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2012 67-1 HIVER WINTER

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Pay Structure, Female Representation and the Gender Pay Gap among University Professors

Christine Doucet, Michael R. Smith and Claire Durand

This research uses data from a large Canadian research university to explore the sources of the gender pay gap. It is the first analysis of the joint impact on the pay gap of two recent factors: the increased use by universities of market supplements and the implementation of the Canada Research Chairs program. In addition, it considers both individual and structural determinants of the remuneration gap, something few other studies have done. We examine the contributions to the gap of the following: base pay, promotion to full professor, access to market supplements, and amounts of market supplements. We show that the effects of these factors vary with the proportions of female faculty members within units and that the magnitude of gender differences may vary with the degree of formalization in remuneration practices.

KEYWORDS: gender pay gap, organization, pay structure, female representation

Despite women's increasing labour market success over the last decades, gender pay differences persist. Researchers advance explanations of these differences pitched at two levels (Marry, 2003; Sonnert and Holton, 1996). At the individual level, differences in labour market outcomes are sometimes attributed to gender-specific preferences. At the structural/institutional level, organizational practices may penalize women, or laws may offset the effects of these practices. Researchers are urged to transcend this theoretical dichotomy by simultaneously examining the processes at both levels (Ridgeway, 2009), but few empirical studies have done so. The study reported here contributes to filling this gap.

Universities provide an interesting context for the examination of gender pay gaps. First, "...academics often cloak their role in the garb of enlightenment and progressive thinking and so, to the degree that this is more than intellectual

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Acknowledgments: Funding for this research was received from the Social Sciences and Humanities Research Council of Canada (SSHRC doctoral grant #767-2006-2267). The authors would also like to acknowledge helpful comments by anonymous reviewers.

posturing, sexist pay practices might be expected to disappear early in this milieu" (Guppy, 1989: 744). Second, most research universities attempt to tie pay to performance. In principle, if applied properly, this should reduce or eliminate gender bias. Higher education, then, might be expected to set a standard in terms of gender equality.

The pay gap in academia is relatively low. In 2006 female faculty members earned 18.2% less than males as compared to gaps of 29.4% in the general population, 34.1% among lawyers, 27.1% among general practitioners, and 40% for senior executives (Statistics Canada, 2006). Nonetheless, the difference is appreciable. Moreover, as we will see, the introduction of the Canada Research Chair (CRC) program has influenced the relative pay of males and females, to some degree to the disadvantage of the latter.

Female Faculty in Canadian Universities

Since the 1970s, both the presence of women in faculty positions (at all ranks) and their relative pay has increased. The proportion of full-time female academics rose from 13 percent in 1973 (Ornstein, Stewart and Drakich, 1998) to 30 percent in 2002-2003 (Sussman and Yssaad, 2005). Ornstein *et al*. (1998) reported a fall in the female pay disadvantage from 22 to 17 percent between 1970 and 1994. More recent studies report gaps of 14% and 15% respectively (Warman, Woolley and Worswick, 2010; Sussman and Yssaad, 2005). The pay gap is partly, but not entirely accounted for by gender differences in rank and field of specialization; the proportion of women who are full professors remains small (17% according to Sussman and Yssaad, 2005).

Perhaps the trend means that gender differences in labour market outcomes will eventually disappear? There are reasons to question this. Universities are more aggressively tying pay to the market value of either fields or individuals. A study of the award of "market premiums" at one Canadian research university found that female academics were almost three times less likely than their male colleagues to have received a market supplement since their appointment (Doucet, Durand and Smith, 2008), net of the impact of career stage, research activities, academic field, individual attitudes towards remuneration, and family situation. The exercise of discretion seemed to reduce the relative pay of females.

The competitive allocation of CRCs since 2000 seems to have had a similar outcome. In 2003, a group of female academics filed a complaint with the Canadian Human Rights Commission, observing that only 15% of Chairs went to women in 2001 and 18% in 2002.[1] Pay supplements of $40,000 and $30,000 respectively are attached to Tier 1 and Tier 2 CRCs at the institution under study, so their effect is to increase the gender pay gap.

Further evidence on the effect of the exercise of discretion on gender pay differences is provided by Finland, often considered a model in terms of gender equality. It does indeed have the highest proportion of female academics in Europe. During the 1990s, professorships were awarded both by invitation and through open competition. In 1997-1998 proportionally twice as many female academics were hired when there were open competitions than when discretion was used (Husu, 2000).

Our general point is that, in Canadian academia, salaries are increasingly individualized and there is some evidence that this process disadvantages women.

Gender Pay Gaps, Gender Relations and Gendered Organizations

Gender pay gaps, it is argued, reflect socially constructed gendered relations within organizations (Daune-Richard and Devreux, 1992; Kergoat, 2005). For example, they may originate in a division of labour that is hierarchically organized along gender lines, or they may originate in informal practices or job descriptions. Whatever the organizational practices, the result may be a devaluation of women's activities (Acker, 1990). Evidently, gendering processes are likely to change over time and across locations. In universities, organizational components or practices likely to influence pay include research activities, research networks, evaluation of research contributions, vertical and horizontal segregation, and remuneration procedures.

Research Activities, Research Networks and Evaluation of Research Contributions

Women's pay might be lower because they publish less. The evidence on this is mixed. Using Canadian data for 1987 and 2002, Nakhaie (2002, 2007) found lower publication rates on the part of women. However, the difference with men was substantially explained by gender differences in rank, field, seniority and university type (research versus others). An American study suggests that differences have been minimal in recent cohorts (Xie and Shauman, 2003).

Suppose women do publish less than men: why might that be so? Given their relatively recent entry into academia, female faculty members may be less integrated into professional networks than males (Sonnert and Holton, 1995), excluded from dominant 'old boys networks' (McKenna *et al.*, 2002; MIT, 1999). Moreover, informal networks within organizations are often segregated along gender lines. High level positions tend to be primarily held by men, so segregation means that women may have less access to influential actors within the institution and to the career advancement advantages they may provide (Brass, 1985).

Also, male and female research contributions may be evaluated differently. Wennerås and Wold (1997) found that women's applications to postdoctoral fellowships were underrated compared to those of males and that, at equal levels of scientific productivity, evaluations of women's scientific competence were inferior to those of men. Nakhaie reports that accumulating publications translated more readily into the promotion of males than females which, the author said, "…tends to support the allegation of discrimination in Canadian universities" (2007: 382). There is contradictory evidence, however. Sandström and Hällsten (2008) replicated the Wennerås and Wold study, examining relative success by gender across a wider range of competitions, and found that women did a little better than men.

Horizontal and Vertical Segregation

Academic pay is tied to academic field (horizontal segregation) and rank (vertical segregation). Human capital theory (Becker, 1994) informs both explanations of the gender pay gap in academia. Women are indeed underrepresented in some highly paying fields such as engineering, applied sciences, mathematics and physical sciences (CAUT, 2004). They are also overrepresented in relatively poorly paid fields (CAUT, 2004). Two explanations have been put forward to account for the lower salaries associated with feminized occupations. They may reflect a devaluation of work done by women (England, 1992, 2005). That is, a concentration of women reduces average pay in a field. Or they may result from job queuing, a process by which women have access to occupations only once they have become unattractive to men (Reskin and Roos, 1990). There is certainly evidence that, after suitable controls, as the proportion of women in a field rises, salaries fall (Bellas, 1994; Umbach, 2007).

With respect to vertical segregation, human capital theorists have argued that women may cumulate fewer years of seniority due to part-time work and career interruptions, including maternity leaves (Milgrom and Petersen, 2006). The cumulated seniority of faculty does differ by gender because of women's more recent presence in the academic profession, career interruptions, and delayed career starts (Ornstein and Stewart, 1996; Ornstein *et al*., 1998; Sussman and Yssaad, 2005). However, gender differences in access to higher ranks are not entirely accounted for by seniority differences. Thus, Ornstein, Stewart and Drakich (2007) found that promotion to full professor took about a year longer for women than for men with wide variation across academic fields.

Characteristics of Pay Systems

Formalized pay-setting procedures that limit discretion reduce the likelihood that women will be paid less than men (Elvira and Graham, 2002; Kulis, 1998; Reskin,

2003; Rubery *et al*., 1998; Silvera, 1996). Collective agreements generally tie pay to seniority and impose salary caps, which tends to prevent one group being advantaged through network ties or the preferences of decision-makers (Ridgeway, 2009). In fact, gender differences in pay are greater in universities where salaries are determined using discretionary judgments of merit rather than seniority (Warman *et al*., 2010). Conversely, in Turkey, where there is a highly transparent promotion system, women are strikingly well-represented within the full professor rank (Healy, Özbilgin and Aliefendioğlu, 2005).

Research Hypotheses

The review above suggests that gender differences in pay are likely to be influenced by formalization and the concentration of women in an academic field. Hence, the following two hypotheses:

H1: the magnitude of gender differences varies according to the degree of formalization in remuneration components;

H2: the level of female representation in a given context is negatively related to remuneration.

Methodology

Data

We use administrative data from a major Canadian research university. Information collected by the university administration between 1997 and 2006 on faculty members' remuneration is provided annually to the Faculty Union. Clinicians in the Faculty of Medicine and faculty occupying administrative positions are excluded because they are not union members. We have data on 1,882 faculty members for which there are from one to ten records (depending on the number of years each faculty member was employed and a member of the Union), for a total of 11,170 observations across 64 units. Units are either non departmentalized Faculties, Schools (within Faculties or autonomous) or departments (within Faculties). For the purposes of multilevel analysis, these data can be conceptualized as being at three levels: level 1 is time, which is nested within individuals (level 2), who are nested within units (level 3).

Measures

Given the longitudinal character of the data, some of the variables are time-varying while others are not. Our principal dependent variable is total salary, which varies with time. To normalize the distribution, we use the natural log of salary, a usual practice with this type of variable (e.g., Ornstein and Stewart, 1996; Barbezat and Hughes, 2005; Toutkoushian, Bellas and Moore, 2007;

Umbach, 2007). We separately analyze the time to promotion to full professor and access to a pay supplement, each of which affects total salary.

Implementing a multilevel analysis requires that independent variables be specified for each level. At level 1, these include year, rank and access to pay supplements which vary with time. Rank has three categories, assistant, associate and full professor. Pay supplements take two forms: so-called "market supplements", and Canada Research Chairs (CRCs).[2]

Level 2 includes the time invariant characteristics of faculty members: gender, pay grade at the first measurement occasion, and year of appointment. Pay grade is a proxy for recognized experience at hiring. Year of appointment is used only in the analysis of promotion to full professor. It controls for the evolution in promotion policies and the fact that faculty members hired before the 1980s who had not yet been promoted were most certainly less likely to become full professor at each observation point. This variable is grouped into three categories, each comprising roughly a third of the faculty members in the data: those hired between 1958 and 1972, between 1973 and 1984, or between 1985 and 1996. This allows for the detection of possible threshold effects.

Finally, level 3 variables are sector of activity of the unit and proportion of female faculty within units at the beginning of the period of observation. The continuous form of female representation is replaced by quintiles. This allows the detection of threshold effects and nonlinearities.[3] Quintiles 1 to 3 all contain small numbers of female faculty members so they are grouped together. The female representation variable thus comprises three categories: units at quintiles 1 to 3 (0–29% female), at quintile 4 (30–39% female) and at quintile 5 (40%+ female). The sectors of activity are grouped into eight categories: Pure and Applied Science, Social Sciences/Psychology, Humanities, Medicine, Specialized Medicine,[4] Nursing/Education, a sector combining Economics, Law and Computer Science, and "other". Academic sector partly accounts for variations in job opportunities which may in turn affect pay. Men and women are unequally represented in the various academic sectors (data not shown), and this factor may explain part of the gender pay gap.

Analyses

Multilevel models deal with the fact that individuals are "nested" within social structures (Hox, 2002). The nesting – clustering – of the data violates a major assumption of regression analysis, that sampling units are independent from each other. Multilevel models address this problem and produce accurate standard errors. In addition, they allow the partitioning of variance between levels of analysis, making it possible to quantify the proportion of variation attributable to differences between individuals and contexts respectively. Survival regression

(Cox model) is used for the analysis of promotion to full professor. This model is suitable for event outcomes for which data are right censored, which is the case for our promotion data: some faculty members not promoted to full professor during the observation window were subsequently promoted. Because the rules of the collective agreement effectively impose a ten year wait before promotion to full professor, we restrict this analysis to those who had cumulated 10 or more years of seniority (1,048 cases).

We first report the relation between gender and pay. Then we add variables consecutively, by level: first variables related to the passage of time followed by individual characteristics and, finally, administrative units. Where relevant, we add cross-level interactions. At each step, it is possible to assess whether there is a significant contribution of the variable(s) entered to the explanation of pay differences and whether this contribution mediates the effect of gender. The final parsimonious models retain only the variables that have a significant relationship with the outcomes.

To test hypothesis 1, we compare gender differences in total salary, in promotion to full professor, and in access to pay supplements. We expect larger gender differences in access to pay supplements and in their amounts because these are substantially discretionary. To test hypothesis 2, we estimate the effect on remuneration of the proportion of females within units.

Results

Total Salary

Table 1 presents the analysis of the determinants of total salary. Variables are indented in the table to indicate the level of analysis to which each is assigned. The base model (0) includes only year as an independent variable. It indicates that 7.8% of the variance in total pay is intra-individual and varies with year, 85.5% is between individuals, and 6.7% is between units. Variance is significant at each level and, therefore, predictors may be added at all three levels.

Model 1 estimates variance in salary associated with gender, a level 2 variable. It shows that women were paid significantly less than men. Gender accounts for 5.7% of the variance within units and 21.7% of the variance between units.[5] Rank, which varies with year and is therefore a level 1 variable, together with pay grade at the start of the period, a level-2 variable, are added in model 2.

This substantially reduces female pay disadvantage, from –0.113 ($p < .001$), which corresponds to a $7537 difference, to 0.015 ($p < .01$), which translates in a $704 gap; the coefficient remains significant. Adding these controls reduces the unexplained variance by 29.1% at level 1, by 86.6% at level 2 and by 52.6% at level 3. This is not surprising since seniority and rank are the main determinants of total pay.

TABLE 1

Longitudinal Multilevel Regressions on Natural Log of Total Pay

Intercept model	**Model 0**	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**
Salary in 1997	11.073***	11.108***	10.757***	10.720***	10.720***	10.715***	10.710***
Female on salary in 1997	–	- 0.113***	- 0.015**	- 0.006	- 0.004	–	–
Academic sector on salary in 1997							
Social Science/Psychology	–	–	–	–	–	ref	ref
Pure/Applied Science	–	–	–	–	–	0.002	0.006
Humanities	–	–	–	–	–	0.004	0.000
Medicine	–	–	–	–	–	0.039***	0.041***
Specialized Medicine	–	–	–	–	–	- 0.009	- 0.010
Nursing / Education	–	–	–	–	–	0.012**	0.014***
Econ., Law, Computer Sc.	–	–	–	–	–	0.010	0.002
Others	–	–	–	–	–	0.000	0.002
Female represent. on salary in 1997							
0–29%	–	–	–	–	–	ref	–
30–39%	–	–	–	–	–	- 0.011	–
40%+	–	–	–	–	–	- 0.003	–
Pay grade	0.011***	0.012***	0.012***	0.011***	0.012***	0.012***	0.012***
Change model							
Year	0.052***	0.052***	0.044***	0.041***	0.041***	0.041***	0.041***
Associate professor	–	–	0.141***	0.141***	0.141***	0.141***	0.141***
Full professor	–	–	0.275***	0.274***	0.274***	0.273***	0.273***
Market supplement	–	–	–	0.121***	0.122***	0.103***	0.115***
Female on market supplement	–	–	–	–	- 0.003	–	–

TABLE 1 (continued)

Change model (continued)	**Model 0**	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**
Academic sector on market suppl.							
Social Science/Psychology	–	–	–	–	–	ref	ref
Pure/Applied Science	–	–	–	–	–	- 0.015	- 0.026+
Humanities	–	–	–	–	–	-0.051*	-0.038*
Medicine	–	–	–	–	–	0.047**	0.041*
Specialized Medicine	–	–	–	–	–	0.001	-0.004
Nursing / Education	–	–	–	–	–	- 0.015	- 0.018
Econ., Law, Computer Sc.	–	–	–	–	–	0.043	0.052
Others	–	–	–	–	–	- 0.027	- 0.030*
Female represent. on market suppl.							
0–29%	–	–	–	–	–	ref	–
30–39%	–	–	–	–	–	0.030	–
40%+	–	–	–	–	–	0.014	–
CRC	–	–	–	0.285***	0.293***	0.287***	0.289***
Female on CRC	–	–	–	–	- 0.045	–	–
Variance components							
Within-person	0.0037***	0.0037***	0.0026***	0.0016***	0.0016***	0.0015***	0.0015***
Between person: salary in 1997	0.0403***	0.0380***	0.0051***	0.0040***	0.0040***	0.0038***	0.0038***
Between units: salary in 1997	0.0032***	0.0025***	0.0012***	0.0007***	0.0007***	0.0002***	0.0002***
Deviance	- 23 383	- 23 497	- 30 196	- 35 467	- 35 482	- 35 848	- 35 812
Difference (df)	–	113.86 (1)	6699.94 (3)	5270.11 (2)	15.05 (2)	366.84 (15)	–36.22 (4)
N at level 1 (within-person)	11 170	11 170	11 170	11 170	11 170	11 170	11 170
N at level 2 (individuals)	1 882	1 882	1 882	1 882	1 882	1 882	1 882
N at level 3 (units)	64	64	64	64	64	64	64

*** p < .000; ** p < .01; * p < .05; + p < .10

The coefficient for gender becomes non-significant when receipt of market and CRC premiums are added in model 3. Clearly, gendered access to these supplements contributes to the gender pay gap. Given that we now control for receipt of market premiums and CRC awards, the coefficients for intercept and year respectively reflect the base salary in 1997 and the average yearly increments in base salary. Since the gender coefficient associated with the intercept is no longer significant, we can conclude that there are no gender differences in base salary.

Models 4 and 5 add cross-level interactions. Model 4 reveals no significant difference by gender in the effect of market supplements and CRCs on total pay. The point estimate for CRCs is, however, quite large: –0.045 for women. Given that few chair holders are women (12 out of 53), a significant effect would be difficult to detect in our data. Models 5 and 6 remove non-significant level 2 variables related to gender and focus on level 3 variables – academic sector and percent female within units. Model 5 shows that total salary tends to be higher in Medicine and Nursing/Education than in Social Sciences/Psychology and that the size of market supplements – their effect on total pay – is larger in Medicine and smaller in Humanities than in Social Sciences/Psychology. After controlling for rank, the percent female in a unit does not influence either salary or the size of market supplements. In Model 6, then, we drop proportion female from the final, parsimonious, model. This does not substantially modify the impact of sector of activity though one sector effect becomes significant – a negative coefficient for the "others" sector. The variables in the model account for 58.2% of the intra-individual variance in total salary, 90.6% of the variance between individuals and 94.0% of the variance between units.

This analysis has shown that the effect of gender on pay is explained by gender differences in rank, pay grade at entrance, and access to market premiums and CRCs. It is not due to gender differences in the value of market premiums. In addition, female representation within units is not related to total pay or to the value of pay supplements. Since the gender pay gap is partly attributable to differences in rank and in access to pay supplements, the remainder of the analysis will determine whether male and female faculty members have equal access to full professorships, market premiums, or CRCs.

Promotion to Full Professor

Model 1, Table 2, shows that, before controls, female faculty members were 1.3 times[6] less likely to be granted full professorship. Model 2 adds year of appointment. Faculty members hired between 1985 and 1996 were 1.37 times more likely to become full professors each year than those hired between 1958 and 1972. Adding this control increases the female disadvantage from –0.261 ($p < .01$) to –0.303 ($p < .001$), this because female faculty members were on average hired more recently.

TABLE 2

Cox Regressions of Promotion to Full Professor

	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
	β	Exp(β)	β	Exp(β)	β	Exp(β)	β	Exp(β)	β	Exp(β)	β	Exp(β)
Female	- 0.261**	0.77	- 0.303***	0.74	- 0.198**	0.82	- 0.196**	0.82	- 0.167*	0.85	–	–
Year of appointment												
1958–72	–	–	ref	–	ref	–	ref	–	ref	–	ref	–
1973–84	–	–	0.051	1.05	0.043	1.04	0.112	1.12	0.106	1.11	0.108	1.11
1985–96	–	–	0.316***	1.37	0.291***	1.34	0.294***	1.34	0.288***	1.33	0.284***	1.33
Academic sector												
Social Sciences/Psycho.	–	–	–	–	–	–	ref	–	ref	–	ref	–
Pure/Applied Science	–	–	–	–	–	–	0.606***	1.83	0.561***	1.75	0.592***	1.81
Humanities	–	–	–	–	–	–	0.148	1.16	0.081	1.09	0.145	1.16
Medicine	–	–	–	–	–	–	0.150	1.16	0.151	1.16	0.150	1.16
Specialized Medicine	–	–	–	–	–	–	0.185	1.20	0.136	1.15	0.169	1.18
Nursing/Education	–	–	–	–	–	–	- 0.333**	0.72	- 0.284*	0.75	- 0.312**	0.73
Econ., Law, Computer Sc.	–	–	–	–	–	–	0.565***	1.76	0.500***	1.65	0.560***	1.75
Others	–	–	–	–	–	–	- 0.370**	0.69	- 0.397***	0.67	- 0.382**	0.68
Female representation												
Quintiles 1–3	–	–	–	–	ref	–	–	–	ref	–	–	–
Quintile 4	–	–	–	–	0.012	1.01	–	–	0.038	1.04	–	–
Quintile 5	–	–	–	–	- 0.337***	0.71	–	–	- 0.159	0.85	–	–
Female*female representation												
Male	–	–	–	–	–	–	–	–	–	–	ref	–
Female quintiles 1–3	–	–	–	–	–	–	–	–	–	–	- 0.097	0.91
Female quintile 4	–	–	–	–	–	–	–	–	–	–	- 0.204	0.82
Female quintile 5	–	–	–	–	–	–	–	–	–	–	- 0.272	0.76
–2Log likelihood	9553.7		9541.9		9528.4		9478.3		9475.7		9477.3	
χ^2 (df)	9.98 (1)		22.10 (3)		34.18 (5)		89.28 (10)		91.30 (12)		89.96 (12)	
N	1 048		1 048		1 048		1 048		1 048		1 048	

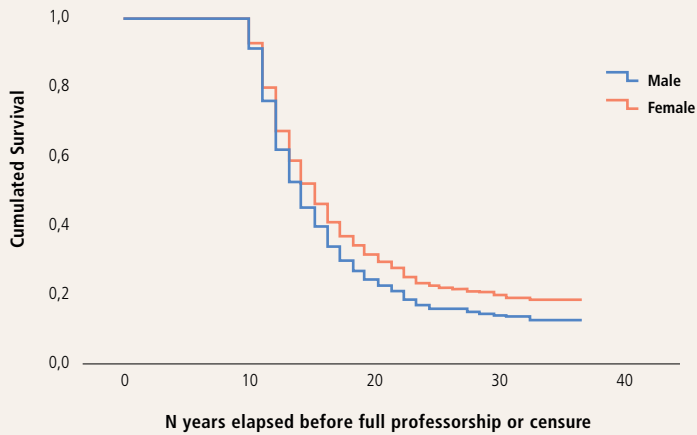
*** p < .000; ** p < .01; * p < .05; + p < .10

Model 3 adds female representation. It shows that faculty members working in units where female representation was highest were 1.4 times less likely to become full professor than those in units where female representation was lowest ($p < .001$). Adding this variable substantially reduces the estimate of female disadvantage. Model 4, which replaces the proportion female with academic sector, shows that time to promotion was lower in Pure and Applied Sciences and in Economics, Law and Computer Science than in Social Sciences/Psychology, and higher in Nursing/Education and in the "Other" sector. Model 5 estimates the joint effects of academic sector and female representation. It shows that the negative effect of proportion female disappears when sector is added. Evidently, women are concentrated in sectors for which promotion rates are low. Model 6 provides a final test of the influence of female representation within units by replacing the gender and female main effects with an interaction term. The results indicate that the interaction is not significantly related to time to promotion.

Our final, parsimonious model is 4. The corresponding survival curves are displayed in Figure 1. After ten years of seniority the proportion of men promoted increases progressively relative to that of women, then after 15 years the difference stabilizes.

FIGURE 1

Survival Function of Time to Promotion to Full Professor (Males and Females)



Access to Market Supplements and CRCs

Table 3 reports estimates of the determinants of access to either a market supplement or a CRC during the observation period. Model 0, the base model, shows that year is positively related to access to market supplements or CRCs because access to these supplements increased from 1997 to 2006. Model 1 adds gender. The coefficient for female is negative and significant ($p < .05$). Without controls, female faculty members were 1.3 times less likely to access market supplements

or CRCs ($p < .04$). Model 2 adds rank. Being an associate or a full professor rather than an assistant professor was negatively related to access to market supplements or CRCs ($p < .05$); assistant professors were more likely to have them. The coefficient for gender is hardly affected by the addition of rank (but the significance level shifts from the .05 to the .01 threshold).

Given the association between proportion female within units and sector,[7] these two level 3 variables are entered separately in models 3 and 4, and then jointly in model 5. In model 3, the level 3 variance is reduced by 15.6% when proportion female is added to the analysis. Compared with their counterparts in departments where less than 30 percent of faculty are female, professors in units with 30–39% female faculty members are less likely to have access to market supplements. However, only the coefficient for males reaches statistical significance. Furthermore, in units with 40 percent or more female faculty members, the odds of accessing market supplements or CRCs are significantly lower for both males (2.2 times) and females (2 times).

Model 4 replaces the proportion female by academic sector. Compared to model 2 (which contains no level 3 variables), the addition of academic sector reduces level 3 variance by 79.5%. As expected, academic sector is a major contributor to the explanation of access to market supplements or CRCs. Compared to the Social Sciences/Psychology sector, access to supplements was 6.6 times higher in Economics, Law and Computer Science ($p < .001$), 5.9 times higher in Specialized Medicine ($p < .001$), but 1.8 and 1.5 times lower in Humanities ($p < .05$) and Medicine ($p < .10$) respectively. The model also shows that the impact of being female on access to supplements and CRCs varies by sector. As compared to faculty members in Social Sciences/Psychology, those in the 'Others' sector were 3.1 times less likely to have access to market supplements or CRCs ($p < .01$).

Finally, model 5 contains estimates of the joint effects of female representation and sector on access to supplements or CRCs. Relative to model 2, the level 3 variance estimate shrinks by 83.4% when both level 3 variables are included in the analysis. The joint effect of the variables is thus larger than their separate impact, which means that they both contribute to explaining access to market supplements and CRCs. The net impact of proportion female is significant only for females. Women working in units with 40 percent plus females were 3.8 times less likely to have access to pay supplements than those working in units with less than 30% of women ($p < .05$). Furthermore, adding proportion female brings the effect of gender within Medicine to significance; female faculty members in Medicine were 2 times less likely to access market supplements or CRCs than faculty members in the reference sector ($p < .05$). Both female representation and sector, then, contribute to the explanation of gender differences in access to pay supplements.

TABLE 3

Multilevel logistic regressions of the presence of market supplements and CRCs

	Model 0		Model 1		Model 2		Model 3		Model 4		Model 5	
Intercept model	β	**Exp(β)**	β	**Exp(β)**	β	**Exp(β)**	β	**Exp(β)**	β	**Exp(β)**	β	**Exp(β)**
Intercept	- 1.24***	0.29	- 1.17***	0.31	- 1.00***	0.37	- 0.77**	0.46	- 1.26***	0.28	- 1.16***	0.31
Academic sector on intercept												
Social Science/Psycho.	–	–	–	–	–	–	–	–	ref	–	ref	–
Pure/Applied Science	–	–	–	–	–	–	–	–	0.31	1.36	0.22	1.25
Humanities	–	–	–	–	–	–	–	–	- 0.59*	0.55	- 0.44+	0.64
Medicine	–	–	–	–	–	–	–	–	- 0.39+	0.68	–0.43+	0.65
Specialized Medicine	–	–	–	–	–	–	–	–	1.78***	5.93	1.75***	5.76
Nursing/Education	–	–	–	–	–	–	–	–	- 0.41	0.67	- 0.34	0.71
Econ., Law, Computer Sc.	–	–	–	–	–	–	–	–	1.88***	6.55	1.90***	6.69
Others	–	–	–	–	–	–	–	–	- 0.19	0.83	- 0.21	0.81
Female represent. on intercept												
0–29%	–	–	–	–	–	–	ref	–	–	–	ref	–
30–39%	–				–	–	- 0.53*	0.59	–	–	- 0.34	0.71
40%+	–	–	–	–	–	–	- 0.71*	0.49	–	–	- 0.13	0.88
Female on intercept	–	–	- 0.28*	0.76	- 0.33**	0.72	- 0.11	0.89	- 0.30	0.74	0.17	1.19
Acad. sector on female												
Social Science/Psycho.	–	–	–	–	–	–	–	–	–	–	–	–
Pure/Applied Science	–	–	–	–	–	–	–	–	0.36	1.44	–0.09	0.91
Humanities	–	–	–	–	–	–	–0.28	0.76	–0.32	0.73	–	–

TABLE 3 (continued)

	Model 0		Model 1		Model 2		Model 3		Model 4		Model 5	
Intercept model (continued)	β	Exp(β)	β	Exp(β)	β	Exp(β)	β	Exp(β)	β	Exp(β)	β	Exp(β)
Medicine	–	–	–	–	–	–	–	–	- 0.57	0.56	- 0.71*	0.49
Specialized Medicine	–	–	–	–	–	–	–	–	0.11	1.12	- 0.24	0.79
Nursing/Education	–	–	–	–	–	–	–	–	- 0.02	0.98	0.02	1.02
Econ., Law, Computer Sc.	–	–	–	–	–	–	–	–	0.28	1.32	0.14	1.15
Others	–	–	–	–	–	–	–	–	- 1.14**	0.32	- 1.34**	0.26
Female represent. on female												
0–29%	–	–	–	–	–	–	ref	–	–	–	ref	–
30–39%	–	–	–	–	–	–	- 0.24	0.79	–	–	- 0.45	0.64
40%+	–	–	–	–	–	–	- 0.77*	0.46	–	–	- 0.82*	0.44
Change model												
Year	0.08***	1.08	0.08***	1.08	0.09***	1.09	0.09***	1.09	0.11***	1.11	0.11***	1.11
Associate professor	–	–	–	–	- 0.20*	0.82	- 0.20*	0.82	- 0.23*	0.79	- 0.23*	0.80
Full professor	–	–	–	–	- 0.27*	0.76	- 0.26*	0.77	- 0.28*	0.75	- 0.27*	0.76
Variance components												
Between person: intercept	7.104***		7.081***		7.153***		7.172***		7.201***		7.227***	
Between units: intercept	3.370***		3.236***		3.261***		2.751***		0.668***		0.540***	
N at level 1 (within-person)	11 170		11 170		11 170		11 170		11 170		11 170	
N at level 2 (individuals)	1 882		1 882		1 882		1 882		1 882		1 882	
N at level 3 (units)	64		64		64		64		64		64	

Estimation using full Penalized Quasi-Likelihood (PQL) with Bernoulli distribution at level-1. Parameter estimates are reported from the population-average model.

*** p < .000; ** p < .01; * p < .05; + p < .10

Discussion and Conclusion

We provide a first analysis of the potential impact on the pay gap of two recent trends among Canadian universities, the increased use of market supplements and the implementation of the CRC program. We estimate the extent to which gender differences are associated with the formalization of pay components, something not previously done in analyses of faculty pay. We also analyze the effect on remuneration of the proportion of female professors in academic units, something also not previously done for faculty. Our use of multilevel analysis allowed adequate controls for the gendered distribution of professors across academic units and produced reliable estimates. In addition, using cross-level interactions, we were able to determine how gender pay differences vary according to the characteristics of academic units. Other research either has not analyzed cross-level interactions (Umbach, 2007) or taken into account the unit level (Porter, Toutkoushian and Moore, 2008).

Hypothesis 1 suggested that formalized pay-setting policies reduce gender differences in earnings. Base pay at the University studied is determined through collective bargaining. It is highly formalized. However, when someone is reviewed for promotion involves substantial discretion, as do judgments with respect to what constitutes a suitable track record to warrant promotion. The award of market supplements or CRCs is highly discretionary. We, therefore, expected no difference in base pay by gender, some difference in promotion rates, and a larger difference in access to pay supplements and their amounts. Consistent with Hypothesis 1, we found no gender differences in base pay, some evidence that it took longer to promote women, and large differences in the probability of receiving a supplement. However, we find no gender difference in the amounts of supplements. This result is inconsistent with our hypothesis. Given the large gender difference in the probability that a supplement will be awarded, however, we think this result requires further research rather than the rejection of Hypothesis 1. It may indicate that, while the attribution of supplements is not formalized, the amount of such supplements is indeed rather formalized as can be seen from the concentration of the distribution in specific amounts ($5,000, $10,000, etc.).

Our results tend to confirm Hypothesis 2 which suggested that larger proportions of females tend to depress remuneration. After controls, proportion female reduced the likelihood that either a market premium or CRC would be awarded. Interestingly, men's access to supplements and CRCs was the same, whatever the proportion female in a unit. This suggests that the relationship between remuneration and female representation was not a consequence of a depreciation of stereotypically feminine activities, though the pay of women

in stereotypically feminine activities may have been depreciated. That is, there may be mechanisms that shelter males in feminized occupations from wage depreciation.

Two factors may have produced the results for female representation. One is the University's affirmative action policy. A law, promulgated in the province where the University is located, mandated increased employment of females in fields where they were underrepresented. This may have generated inter-university competition for females in the relevant fields which, in turn, would have improved the bargaining position of women in those fields. This advantage would only have applied to market supplements because they are the sole negotiable pay component at the institution. Conversely, women in units disproportionately composed of females may not have benefited from this bargaining advantage because the policy did not apply to their units. Given the informal character of the University's market supplements policy, access to administrative positions might plausibly have facilitated access to information on the policy and ways to exploit it. To the extent that women are less likely to have access to these networks or to key institutional positions, they might have been less likely to secure market supplements.

At the institution studied, then, the rules of the collective agreement mean that the base pay of men and women does not differ. In contrast, promotion decisions and pay supplements are discretionary and they do seem to disadvantage women. These discretionary outcomes, of course, ought to be based on performance judgments. It is possible that women's research performance is inferior to men's; family obligations provide a standard reason for expecting that to be the case.

Consider, first, the issue of research productivity. Some studies have found gender gaps in research productivity (Cole and Zuckerman, 1984; Nakhaie, 2002, 2007; Xie and Shauman, 2003). While there is not space for a detailed review of the research on gender differences in research productivity, there are reasons for thinking that controlling for productivity would not change our results.

Previous research on gender gaps in publication draws data from multiple institutions. First, Nakhaie (2002) has shown that gender differences in publication rates are partly accounted for by differences in university types. Women have been disproportionately present in universities with low publication rates. Since this study deals with a single university, this effect is eliminated. Second, there is evidence from this University that research activity has not differed by gender (Doucet, Durand and Smith, 2008).[8] Finally, research productivity may be a "corrupt" variable. There is some evidence that women receive less than their fair share of research funding (MIT, 1999). There is also evidence that their research

contributions have been less valued than those of males (Wennerås and Wold, 1997; Nakhaie, 2007). Insofar as this is the case, controlling for productivity may lead to an underestimate of female disadvantage.

It remains the case that, for this research, no direct measure of productivity was available. What about indirect evidence, that women's academic performance has been compromised by their family obligations? That this is the case is frequently argued (Ginther and Hayes, 2003; American Sociological Association, 2004; Perna, 2005). Being an academic implies a heavy workload and, sometimes, high mobility, which can be difficult to reconcile with family responsibilities. In addition, child bearing years usually coincide with a period when academics are working towards becoming tenured. We cannot exclude the possibility that the gender differences observed in the present research are at least partially due to the absence of controls for family constraints. But there are sound reasons for doubting that.

First, knowing the likely effects of child-rearing on their careers, female faculty use strategies to minimize its disruption. Female professors are less likely than males to become parents and when they do, they have fewer children (Ginther and Hayes, 2003; Drago and Colbeck, 2003). Many postpone having children until after tenure (Armenti, 2004). They may also delay the beginning of their careers to have a first child and wait until after tenure to have a second (Drago and Colbeck, 2003). Survey data collected at the institution under study in 2002 revealed gender differences in the presence of children among faculty: 49.6% of surveyed women were childless compared to 42.6% of men. However, among those who were parents, virtually no difference by gender was found in the presence of young children or number of children.

Universities increasingly have policies that allow faculty to stop the tenure clock in response to childcare obligations. A study of a large American research university found that use of that option was inversely related to pay for both men and women (Flaherty, Leslie and Kramer, 2010). Drago and Colbeck (2003) provide further evidence of adaptive behaviour. They found that women were more likely than men to refrain from using reduced teaching load provisions and did so to avoid potentially detrimental effects to their career.

There is, however, evidence of damage to female careers from child care. Ginther and Hayes (2001) found lower promotion rates among female professors with children than their childless counterparts, Ginther and Khan (2009) that having school-aged children fifteen years post-Ph.D. was positively associated with the odds of promotion to full professor for male faculty in engineering, but negatively for women, and Perna (2005) that being married or having

children was positively related to the odds of promotion among males, but not among females. However, two recent studies report no relation between being a parent and promotion to full professor, for either sex (Wolfinger, Mason and Goulden, 2008; Morrison, Rudd and Nerad, 2011).

We have some evidence relevant to childcare effects on performance and promotion from our case study. First, the likelihood of negative effects on productivity is reduced by the fact that, after childbirth, women are entitled to a reduced teaching load for the two subsequent years. Second, separate research conducted at the institution under study found no relation between family constraints and the receipt of a market supplement (anonymized self-citation). Third, we have examined detailed data on maternity leaves. The most striking result is how few women take maternity leaves. During the period studied, on average, there were 8.6 maternity leaves per year; about 7% of female assistant professors and 2.5% of all female professors took one. Detailed examination of the institution's maternity leave data revealed that no woman took more than one semester of maternity leave and only one asked for a delayed tenure review. Because of the small number of cases, we could not estimate the effect of maternity leave by adding the variable to the models presented earlier. Descriptive data, however, revealed that women who had taken a maternity leave were more likely to have received a market premium than their counterparts who had not taken one. This reflects the fact that the use of market premiums increased during the period of study and younger faculty tend to take maternity leaves. Our general conclusion is that it is very unlikely that maternity explains the female disadvantage in outcomes of discretionary decisions that this study identifies.

These results from a single Canadian research university are consistent with continuing female pay disadvantage, even in an ostensibly 'progressive' institutional context. We may, in fact, underestimate female disadvantage because we control for entry salary. But it is possible that the salaries of women at the point of hire are lower than those of men. Female disadvantage originates in pay supplements, the allocation of which is not formalized, and in employment in units with higher female representation. Evidently, the study of other universities and organizations is necessary to determine the extent and magnitude of these disadvantages.

Notes

1 See <http://www.unb.ca/PAR-L/PCR1.htm>.

2 These two independent variables are used in the analysis of total salary to determine whether there are gender differences in the amounts of market supplements and CRCs. Then, the two variables are combined into one dependent variable – the presence of a pay supplement – which is finally analyzed to determine whether there is a pay gap and, if there is, what explains it.

3 More information on these measures and descriptive statistics for all variables are available from the first author upon request.

4 This sector includes Optometry, Pharmacy, Dentistry and Veterinary Medicine.

5 These variances are calculated for each level by dividing the difference between the unexplained variances in models 0 and 1 by the variance to be explained in model 0. Thus, the level 2 variance is (0.0403 – 0.0380)/0.0403 = 0.057.

6 To make the description of the results more readily understandable, the negative odds (exp β of less than 1) are presented as 1/exp β. A value of 0.77 for exp β gives a value of 1.3 for 1/exp β.

7 The proportion of women professors differ significantly by sector ($F(7, 56) = 3.871$ $p < .01$, results not shown).

8 The analysis did not include publication rates but did use several indicators of research activity – research grants, research contracts, use of research assistants, research agents or post-doctoral fellows, and membership in a research team.

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SUMMARY

Pay Structure, Female Representation and the Gender Pay Gap among University Professors

In this case study of faculty at a large Canadian research university we examine the extent to which the gender pay gap varies with the formalization of remuneration practices and female representation within units.

We estimate the respective contributions to the gender pay gap of base pay, access to the rank of full professor, access to and amounts of market supplements, and Canada Research Chairs. These remuneration components differ in their degree of formalization. We also examine variations in the gender pay gap across departments with different proportions of females. The use of multilevel analysis allows for the estimation of the respective contributions of individual and institutional determinants of pay.

Mixed support is found for the first hypothesis – that the magnitude of the gap varies with the degree of formalization in remuneration components. The second hypothesis that, all else being equal, the level of female representation in a given context is negatively related to remuneration is supported. Overall, the results are consistent with continuing female pay disadvantage, even in an ostensibly 'progressive' institutional context.

KEYWORDS: gender pay gap, organization, pay structure, female representation

RÉSUMÉ

Structure salariale, représentation féminine et écarts de rémunération selon le genre chez les professeurs d'université

Cette étude de cas des professeurs d'une grande université de recherche canadienne vise à déterminer dans quelle mesure l'écart de rémunération selon le genre varie en fonction du degré de formalisation des pratiques de rémunération et de la représentation féminine au sein des unités.

Les contributions respectives de diverses composantes des écarts dans la rémunération sont examinées, soit le salaire de base, l'accès au rang de professeur titulaire, l'accès aux primes de marché et aux Chaires de recherche du Canada et leurs montants. Ces composantes de la rémunération sont caractérisées par des degrés variés de formalisation. Les variations de l'écart sont aussi examinées en fonction de la représentation relative des femmes professeurs au sein des unités. L'utilisation de l'analyse multiniveaux permet d'estimer les contributions respectives de déterminants individuels et institutionnels de la rémunération.

Les résultats sont mitigés en ce qui a trait à la première hypothèse selon laquelle l'ampleur de l'écart varie en fonction du degré de formalisation des composantes de la rémunération. La seconde hypothèse, selon laquelle, toutes choses étant égales par ailleurs, la représentation des femmes dans un contexte donné est négativement liée à la rémunération, est confirmée. Dans l'ensemble, les résultats concordent avec l'existence d'un désavantage féminin en ce qui a trait à la rémunération et ce, même dans un contexte institutionnel apparemment favorable à l'égalité.

MOTS-CLÉS : écart de rémunération selon le genre, organisation, structure salariale, représentation féminine

RESUMEN

Estructura salarial, representación femenina y brecha de remuneración según el género en los profesores de universidad

El presente estudio de caso de profesores de una universidad de investigación canadiense pretende determinar en qué medida la brecha de remuneración según el género varía en función del grado de formalización de las prácticas de remuneración así como de la representación femenina al interior de las unidades académicas.

En nuestro artículo se examinan cuáles son las contribuciones de diversos componentes de la remuneración a esta brecha, entre ellas se encuentran: el salario-base, el acceso al rango de profesor titular, el acceso a las primas de mercado y a las Cátedras de investigación de Canadá y sus respectivos montos. Estos componentes de la remuneración están caracterizados por tener diferentes grados de formalización. Las variaciones de la brecha son también examinadas en

función de la representación relativa de las mujeres profesoras en el seno de las unidades académicas. La utilización de un análisis multiniveles permite estimar las contribuciones respectivas de los determinantes individuales e institucionales de la remuneración.

Los resultados son mitigados en lo que respecta a la primera hipótesis, según la cual la magnitud de la brecha varía en función del grado de formalización de los componentes de la remuneración. La segunda hipótesis, según la cual a condiciones iguales, la representación femenina en un contexto dado está ligada negativamente a la remuneración, es confirmada. En su conjunto, nuestros resultados muestran la existencia de una desventaja femenina en cuanto a la remuneración, incluso dentro de un contexto institucional aparentemente favorable a la igualdad.

PALABRAS claves: brecha de remuneración según el género, organización, estructura salarial, representación femenina