

## THE FIRST STEPS INTO A 'LEAKY PIPELINE'- A LONGITUDINAL STUDY OF THE PIPELINE WITHIN A DANISH UNIVERSITY<sup>1</sup>

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### ABSTRACT:

Research shows that the higher the level of academic positions at universities the lower the percentage of women among employees also applies at Danish universities. This may be due to a historical backlog or merely to a 'leaky pipeline', as earlier studies have revealed that an increasing proportion of women among university graduates has not resulted in an increasing proportion of women among university academics. This study based on data from Aalborg University documents by the use of longitudinal analyses that the 'pipeline' leaks women at the very first steps of the career ladder.

**KEYWORDS:** Gender Inequality, Academic Staff at Universities, Longitudinal Study.

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## INTRODUCTION

### Aalborg University as a case

A predominant explanation of the unequal gender profile at Danish universities was – for many years – a time lag. It was expected that the proportion of women among researchers would increase with the increasing number of female candidates with academic education. The problem of the gender-biased staff at the universities would – as it were – be solved automatically in a matter of time (e.g. Ståhle (1993)). However, this expectation has not been fulfilled, and it has become clear that there exists no such self-correcting automatic (Borchorst, Christensen & Rasmussen (1992); Jensen (1997); Henningsen et al. (1998)). An increasing percentage of women among graduates in higher education has not resulted in a similar increase either in the lower research positions as PhD fellows or assistant professors or in the higher positions as associate professors and professors. Hence the idea that what you pour into a pipeline at one end will also come out the other end has been challenged as the pipeline leaks along the way (see Henningsen & Højgaard (2002)). Furthermore, the gender-biased recruitment to research positions has not only proved to be remarkably stable in Denmark, it also lags behind countries Denmark is usually compared with (European Commission (2006); European Commission (2009)). The percentage of women in a professor position is considerably lower in Denmark than in other Nordic countries (Langberg (2008)).

In 2008 Aalborg University commissioned a research project of gender equality or inequality in recruitment of staff to Aalborg University. The project combines a quantitative study based on longitudinal methods and a qualitative study based on interviews with academic staff. The purpose was to shed light on the gender bias in recruitment, and to investigate the pipeline. We were responsible for the quantitative study, and we believe that the results of our research can contribute to the general knowledge of the development of the gender imbalance of academic staff in universities, although Aalborg University in some ways is a special case. The results presented here are based on our research report (Emerek & Larsen (2008)).

Aalborg University (established in 1974) is the youngest university in Denmark – and as the overall number of academic staff in the various positions has increased by more than 100% along with the increased number of female graduates, it should have been possible to achieve a gender-balanced academic staff. However, this is not the case as table 1 reveals. The percentage of women in the academic staff at Aalborg University declines from one job category to the next forming the characteristic pyramid-shaped gender profile: the higher the position the lower the percentage of women among employees – also during the last 20 years, where the numbers of graduates and assistants, associates and full professors have grown rapidly.

**TABLE 1. THE PERCENTAGE OF WOMEN AMONG GRADUATES AND ACADEMIC STAFF AT AALBORG UNIVERSITY 1980-2007 (TOTAL NUMBER OF GRADUATES AND STAFF IN BRACKETS)**

	Year									
	1980	1985	1990	1995	1997	1999	2001	2003	2005	2007
<b>Graduate</b>	-	18 (239)	24 (543)	32 (735)	38 (755)	35 (813)	36 (993)	39 (1095)	41 (1376)	46 (1591)
<b>PhD fellow</b>	-	-	-	32 (31)	21 (38)	21 (61)	25 (59)	26 (77)	26 (88)	30 (100)
<b>Assistant professor</b>	26 (61)	28 (40)	16 (69)	22 (99)	27 (92)	18 (136)	26 (155)	25 (193)	27 (164)	26 (112)
<b>Associate professor</b>	10 (255)	14 (253)	13 (282)	13 (327)	13 (343)	16 (367)	16 (366)	17 (389)	19 (426)	20 (400)
<b>Professor</b>	11 (19)	7 (28)	3 (39)	0 (57)	1 (67)	2 (82)	5 (110)	5 (121)	6 (119)	9 (127)

*Sources:* Data from 1980, 1985 and 1990 (Borchorst et al. (1992)), data from 1995 to 2007 from Aalborg University's administrative register of students and employees.

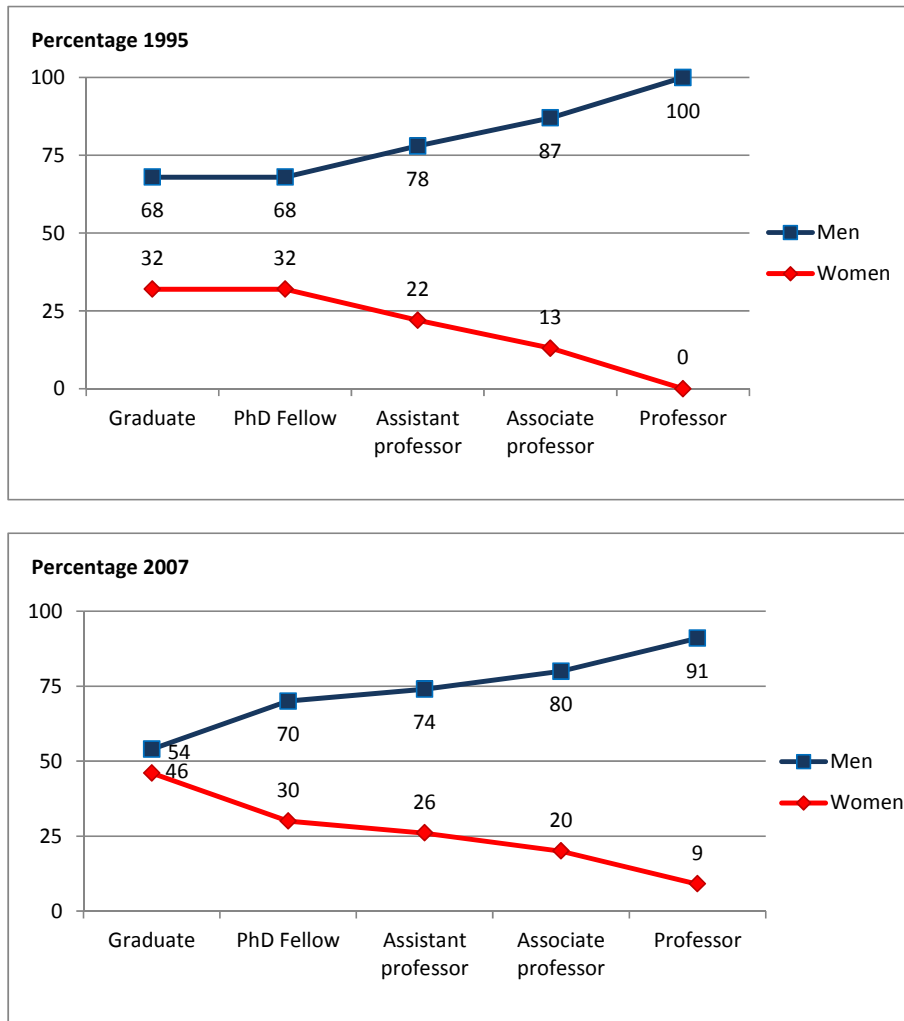
The increase of women among graduates resulted in an almost equal gender distribution in 2007. This improved potential recruitment basis of women at the graduate level has, however, not resulted in a higher proportion of women among PhD fellows or assistant professors. Over the period 1995-2007 women held 21-32% of the PhD positions and 18-27% of the assistant professor positions.

At associate professor level there has been an increase in women's share of the positions – from 10% in 1980 to 20% in 2007. Even though the number of female full professors has varied during this period, and the proportion of women among full professors shows an increasing tendency in later years, the proportion of women among full professors still remained markedly low.

The table thus reveals a clear under-representation of women in academic positions at Aalborg University, where the gender gap is still persistent despite e.g. the increased number of staff positions. Aalborg University remains characterised by strong vertical gender segregation in academic positions. Figure 1 (next page) illustrates this point with a leaky pipeline at Aalborg University in 1995 as well as in 2007. Although the leak is somewhat reduced in 2007 compared with 1995 the overall pattern is the same, and the most notable difference between the two 'pipelines' is the difference between the proportion of women among graduates and PhD fellows in 2007 as compared with 1995.

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**FIGURE 1. PROPORTION OF WOMEN AND MEN AMONG GRADUATES, PHD-FELLOWS, ASSISTANT PROFESSORS, ASSOCIATE PROFESSORS AND PROFESSORS AT AALBORG UNIVERSITY IN 1995 AND 2007**

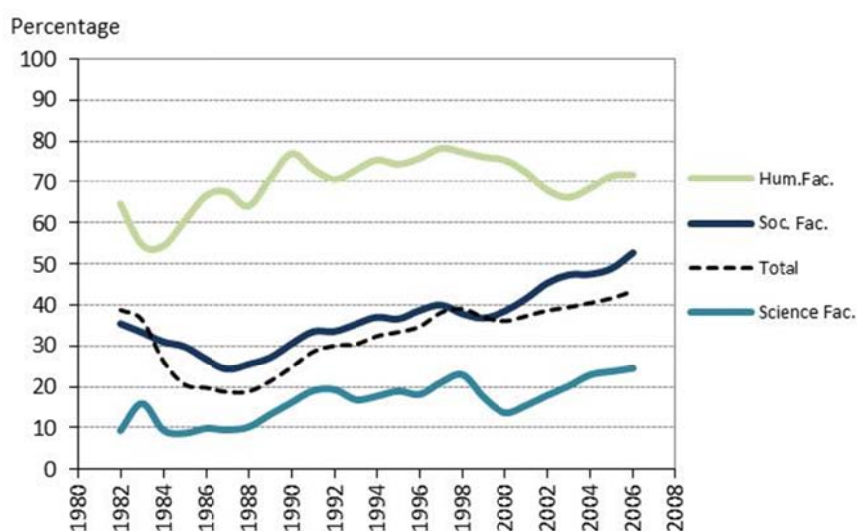


Sources: data from Aalborg University's administrative register of students and employees.

Aalborg University is situated in the North of Jutland – distant (in Danish measures) from the capital of Denmark, and as Danes are reluctant to move after new jobs (Andersen, 2010), Aalborg University has to rely mainly on internal recruitment to secure sufficient applicants for the various positions at the university. Research shows that 80% of assistant professors employed in 2001-2006 have had previous employment at Aalborg University – the percentage was highest at the Faculty of Humanities (almost 100%) and lowest at the Faculty of Science and Technology (76%). Although internal recruitment is not exclusive for Aalborg University it is 10-20% higher than for other Danish universities (Stähle (2007)). At the same time

Aalborg University differs from other Danish universities as it until recently had only three faculties: the Faculty of Science and Technology, the Faculty of Social Science and the Faculty of Humanities. The gender profile, however, among graduates at Aalborg University is similar to gender profiles at other universities in Denmark within the faculties (Stähle (1998; 1999; 2005 and 2007)). The overall proportion of women among graduates at Aalborg University covers significant differences in the gender distribution among graduates from the three faculties (see figure 2).

**FIGURE 2. PROPORTION OF WOMEN AMONG GRADUATES AT AALBORG UNIVERSITY 1981-2007**



Sources: Calculations based on data from Aalborg University.

Women represent about 70% of graduates from the Faculty of Humanities throughout the period. At the faculty of Science and Technology the population of female students represents up to 25%. Over the period 1982-2006 30 to 50% of all graduates at the Faculty of Social Science were women, and here – as at the Faculty of Science and Technology – there has been a continuous upward trend since 2000. These simple descriptive analyses reveal that the basis for an increasing – and higher – female percentage of the academic staff at all levels has existed for many years at Aalborg University. Thus Aalborg University is an interesting case, and the results of the research project (commissioned by the university itself) can be useful as part of a new knowledge as to where, how and why the ‘university pipeline’ leaks in relation to a gender-balanced representation. The gender-biased profile at Aalborg University can be explained not only as a historical backlog, but points to a ‘leaky pipeline’, where women gradually drain from the university’s career ladder. This article may thus contribute to fill the gap as to why women disappear from the pipeline. We will concentrate on the first and mandatory steps on the university career ladder.

The first step of the university career ladder has, however, changed within the last 30 years. Until 1998 employment as assistant professor was the first possible employment step.<sup>4</sup> In 1998 the PhD student grant was, however, changed to a regular position at the Danish universities and from then onwards a Danish PhD fellow is employed on normal employment conditions – with a three-year contract including e.g. a pension scheme and right to maternity leave.<sup>5</sup> Between 1988 when the PhD degree was introduced in Denmark and 1998 PhD students had (publicly financed) grants like other Danish students. From 1998 the employment as a PhD fellow is the first real employment at a university, and a PhD degree or qualifications corresponding to this degree have gradually become a necessary qualification for employment as assistant professor.

Therefore, in this article we focus on gender differences in transition from graduate to PhD fellow (including PhD students) (section 3) and to assistant professor (section 5). As a PhD degree today is a necessary precondition for employment as assistant professor, we will also present an analysis of the possible gender difference in the completion of the PhD programme (section 4). We present our conclusions in section 6.

## 1. DESIGN, DATA AND METHOD

The number of studies using large datasets and multivariable longitudinal techniques is limited within the field of gender segregation (Meulders et al. (2010)). We do, however, investigate the question of a leaky pipeline in a new and more adequate way by applying a longitudinal design and multivariate regression models. By this design it has been possible to compare the academic career tracks of female and male graduates and control for graduation year, faculty, academic abilities etc.

Our study includes 14,773 persons, who graduated from Aalborg University in the period 1981-2005. We have followed the graduates for a period of 3-17 years from graduation to potential employment as PhD fellows or assistant professors<sup>6</sup> at Aalborg University, and PhD students/fellows from their employment in PhD positions (or enrolment as PhD students) until they receive their PhD degree.

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<sup>4</sup>We do not include the position as research assistant as a real first step, as this position is an 'assistant' position – and normally does not include own individual research.

<sup>5</sup>The PhD fellows in Denmark are normally employed by a university or/and by a private enterprise. The salary is around DDK 325,000 a year (equalising around 43,000 EURO), which is a normal/average salary for a graduate in the first years after graduation. The main obligation for a PhD fellow is to fulfil a PhD education, deliver a PhD dissertation, and defend this dissertation to get the PhD degree. Beside this the PhD fellow has to execute tasks for the institutions, normally corresponding to a semester's full teaching (840 hours of work) (Finansministeriet (2000)). Although a PhD programme usually lasts three years, quite a few PhD fellows take longer to finish their degree, some are employed as research assistants before and after their employment as PhD fellows. Self-financed PhD programmes are uncommon in Denmark.

<sup>6</sup>The category 'assistant professor' in our study also includes post doctoral positions (post.doc.). These positions are also temporary, and may be of shorter duration than the four-year assistant professor profession. A post.doc. position may include teaching and thus also qualify to an associate professor position. The available data do not allow a differentiation between post.doc. positions and assistant professors.

The study is based on data from Aalborg University's administrative register of students and employees combined with data from longitudinal registers from Statistics Denmark. This is possible due to the Danish person identity system, where all residents have a unique personal number, which follows them from the cradle to the grave, and which makes it possible to match individual information from various administrative registers and create population-based panel data.<sup>7</sup>

The longitudinal dataset covers the period 1981-2007 and enables us to follow graduates and PhD students/fellows on a yearly basis. Various factors have been included in the study inspired by results from previous generic studies of educational attainments. Data from Aalborg University's registers include information for each graduate on: graduation year, faculty, average marks, student jobs at Aalborg University, employment in a PhD fellowship or enrolment as PhD student at Aalborg University, a PhD degree and employment as assistant professor. This information has been linked to data from Danish administrative registers at Statistics Denmark on graduates' residency, number of children and parental educational attainment.<sup>8</sup> An overview of variables is shown in Annex table 1.

The large panel dataset enables us to follow graduates on a yearly basis from completion of their master's programme at Aalborg University until they emigrate, die or information ends in 2007. We use a Cox regression model, which is an appropriate model in the analysis of event histories. The Cox regression model is based on the estimation of hazard rates and generally describes the effect of various explanatory variables on the risk of an event occurring. The graduates' history is broken up into a set of time intervals in which an event (e.g. entering a PhD position) either did or did not occur. The hazard rate describes the probability of graduates experiencing an event in a time interval (given that it has not already occurred). The Cox regression model is based on the hazard function ( $h(t)$ ) and can be written (including time-dependent covariates) as:

$$h_i(t) = h_0(t) \exp(\beta \mathbf{x}_i + \gamma \mathbf{z}_i(t)) \quad (1)$$

where  $h_0(t)$  is the baseline hazard,  $h_i(t)$  the hazard for person  $i$ ,  $\beta$  are the parameters for the time independent covariates  $\mathbf{x}_i$  (as for instance gender) and  $\gamma$  are the parameters for the time dependant covariates  $\mathbf{z}_i$  (as for instance residency).

The risk ratio for a person ( $i$ ) compared with a person in the baseline reference group for a transition from one position to another (for instance from graduate to assistant professor) is

$$R_i(t) = \exp(\beta \mathbf{x}_i + \gamma \mathbf{z}_i(t)) \quad (2)$$

This risk ratio will give an estimate of the relative 'risk' of e.g. women getting an assistant professorship compared to men. A risk ratio of one means there is no

<sup>7</sup>Researchers employed at Danish universities and research institutes can get access to these data from Statistics Denmark under a set of strict rules and regulations ([http://www.dst.dk/upload/introduktion\\_til\\_forskningsservice\\_001.pdf](http://www.dst.dk/upload/introduktion_til_forskningsservice_001.pdf)).

<sup>8</sup>The unique personal number also makes it possible to link data of graduates with data about their parents, and include data on the parent's highest completed level of education in the analyses.

difference between the two groups, whereas a risk ratio greater than one means that women have a greater chance of getting an assistant professorship, whereas a risk ratio lower than one means that women are less likely to get an assistant professorship.

In the article we discuss the results of the study of three events/transitions (as pointed out earlier): 1) from graduate to PhD student/fellow 2) from enrolment as PhD student/fellow to PhD graduate and 3) from graduate to assistant professor. The panel data for the analysis of the first and third transition include all Aalborg University graduates from 1981 to 2005, 2003 respectively, while the panel data for the analysis of the second transition include all Aalborg University graduates, who were PhD students and fellows at Aalborg University from 1988 to 2004. The time span in the datasets ensures that all persons in the datasets have a 'fair' chance of getting a PhD fellowship, and an assistant professorship and a PhD degree before 2007, where the information from Aalborg University ends and data are censored.

Although the vast majority of graduates from Aalborg University may not want – or do not have the ability for an academic career at Aalborg University – all graduates from Aalborg University are recognised as potential PhD students/fellows and assistant professors at Aalborg University. Thus a large percentage of data will technically be right censored, which can be handled by applying longitudinal event models (like the Cox regression model). Furthermore, these analytical methods allow a full use of the dataset, since time-dependent covariates can be included. This applies, for example, to a graduate's place of residence, which may change during the studied periods, and which may be relevant as to whether he/she applies for a PhD fellowship at the Aalborg University and finishes with a PhD degree.

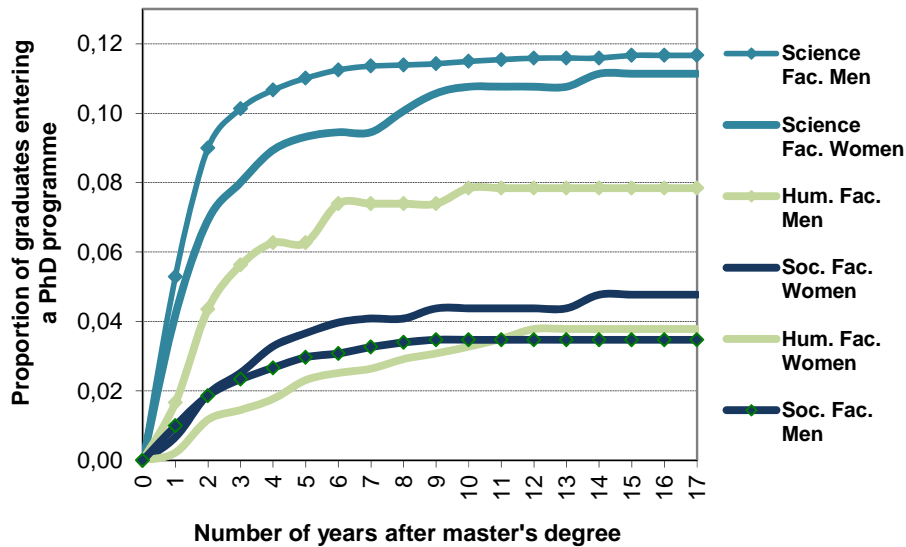
The analyses of the gender bias in the transitions to a PhD fellowship, a PhD-degree and an assistant professorship, respectively, are based on a series of Cox regression models, where we control for various factors. Besides this we have included separated – but similar – models for female and male graduates in order to discover potential gender differences as the various factors may influence the career transitions for female and male graduates adversely .

## **2. FROM GRADUATE TO PHD STUDENT OR FELLOW**

The possibility of getting a PhD fellowship varies significantly between the three faculties at Aalborg University. The percentage of graduates getting a PhD fellowship is highest (about 12%) in the Faculty of Science and Technology and lowest (about 4%) in the Faculty of Social Science (see figure 3).



**FIGURE 3. THE PROPORTION OF GRADUATES FROM AALBORG UNIVERSITY (1981-2005), WHO HAVE ENTERED A PHD PROGRAMME FROM 1988 AS A FUNCTION OF TIME SINCE THEY COMPLETED THE MASTER PROGRAMME – BY FACULTY AND GENDER**



Sources: Calculations based on data from Aalborg University’s administrative register of students and employees.

Figure 3 shows that graduates from Aalborg University start predominately as PhD students/fellows within the first five years after their master’s degree.<sup>9</sup> A relatively higher proportion of graduates from the Faculty of Science and Technology than from other faculties start as PhD students/fellows and these graduates also have (on average) a shorter time lag from their master’s degree to a PhD student grant or fellowship. The figure also indicates that male graduates have a greater chance of getting a PhD student grant or fellowship within the Faculty of Science and Technology and the Faculty of Humanities, whereas female graduates have a greater chance of getting a PhD student grant or fellowship within the Faculty of Social Science.

The results of the multivariate Cox regression models with estimated risk ratios for gender controlled for a number of explanatory covariates are shown in table 2. The estimates of the difference between male and female graduates are presented in Model A, estimates controlled for differences between faculties are presented in Model B, and estimates controlled for other included background factors are presented in Model C. Results from the two separate models for female and male graduates are presented as Model D and Model E, in order to address the second

<sup>9</sup>This is of course not possible for the graduates in the early part of the period as the PhD programme was not introduced until 1988 in Denmark.

question: do different background factors affect male and female graduates differently in terms of achieving PhD student grant or fellowship?

There is a gender bias in the retention rates at Aalborg University as a higher percentage of male than female graduates starts in a PhD programme. The longitudinal analyses document a significant gender effect, as male graduates are almost twice as likely to get a PhD student grant or fellowship compared to female graduates (Model A in table 2).

The lower share of women among PhD students/fellows is partly ascribed to differences between the three faculties in terms of the proportion of women among graduates and to the different number of PhD fellowships at the faculties. However, female graduates are still less likely (although not as significantly) to get a PhD student grant/fellowship, even when the differences between the faculties are taken into account. The probability of a female graduate getting into a PhD programme is only about 85% of the probability of a male graduate getting into a PhD programme (Model B).

This gender difference still exists even when a number of relevant background factors as marks, faculty, parental background, residence and the number of children are accounted for at the same time (see Model C). The probability, however, of a female graduate starting in a PhD programme is about 85% of the probability of a male graduate.

The background factors themselves have an effect on the possibility of a PhD student grant or fellowship – and apparently some of them affect female and male graduates in different ways.

#### *Faculty*

The significant differences between the three faculties in relation to the percentage of graduates starting in a PhD programme are also evident in the multivariate analysis as graduates from the Faculty of Science and Technology have about twice the chance of a PhD student grant or fellowship than graduates from the Faculty of Humanities and the Faculty of Social Science (Model C).

The difference between the faculties is even more distinct for female graduates. Women with a master's degree from the Faculty of Science and Technology are about four times more likely to start in a PhD programme than women with a master's degree from the Faculty of Humanities and approximately one and a half times more likely than women with a master's degree from the Faculty of Social Science (see Model D). It is paradoxical that the higher the percentage of women in the recruiting bases at Aalborg University the lower the chances of getting a PhD student grant or fellowship for female graduates. This is due to the much lower number of PhD grants or fellowships at the Faculty of Humanities (as Model C reveals), it may, however, also be due to positive selection, where the highly underrepresented gender is presumed on average to have better abilities.

**TABLE 2. RESULTS (COX REGRESSION MODELS) – EFFECTS OF EXPLANATORY VARIABLES ON THE PROBABILITY OF GRADUATES FROM AALBORG (1981-2005) START A PHD PROGRAMME (PHD STUDENT GRANT OR FELLOWSHIP) AT AALBORG UNIVERSITY.**

		Model A	Model B	Model C	Model D	Model E
					Women	Men
		Risk ratio	Risk ratio	Risk ratio	Risk ratio	Risk ratio
X <sub>1</sub>	Men	-	-	-		
	Women	<b>0.563****</b>	0.829*	0.838*		
X <sub>2</sub>	Faculty of Science and Technology		-	-	-	-
	Faculty of Humanities		<b>0.359****</b>	<b>0.394****</b>	<b>0.259****</b>	0.600**
	Faculty of Social Science		<b>0.300****</b>	<b>0.561****</b>	0.631**	<b>0.508****</b>
Z <sub>1</sub> (t)	Before 1998 (PhD student)					
	1998 and onwards (PhD fellow)			1.474**	1.627	1.448*
X <sub>3</sub>	Class of 1981-1990			-	-	-
	Class of 1991-1995			<b>1.738****</b>	1.537	<b>1.784****</b>
	Class of 1996-2000			<b>1.899****</b>	1.486	<b>2.002****</b>
	Class of 2001-2005			<b>2.004****</b>	2.006	1.974**
X <sub>4</sub>	Average marks (master) low (< 8)			<b>0.341****</b>	0.237*	<b>0.385****</b>
	Average marks (master) medium (8)			-	-	-
	Average marks (master) medium (9)			<b>2.827****</b>	<b>3.204****</b>	<b>2.681****</b>
	Average marks (master) high (10)			<b>6.520****</b>	<b>10.864****</b>	<b>5.482****</b>
	Average marks (master) high (11 and 13)			<b>8.835****</b>	<b>10.439****</b>	<b>8.257****</b>
X <sub>5</sub>	No student job at Aalborg University			-		-
	Student job at Aalborg University			1.342*	0.847	1.457**
X <sub>6</sub>	Mother and father lower education			-	-	
	Father medium/long cycle higher education			0.987	0.848	1.018
	Mother medium/long cycle higher education			1.269*	1.472	1.212
	Mother and father long-cycle higher education			0.865	0.953	0.870
Z <sub>2</sub> (t)	Region 1 (Location of Aalborg University)			-	-	-
	Region 2			<b>0.343****</b>	<b>0.256****</b>	<b>0.390****</b>
	Region 3			<b>0.203****</b>	<b>0.078****</b>	<b>0.253****</b>
	Region 4			<b>0.135****</b>	<b>0.153****</b>	<b>0.121****</b>
	Region unknown			<b>0.313****</b>	<b>0.265****</b>	<b>0.334****</b>
Z <sub>3</sub> (t)	No children			-		
	One child			1.158	1.198	1.113
	Two children			1.205	1.126	1.207
	More than two children			1.214	1.018	1.284
Observations		14.773	14.773	14.478	4.862	9.616

†:p<0.1, \* p < 0.05, \*\* p < 0.01, \*\*\* p < 0.001, \*\*\*\* P<0.0001

Baseline for the models is marked with a darker line in the table.  
Parameters in the risk ratio model are represented in exponential form (as exp (β) and exp(γ)), x marks time independent and z time dependent covariates.

See table 1 in Annex for definition of Region 1-4.

*Sources:* Calculations based on data from Aalborg University on graduates and employees at Aalborg University and data from Statistics Denmark.

### *Developments over time*

The change from PhD student grants to employment as PhD fellows in 1998 seems in general to make the PhD programme more attractive for graduates at Aalborg University – this alone seems to enlarge the possibility of graduates entering a PhD programme by about 50%. At the same time the number of available PhD fellowships increases during the period at Aalborg University (as earlier shown in table 1), and later cohorts classes have a greater chance of starting in a PhD programme (Model C).<sup>10</sup> This increase seems, however, primarily and significantly to have benefited the male graduates (see Model D and E).

### *The importance of high average marks*

As expected, academic abilities (measured as average marks from the master programme) have a significant influence on students' chances of achieving a PhD student grant or fellowship. Graduates with high average marks from their master programme have a more than six times greater chance of starting in a PhD programme at Aalborg University than graduates with medium (8) average marks (see Model C).

It is, however, remarkable that the academic abilities seem to be of significantly greater importance to the female graduates (see Model D and E). This implies that academic abilities tested in the master programme have a greater differential impact on female than male graduates according to their choice and opportunity of a research career.

### *Student job*

A student job at Aalborg University (as student research assistant) during the master programme increases the chances of starting in a PhD programme at the university (see Model C). The models for female and male graduates, respectively, document that student jobs are only of significant importance to male graduates, and male graduates with a student job increase their chance of a PhD student grant or fellowship with almost 50% (see Model D and E).

### *Family background*

Parental educational background in the form of a mother with a medium or long cycle higher education significantly increases the chance of a PhD student grant or fellowship (see Model C). The results for female and male graduates, respectively, show that parental educational background seems to be more important for female graduates, as female graduates with a mother with a medium or long cycle higher education have a greater chance of a PhD student grant or fellowship – almost 50% greater than other female graduates (see Model D (and E)).

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<sup>10</sup>Cohorts are called 'classes' in the tables.

*The difficulty of attracting graduates living in other regions*

Entering a PhD programme at Aalborg University also depends on the candidate's residence (see Model C).<sup>11</sup> Graduates, who live in the North Denmark Region where Aalborg University is located, are three times more likely to start a PhD programme than graduates residing in other parts of the country. This makes the residence of the graduates an important determinant of the Aalborg University's recruitment. This also implies that if a person moves away from the Northern part of Denmark after graduation, it becomes more difficult to attract her/him into a PhD programme at Aalborg University.<sup>12</sup> Residence seems to be of more importance for women than for men, and the question is why. It may be due to the gender division of childcare, as women in Denmark still have the main responsibility for children and often are responsible for collecting the children from the crèche and kindergarten fairly early in the afternoon (no later than five o'clock – and in some crèches and kindergartens earlier), which makes long commuting time almost impossible to combine with a full-time job.

*Children are no obstacle*

Students in Denmark are on average 27-31 years old when leaving the master programme, and typically between 28 and 35 years when they enter a PhD programme. Therefore, it is not uncommon for Danish graduates to have children of their own. However, there is no evidence that suggests that either female or male graduates with children are discriminated or to a lesser extent start a PhD programme at Aalborg University (see Model C, D and E). Children may, however, as mentioned above, prevent women not living in the region to apply for a PhD fellowship. The model is, however, not checked for this interaction between region and children.

Consequently, the first step into a research career at Aalborg University for the university's own graduates is gender biased, although not as gender biased as at first sight as the faculty background explains part of the gender differences. The next question is if there is also a gender bias as well in completing the PhD programme.

### **3. FROM ENROLMENT AS PHD STUDENT OR EMPLOYMENT AS PHD FELLOW TO THE PHD DEGREE**

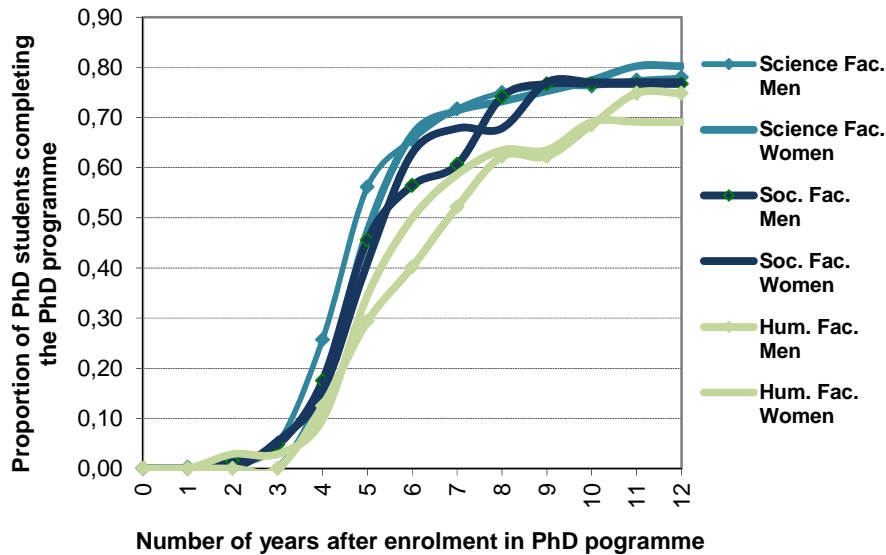
Although completion of the PhD programme today is a crucial step on a researcher's career ladder, not all graduates from Aalborg University who entered a PhD programme in the period 1988-2004 have been successful. Between 70 and 80% of the graduates completed their programme within 10 years (see figure 4) – and more than half within four years. Very few get a PhD degree later than ten years after they have started, and the chance of completing with a degree later is relatively low.

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<sup>11</sup>Residence is a time-dependent covariate divided in five regions (the higher number – the longer distance from Aalborg University).

<sup>12</sup>It has been outside this study to investigate alternatives to a university career at Aalborg University – graduates may, however, have chosen a PhD programme and a university career at another university.

**FIGURE 4. THE PROPORTION OF PHD STUDENTS/FELLOWS WHO START A PHD PROGRAMME AT AALBORG UNIVERSITY IN THE PERIOD 1988-2004, AND DEFEND THEIR PHD DISSERTATION AS A FUNCTION OF TIME SINCE THEY STARTED – BY FACULTY AND GENDER**



Sources: Calculations based on data from Aalborg University's administrative register of students and employees.

The gender difference found in relation to the enrolment as a PhD student or employment as a PhD fellow is not prevalent in relation to completion of the PhD programme with a degree (see table 3). A number of other factors have, however, importance for the completion of the PhD degree.

#### Faculty

PhD students and fellows with a master's degree from the Faculty of Humanities have a significantly lower chance of completing their enrolment/employment with a degree – their chance of finishing the programme is only about 60% of their colleagues' with a master's degree from the Faculty of Technology and Science. It seems to be of no significant importance whether the person is enrolled as a PhD student or employed as a PhD fellow. This is, however, surprising as one may have expected that the employment on ordinary conditions with the main obligation to complete the PhD education, write a PhD dissertation, and defend this dissertation to get the PhD degree should have increased the completion rate.

**TABLE 3. RESULTS (COX REGRESSION MODELS) – EFFECTS OF EXPLANATORY VARIABLES ON THE PROBABILITY OF PHD STUDENTS/FELLOWS FROM AALBORG (1981-2005) FINISH WITH A PHD DEGREE**

		Model A	Model B	Model C	Model D Women	Model E Men
		Risk ratio	Risk ratio	Risk ratio	Risk ratio	Risk ratio
X <sub>1</sub>	Men	-	-	-		
	Women	0.859	0.934	1.121		
X <sub>2</sub>	Faculty of Science and Technology		-	-	-	-
	Faculty of Humanities		0.656*	0.597**	0.555'	0.596*
	Faculty of Social Science		0.829	0.866	0.713	0.972
Z <sub>1(t)</sub>	Before 1998 (PhD student)			0.851	0.801	0.839
	1998 and onwards (PhD fellow)					
X <sub>3</sub>	Average marks (master) medium (8)			-	-	-
	Average marks (master) medium (9)			0.997	0.529	1.125
	Average marks (master) high (10)			1.588**	1.095	1.749**
	Average marks (master) high (11 and 13)			1.714**	1.866	1.769**
X <sub>3</sub>	No student job at Aalborg University			-	-	-
	Student job at Aalborg University			0.798	0.606	0.785
X <sub>5</sub>	Mother and father lower education			-	-	-
	Father medium/long cycle higher education			1.284'	1.517	1.278'
	Mother medium/long cycle higher education			1.194	1.153	1.190
	Mother and father long-cycle higher education			0.781	0.696	0.818
Z <sub>2(t)</sub>	Region 1 (Location of Aalborg University)			-	-	-
	Region 2			0.651*	0.764	0.597*
	Region 3			0.703'	0.400	0.736
	Region 4			0.543**	0.622	0.519*
	Region unknown			0.545*	0.472	0.559'
Z <sub>3(t)</sub>	No children			-	-	-
	One child			0.734*	0.688	0.719*
	Two children			<b>0.462****</b>	<b>0.310***</b>	<b>0.479****</b>
	More than two children			<b>0.211****</b>	<b>0.107****</b>	<b>0.235****</b>
Observations	781	781	767	174	593	

'p<0.1, \* p < 0.05, \*\* p < 0.01, \*\*\* p < 0.001, \*\*\*\* P<0.0001

Baseline for the models is marked with a darker line in the table.  
Parameters in the risk ratio model are represented in exponential form (as exp (β) and exp(γ)) – x marks time independent and z time dependent covariates.  
See table 1 in Annex for definition of Region 1-4.

*Sources:* Calculations based on data from Aalborg University's administrative register of students and employees and data from Statistics Denmark.

#### *Academic abilities and student jobs*

Academic ability (measured as average marks from the master programme) has also a significant influence to the completion of the PhD programme with a degree – the higher the marks the higher the possibility of a degree. Male PhD students or fellows with average marks of 10 or more have approximately 1.8 times higher chance to complete their PhD programme with a degree than their male colleagues with average marks less than 9 (see Model C and E). The marks seem to have no significant impact on the female PhD students and fellows – possibly because high marks were a precondition for their enrolment or employment (Model D). At the same time a student job seems to have no significant effect on the completion rates. The results suggest that a student job works as an entrance to the programme rather than a guarantee for success within the programme.

#### *Residence*

Residence during the PhD programme also plays an important role to the PhD student/fellow – if the PhD student/fellow does not live close to the university (in the same region as the university is located) she or he has a lower chance (70% or less) of finishing the programme with a degree. There seems to be no significant difference for female and male PhD fellows/students.

#### *Family*

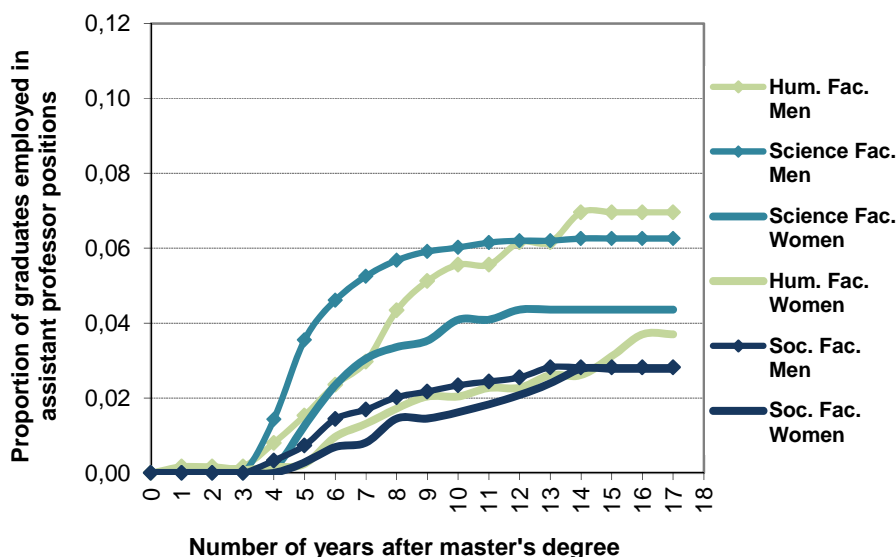
Family background (in the form of parental educational background) plays a minor part whereas the PhD student/fellow's own family is of great influence. A PhD student/fellow with two (or more) children has less than half the chance of finishing the programme compared to a PhD student/fellow without children (see Model C). Children seem to be a greater obstacle for women's possibility of success in the PhD programme (Model D and E), a female PhD student/fellow with two (or more) children has less than one third the chance of getting a degree than a female PhD student/fellow without children. In this sense the completion of a PhD programme has also a gender bias as the intersection of gender and children reveals a negative gender effect.

#### **4. FROM GRADUATE TO ASSISTANT PROFESSOR**

3-7% of Aalborg University graduates from 1981-2003 get employment as assistant professor at Aalborg University. Recruitment to assistant professor positions at Aalborg University often takes place from three to about eight years after the master's degree – typically after finishing the three-year PhD programme (figure 5).



**FIGURE 5. PERCENTAGE OF GRADUATES FROM AALBORG UNIVERSITY (1981-2003), WHO ARE EMPLOYED AS ASSISTANT PROFESSOR AS A FUNCTION OF TIME SINCE THEY COMPLETED THE MASTER PROGRAMME – BY FACULTY AND GENDER**



Sources: Calculations based on data from Aalborg University's administrative register of students and employees.

#### *Gender bias*

The longitudinal analysis also reveals a gender bias at assistant professor level. The probability that a female graduate is employed as assistant professor is only half the probability to that of a male graduate (see table 4 Model A).

Differences between the three faculties at Aalborg University have some effect on the retention rate of women at the assistant professor level. However, the female graduates still have a much lower chance of receiving an assistant professor position. The probability that a woman is employed as assistant professor is 60% of the probability to that of a man's, when faculty background is adjusted for (see Model B).

This gender difference still remains the same when other relevant background factors are accounted for, whereas faculty background seems to have no significant effect for employment at the assistant professor level when the model is adjusted for characteristics of the graduate (see Model C).

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**TABLE 4. RESULTS (COX REGRESSION MODELS) – EFFECTS OF EXPLANATORY VARIABLES ON THE PROBABILITY OF GRADUATES FROM AALBORG UNIVERSITY (1981-2003) BEING EMPLOYED AS ASSISTANT PROFESSOR AT AALBORG UNIVERSITY.**

		Model A	Model B	Model C	Model D	Model E
					Women	Men
		Risk ratio	Risk ratio	Risk ratio	Risk ratio	Risk ratio
X <sub>1</sub>	Men	-	-	-		
	Women	<b>0.503****</b>	<b>0.590***</b>	0.605**		
X <sub>2</sub>	Faculty of Science and Technology		-	-		
	Faculty of Humanities		0.720	0.862	0.901	0.940
	Faculty of Social Science		<b>0.413****</b>	0.853	0.609	0.855
X <sub>3</sub>	Class of 1981-1990			-	-	-
	Class of 1991-1995			1.954****	1.594	2.067****
	Class of 1996-2000			2.915****	2.029 <sup>†</sup>	3.262****
	Class of 2001-2003			4.614****	3.943	4.927****
Z <sub>1</sub> (t)	No PhD degree			-	-	-
	PhD degree			10.577****	46.270****	8.058****
X <sub>4</sub>	Average marks (master) low (under 8)			0.291**	0.388	0.296*
	Average marks (master) medium (8)			-	-	-
	Average marks (master) medium (9)			2.009****	2.570*	1.972**
	Average marks (master) high (10)			3.062****	2.762*	2.943****
	Average marks (master) high (11 and 13)			3.659****	1.105	4.284****
X <sub>5</sub>	No student job at Aalborg University			-	-	-
	Student job at Aalborg University			1.054	-	1.104
X <sub>6</sub>	Mother and father lower education			-	-	-
	Father medium/long cycle higher education			1.207	1.004	1.322 <sup>†</sup>
	Mother medium/long cycle higher education			1.381 <sup>†</sup>	1.010	1.397 <sup>†</sup>
	Mother and father long-cycle higher education			0.776	0.736	0.752
Z <sub>2</sub> (t)	Region 1 (Location of Aalborg University)			-	-	-
	Region 2			0.133****	0.235**	0.106****
	Region 3			0.061****	0.085*	0.057****
	Region 4			0.022****	-	0.026****
	Region unknown			0.092****	0.093*	0.093****
Z <sub>3</sub> (t)	No children			-	-	-
	One child			1.005	1.512	0.988
	Two children			1.059	1.482	1.009
	More than two children			0.738	1.692	0.643
Observations (in 1000)		12.471	12.471	12.179	3.939	8.240

<sup>†</sup>:p<0.1, \* p < 0.05, \*\* p < 0.01, \*\*\* p < 0.001, \*\*\*\* P<0.0001

Baseline for the models is marked with a darker line in the table.  
Parameters in the risk ratio model are represented in exponential form (as exp( $\beta$ ) and exp( $\gamma$ )) – x marks time independent and z time dependent covariates.  
See table 1 in Annex for definition of Region 1-4.

Sources: Calculations based on data from Aalborg University's administrative register of students and employees and data from Statistics Denmark.

*Developments over time*

Graduates' chances of employment in an assistant professor position at Aalborg University increase over the period, reflecting a doubling in the number of assistant professor positions in the period (Model C). However, this growth in positions primarily benefited the male graduates. Men's chances increased fivefold during this period (Model E). This is mostly due to the fact that the increase in assistant professor positions predominately occurs at the Faculty of Technology and Science, where women only form 10-20% of the graduates in the period. Consequently, the faculties still have an important role in the lack of gender balance in employment of assistant professors.

*Academic abilities*

Academic abilities also have a significant influence on the recruitment to assistant professor positions at Aalborg University. A PhD degree gives 10 times as high a chance than no PhD degree, which reflects that a PhD degree has become a precondition for employment as assistant professor over the last ten years. At the same time graduates with high average marks from their master's degree have a more than three times greater chance of being employed as assistant professor at Aalborg University than graduates with medium (8) average marks. Hence the average marks as an indicator for the academic abilities have a significant effect on the recruitment to the first steps on the university career ladder. However, average marks from the master's degree seem to be more important for male than female graduates' employment.

A PhD degree is more important for women's employment than for men's. Female graduates with a PhD degree from Aalborg University have a more than 45 times as high a chance for employment than female graduates without (Model D). For male graduates the similar figure is 8 times. (Model E). This is another indication that women's way into university employment is more direct and traditional – with high average marks she gets into a PhD programme, and she uses a PhD degree from Aalborg University as an entrance to employment as assistant professor at the same university. Men's way seems to be more untraditional and less direct – possibly with a PhD degree from another university or a still unfinished PhD, when employed as assistant professor (this could explain why high average marks still are important for men's employment). However, the gender difference which was evident at PhD level, where a student job seems to open doors for the male graduate to a PhD position, is not present at the assistant professor level, where a student job seems to have no impact.

*Family background*

Parental educational level is associated with graduates' aspirations to a research career. However, according to the results of the Cox-regression model, there is just a small effect for male graduates, as male graduates whose fathers or mothers have medium or long cycle higher education are more likely to be employed as assistant professor (see Model C and E).

### *Residence*

Another important factor in relation to the recruitment of graduates to assistant professor positions is residence. Graduates still living in the North Denmark Region where Aalborg University is located are more than six times as likely to be employed as assistant professors compared to graduates living outside the region (see Model C, D and E). This factor was also important for graduates' probability of a PhD fellowship at Aalborg University, but the effect was considerably smaller. This suggests, therefore, that graduates' residence is particularly relevant to appointment at assistant professor level, where a high degree of daily presence is expected. In nearby regions men seem to a higher degree to be employed as assistant professors than women.

### *Children*

Whether the graduate has children or not does not affect the probability of being employed as assistant professor – neither for female nor male graduates (see Model C, D and E). In this way the recruitment of assistant professors resembles the results of the analyses on transition to PhD positions. Family commitments and responsibilities do not seem to be a direct obstacle for graduates, who are employed as assistant professors at Aalborg University. Family commitment may, however, be the explanation as to why residence is so important – without family commitment it would be easier for a person to move after a job.

## **5. DISCUSSION AND CONCLUSION**

The proportion of women among PhD fellows, assistant professors, associate professors and professors at Aalborg University has remained remarkably low even after years of an improved recruitment basis for women at graduate level and an increase in the number of academic positions at Aalborg University. These historic settings formed the point of departure of this longitudinal study based on a large panel dataset from administrative register data. The aim of this article was to investigate whether the low retention rate of female graduates from Aalborg University was due to pure gender discrimination in recruitment to PhD and assistant professor positions (with a continuing loss of high potential and high performing talents) or other factors as for instance low academic abilities. Therefore, we have used multivariate regression models which have enabled us to compare academic tracks of male and female graduates when controlling for a number of factors.

The analyses documented that female graduates have a lower probability of getting a job than male graduates as PhD fellow or assistant professor – also when the special distribution of students and academic positions between the faculties at Aalborg University are taken into account. Although the overall number of positions has increased over the period 1995-2007 women's relative chance of getting a research position as PhD fellow or assistant professor has not significantly altered. Even when the results are controlled for a number of background factors, female graduates' possibility of getting a position at Aalborg University is still lower than

male graduates and the gender difference is even greater at assistant professor than at PhD level. This, combined with the results from the corresponding qualitative research, suggests that women are to a lesser extent than men seen and acknowledged by their teachers and mentors as most PhD fellows have been recruited by their mentor, and encouraged to seek a PhD position (Lützen & Henriksen (2008)). Most female PhD-fellows say in the interviews that they themselves had not thought about a PhD position, if it had not been suggested to them to apply. Whereas many male PhD fellows reveal that they had thought about a research carrier already from the second year at university, and some already knew in high school that they wanted to pursue an academic career and have told their teachers continuously during their studies

Furthermore, female PhD students/fellows do not have lower chances than their male colleagues in getting their degree, although two or more children seem to lower women's chance of a degree more than men's. The corresponding qualitative study reveals that especially female PhD fellows with children find it hard to stay three or six months at another university (preferably in another country) – which they are required to during their fellowship (Lützen & Henriksen (2008)). This may partly explain why female PhD students/fellows with children do not succeed in getting their degree, which is crucial, as the PhD degree is significantly more important for women than for men for the next step: employment as assistant professor.

The results reveal that women disappear from the university already at the very first steps of the career ladder: women do not apply for a PhD position – unless they are encouraged to do so. Furthermore, female PhD fellows with children have less chances of getting their degree than male PhD fellows with children and PhD fellows without children or only one child. This again adds to women having a minor chance of getting employment as assistant professor, as the PhD degree is the most important factor for this employment – and of far more importance than for men.

Women do not choose – or are not chosen to – an academic position. High marks – which make a person visible – seem to be more important for women's start of an academic career, whereas a student job – which makes a person visible in another way – adds to men's possibility of starting as a PhD fellow. This may suggest that female graduates to a greater extent choose or are encouraged to apply for a PhD-position due to high marks, whereas male graduates also get inspired or encouraged to apply because of their knowledge of researchers and research units qua their student job.

The study clearly documents a gender-biased recruitment to academic positions at Aalborg University. The relatively high staff-student ratio at the Faculty for Science and Technology means a relatively higher number of academic positions in this male dominated faculty. Still, when this fact has been accounted for male graduates to a greater extent get PhD positions. Furthermore, the main part of the positions as assistant professor, associate professor and professor have only one applicant, or applicants from one sex, which indicates that the recruitment process in itself to higher positions is also an important element in the reproduction of the gender bias profile in the academic staff.

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Finally, the study shows that graduates who have left the region, where Aalborg University is located, to a much lesser degree are employed as PhD fellows or assistant professors – whether this is due to the fact that they no longer are seen as potential employees or that they simply just do not apply – or both, is not possible to tell based on either the quantitative or qualitative study. It shows, however, that recruitment to the very first steps in the academic employment at Aalborg University is not only internal, it is also local.

The question is as to what extent the results from Aalborg University apply for other Danish universities and for universities in other countries. We would argue that the results in some cases are universal. It is a well-known prejudice that women have to be better to be thought of as good as men, and this study based on longitudinal methods supplemented with the results of the interviews in the qualitative study do unfortunately not contradict this universal prejudice. Female students have to choose the 'right' educations (that is within science and technology) and have higher marks to be encouraged to apply for PhD positions and a PhD degree to apply for employment as assistant professors, while male students even in the 'wrong' educations (that is within humanities) have an advantage because of their sex. It is evident that the pipeline leaks women from the very first steps of the career ladder.

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**ANNEX:**

**TABLE 1. INFORMATION FROM DANISH ADMINISTRATIVE REGISTERS AT STATISTICS DENMARK AND FROM AALBORG UNIVERSITY ON GRADUATES FROM AALBORG UNIVERSITY USED IN THE LONGITUDINAL ANALYSES**

Data source	Variable	Description
<b>Master programme (from Aalborg University)</b>	Gender	
	Faculty	Faculty of Science and Technology, Faculty of Humanities and Faculty of Social Science
	Average marks – old scale (13 scale)	Divided into categories: Low(<8), medium (8), medium (9), high (10) and high (11-13)
	Job	Student job at Aalborg University – or not
	Graduation year	Year  Divided into categories: Class of 1981-1990, 1991-1995, 1996-2000 and 2001-2005 for PhD 2001-2003 for assistant professors
<b>PhD</b>	Enrolment/employment year	Year
		Before 1998, and 1998 onwards
	PhD degree	Year  Yes or no
<b>Assistant professor</b>	Employment year	Year
<b>PhD arrangement</b>		Before and after (including) 1998
<b>Social background (from Statistics Denmark)</b>	Parent's education – (students aged 15)	Divided into categories Mother and father lower education Father medium/long cycle higher education Mother medium/long cycle higher education Mother and father long cycle higher education
<b>Demography (from Statistics Denmark)</b>	Residence at – and after – master's degree	Divided into 5 regions (old counties) – the higher number – the longer distance from Aalborg University: Region 1: Nordjylland county Region 2: Århus & Viborg counties Region 3: Ringkøbing, Vejle, Ribe, Sønderjylland & Fyn counties Region 4: Københavns, Frederiksborg, Roskilde, Vestsjælland, Storstrøm & Bornholm counties
	Family responsibility	Number of children divided into categories: No children One child Two children More than two children