjusted}$** | 0.77 | 0.79 | 0.80 | | |
| **Pseudo $R^2$** | | | | 0.40 | 0.41 |
| **Log likelihood** | | | | −1016.9 | −992.0 |

Notes: Standard errors in parentheses. The models also included the control variables reported in the footnote to Table 6. Significant at the * 10% level; ** 5% level; *** 1% level.

# APPENDIX

TABLE A.1 Description of the variables

| Variable name | Description |
|---|---|
| **Monthly earnings** | Monthly earnings in euros |
| **Female** | = 1 if female, = 0 if male |
| **Age** | Age in full years |
| **Tenure** | For most employees, this variable measures the years of service in the university. For some employees, this variable measures the length of time since the latest labour contract was negotiated (due to missing information on years of service) |
| **Education (highest degree)** | Options: Master, Licentiate, Doctor |
| **Occupational group** | Options: teaching assistant, researcher, lecturer, senior assistant, professor |
| **Job complexity level** | Options: 11 different levels |
| **Number of publications** | Three categories: refereed international publications, refereed national publications, all other publications |
| **Department** | Options: 27 different departments |
| **Gender of department head** | = 1 if department head was female; = 0 otherwise |

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