Gender differences in research productivity

A comparative analysis of Norway and Australia

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Abstract

This thesis is a comparative and empirical analysis of gender differences in research productivity among Norwegian and Australian academics. This study uses the Norwegian and Australian data from the Changing nature of the Academic Profession (CAP) project to examine the size of gender differences in research productivity and the correlates of productivity. Secondary sources are used to indicate how gender differences have changed over time. Research productivity is calculated as "article equivalents", which is a weighted sum of journal articles (1 point), books edited (2 points) and books authored (5 points). Extensive bi-variate analyses are conducted on each of the hypothesised determinants of research productivity and separate multiple regression analyses are made for men and women in both countries.

The major findings from this thesis are that Norwegian women averaged 21 percent fewer article equivalents than Norwegian men, while Australian women averaged 26 percent fewer than Australian men. There is little evidence of an overall reduction in gender differences in research productivity in Norway, but this is partly due to an increase in male research productivity among a small group of prolific publishers. It is far less clear how differences in gender-based research productivity have changed over time in Australia, but female participation in research has risen dramatically since 1993.

The multiple regression analysis explains considerably more of the variation in individual research productivity in Australia (R^2 = 0.42 women, 0.31 men) than in Norway (R^2 = 0.21 women, 0.14 men). The strongest correlate of research productivity across all staff groups is academic rank, which is a particularly strong in the Australian sample given the more hierarchic nature of the Australian academic career structure. International collaboration also exhibits a strong effect size for all staff, while time spent on research is significant for most. The institutional variables included fail to generate large effect sizes or significance. Marital and family statuses also fail to account for gender differences, which may be due to imprecise questioning in the CAP survey.

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Sincerely,

Peter Bentley
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1. Introduction

1.1 Background to the study

The primary objective of this thesis is to examine gender differences in research productivity among Norwegian and Australian academics. The two countries offer an interesting comparison as, while their higher education systems perform favourably by international standards, each country has taken a strikingly different path to achieve their goals. Australia has a unified higher education system characterised by diversity, decentralised management, competitiveness and a heavy concentration of resources within a small number of research intensive universities. Norway by comparison has a binary divide between the college and the university sector, and has steadfastly maintained the research-teaching nexus and equality across universities. The differences in higher education systems in many ways reflect broader cultural differences between the two countries. Australia represents a highly “masculine” and “individualistic” culture that respects achievement, heroism and assertiveness, while Norway represents a “feminine” culture promoting modesty, caring and equality (Hofestede 1984).

Historically, women have been placed at a severe disadvantage in academia by being excluded from scientific networks and unfairly viewed as intellectually unsuited to the demands of scientific research (Cole and Zuckerman 1984: 221). It is therefore unsurprising that early twentieth century studies of research output showed women to be far less prolific in their research productivity. Of greater surprise is that later studies in the 1960s and 1970s showed no appreciable improvement in the gender-based differences in research output (Cole and Zuckerman 1984). Studies in the 1990s (Zuckerman 1991 in Xie and Shauman 1998: 847) found women still averaged only 50 to 60 percent of male research output. Norwegian studies have shown a comparably small gender divide in research productivity, with women achieving between 75 and 80 percent of male research output (Kyvik 1991; Kyvik and Teigen 1996). Less is known about the precise size of the gender divide in Australia, but women remain heavily concentrated in the lower academic ranks where research productivity and arguably opportunities to research are poorer (Ramsden 1994). The persistence of higher male research productivity led Cole and Zuckerman (1984) to metaphorically conceptualise this as a ‘productivity puzzle’.

While it is relatively easy and accurate to claim that women publish less than men, it is far more difficult to disentangle the impact of being female from other factors that also affect research output. In a comprehensive and widely cited literature review, Fox (1983: 298) theorises that determinants of research output fall into three broad categories: individual-level characteristics (psychological abilities; work habits; demographics); environmental location; and feedback processes. Fox’s framework provides a solid theoretical base for selection and operationalisation of independent variables that correlate with research output, but falls somewhat short of explaining gender differences. Identical choices or characteristics, such as marriage and children, affect research output differently for men and women. The determinants of research output also overlap, adding complexity to the already ambiguous causal relationships.

Sonnert and Holton (1995) explain differences between men and women through models of gender deficits and gender differences. Gender-based deficits are the structural barriers faced by women, ranging from overt discrimination to the less tangible day-to-day practices that treat women as ‘outsiders’ from circles of influence. Women have no control over these impediments and while the removal of formal barriers can be offered as an explanation for some of the reduction in gender inequality, informal barriers still persist. Sonnert and Holton’s gender differences model explains how women make choices that inhibit their research, such as spending less time on research or attending less prestigious graduate schools. These factors are within the control of women, but social pressures often subtly encourage women to behave differently to men, such as placing greater respectability on family care or discouraging competitive behaviours.

Some studies which have taken a multivariate approach to understanding gender differences in research productivity have identified growing evidence of gender equality. When personal characteristics, structural positions and marital status are controlled, differences between men and women are often negligible (Xie and Shauman 1998). Many researchers now claim that gender has no direct effect on research output as women achieve similar productivity to men in comparable positions (Castleman et al. 1995 in Hawkes 1996: 58: Ramsden 1994). These identified improvements in gender equity have been linked to an overall improvement in the distribution of resources and structural positions of women in universities (Xie and Shauman 1998). However, while comparisons between male and female research output should take into consideration the effects of academic rank, teaching status and other factors to ensure that “comparable” groups of academics are indeed compared (Burton 1997: 21), controlling for these factors may oversimplify or simply reshape the problem. It may be insightful to know that men and women of similar rank and teaching status exhibit negligible differences in research output, but this says little about why women are more likely to exhibit these characteristics. Therefore, when such control variables reduce gender differences, it is important to ask whether teaching status and academic rank explain differences in research productivity, or whether research productivity explains differences in rank and employment status.

1.2 Rationale and research questions

This thesis adds empirical evidence to the theories of why men and women differ in research publishing. The data for this thesis comes from the Changing nature of the Academic Profession (CAP) project. While gender-based research productivity has already been studied extensively in Norway (Kyvik 1991, Kyvik and Teigen 1996), it has received comparably less attention in Australia. This is likely the first Australian study that examines gender differences in research productivity across multiple publication channels (e.g. books and journal articles) and academic fields, and applies multiple regression analysis separately for men and women. Many previous studies from Australia assume men are more productive than women, but pay little attention to the size of the difference. Therefore, the first research question to be addressed in this thesis is:

- What is the size of the gender difference in research productivity at Australian and Norwegian universities?

A second objective is to empirically examine the determinants of research productivity for men and women separately. It is frequently stated that women are less interested in research, have heavier teaching loads, have fewer available hours for research, poorer opportunities for international collaboration, receive inadequate research funding, are concentrated in lower academic ranks and are negatively affected by traditional gender roles in marriage and family. While there is evidence to suggest that men and women differ on at least some of these characteristics, there is less empirical support directly linking each of these factors with research productivity. Therefore, the second research question is:

- How strongly do the determinants of research productivity correlate with the research productivity of Norwegian and Australian academics?

Many of the factors associated with research productivity overlap. For example, parenting children may be negatively correlated with research productivity, but the effect of children may also be reflected in the working time patterns. Age may be positively correlated with research output, but this may primarily be due to older academics tending to be located in higher academic ranks. The effect of age may be very small when comparing the productivity of older and younger staff of similar academic ranks. To identify the strength of the relationship between the determinants of research productivity, it is important to separate the effects of each of these variables independently. This is achieved through multiple regression analysis. Therefore, the third research question for this thesis is:

- How large are the effects of the determinants of research productivity after controlling for the effects of other variables?

There are reasons to believe gender differences in research productivity may have decreased. The number of women employed in universities has increased and while women are still a minority in higher ranks, women may have begun to reach a "critical mass" in certain fields. Access to workplace flexibility schemes have widened and the traditionally masculine workplace culture may have moderated. The entrance of a new generation of fathers in dual income families, no longer willing or able to ignore their family responsibilities, may have helped increase the pace of these changes. Therefore a final question, which underlies much of this study, is:

- What is the evidence that gender-based differences in research productivity have decreased over time?

Through these four research questions the "productivity puzzle" for Australia and Norway will be examined. The Background section will give the reader a brief overview of the Australian and Norwegian university and academic career structures. The Theoretical Framework and Literature Review section will address some of the key concepts and theories that explain differences in individual research productivity and gender differences. The Data and Methodology section briefly describes the data and how the variables have been selected and operationalised with reference to the existing theoretical base. In the Analysis section, the effects of hypothesised determinants of research output will be introduced through extensive bi-variate analyses. The Analysis section concludes with four separate multiple regression analyses for men and women in each country. As many determinants of research productivity are also the effects of being highly productive, it is important that each variable is understood in detail and in isolation before being incorporated into the multiple regression analyses. The thesis concludes with a Discussion section outlining the findings, conclusions and recommendations for future research.

2. Background: academic work in Norway and Australia

This thesis will examine statistical data regarding research output of academics in Australia and Norway. While Australian and Norwegian universities share similar missions incorporating the pursuit of teaching and research, methods for achieving these goals differ in subtle but important ways. One of the key areas of difference is the structure of employment relations. Different formal and informal regulations govern academic career structures and progression in both countries. As comparisons will be made between and within diverse groups of academics from Australia and Norway, it is important to recognise these differences in career structures from the outset before conclusions are drawn on relevant data. This is particularly the case in Australia where workplace relations decisions are delegated to institutions, resulting in potentially great diversity within the Australian university sector and hence different institutional conditions for undertaking research.

This section will begin by providing an institutional overview of the Australian and Norwegian university sectors, followed by the career and promotional structures implemented within universities. The institutional background information will be of relevance for sampling considerations and data analysis of individual research productivity. As the two countries differ significantly regarding expectations universities place on academic staff, this has clear consequences for comparing research output between academics. Different academic career structures are of great importance, as it is through formal academic ranks that many of the within-country and between country analyses will be made. As additional resources, rewards, recognition and reinforcement follow promotion up the academic ranks, academic rank is frequently offered as an explanation for why men and women differ in their research output (Creamer 1998). The role of research output and the structure of the promotion systems will be examined in greater detail in the final part of this section

2.1 University sectors

The Australian higher education sector can be divided into self-accrediting and non self-accrediting providers. Australian self-accrediting higher education providers are legally entitled to establish educational programs and awards independently, while non self-accrediting providers issue specific degrees below the PhD level which must be approved by the relevant Commonwealth, Territory, or State Government. The label of “university” is limited to self-accrediting providers of doctoral-level qualifications, of which there are 37 public universities and 2 private not-for-profit universities (AQF 2008). Additionally, there are 4 public self-accrediting non-university institutions, one branch of an overseas university and over 150 public and private non self-accrediting institutions.

Norway's higher education sector is comparably smaller, comprising 7 public comprehensive universities, 8 public specialised universities, 24 state university colleges and 29 small private colleges (NOKUT 2008). While all academics within universities are expected to engage in research equally, research is not an equal requirement for all staff at university colleges. The other main distinction between universities and colleges is that universities are self-accrediting doctoral training providers, whereas colleges must receive additional accreditation to provide doctoral degrees in specialised disciplines. In recent years, the binary distinction between the university and non-university sector has become less clear due to academic drift in the college sector. The upgrading of some specialised universities and university colleges into full universities has seen an expansion in the university sector from four universities in 1994 to seven in 2009.

The Australian university sector is characterised by self-defined diversity, reflected through different formal and informal institutional groupings. The "Group of Eight" (Go8) is a formal group of Australia's most prestigious and research intensive universities. The Innovative Research Universities (IRU; six universities of similar research ambitions) and the Australian Technology Network of Universities (ATN; five technical universities located in each mainland state) also formally represent universities of similar ambitions, histories and values. A further two informal groupings are the Regional Universities (REG) and the New Generation Universities (NGU), representing Australia's regional and younger universities established during the 1980s merger process (Goedegeburre, Coates, van der Lee and Meek 2009: 1-2). While the true level of institutional diversity may not be as great as the groupings suggest, the groupings do reflect the inequity in research funding. For example, the Higher Education Research and Development funding (HERD) from the Australian Government is heavily concentrated in the Go8 universities who receive almost twice the research funding of the other 31 universities combined (DEEWR 2008: 44). Not surprisingly, many studies have found research output is also more concentrated within the elite and research intensive groups of universities (Ramsden 1994; Sheehan and Welch 1996).

This contrasts sharply with the experience of institutional diversity in Norway where equality remains a key characteristic between universities. The stronger role of the Norwegian Government in funding and steering the higher education sector means the four oldest Norwegian universities (Oslo, Bergen, Tromsø and the Norwegian University of Science and Technology) have traditionally shared an equal level of prestige and research opportunities for their staff (Smeby 2000: 9). Given recent growth in accreditation of new universities, the level of diversity within the doctoral granting sector may now be greater. Norway has retained a binary system and the expansion of the university sector has occurred on case-by-case basis. This step-wise approach has maintained equality in research opportunities and prestige between universities to a far greater extent than in Australia, where abolition of the binary divide promoted stratification within the university sector.

2.2 Academic career structures

Australian universities negotiate collective bargaining agreements which stipulate conditions of employment for academics, including the formal academic classification structure. Collective agreements are negotiated separately for each of the 39 universities and therefore there is no standard academic classification or career structure. Most universities also have additional collective agreements covering non-academic staff. As collective agreements are negotiated with the National Tertiary Education Union (NTEU), a union representing all academics across Australia, conditions of employment do not vary considerably between institutions. One reason for this is that the NTEU has traditionally engaged in 'coordinated bargaining', a type of pattern bargaining whereby gains from the most recent university agreement are used as a precedent for subsequent agreements. As such techniques rely on comparability between university collective agreements, the academic career classifications tend to be uniform across the university sector under the rationale of "equal pay for equal work" (NTEU in DEST 2002: 36). The academic classifications outlined in collective agreements include both research-only and combined teaching and research positions, but do not cover teaching-only staff who, strictly speaking, only exist within English language (ELICOS) teaching centres of some universities. While there are exceptions[1], the Australian academic career structure generally follows a five-tier ranking scale: Level A (Associate Lecturer/Research Associate/Tutor); Level B (Lecturer/Research Fellow); Level C (Senior Lecturer/Senior Research Fellow); Level D (Associate Professor/Principal Research Fellow); and Level E (Senior Principal Research Fellow/Professor).

[1] One notable exception is the University of Western Australia (see: http://www.news.uwa.edu.au/oct-2008/new-titles-uwa-academics)

The Norwegian academic career structure is regulated through the Norwegian Ministry of Education and Research and there is a uniform career structure across the higher education sector. Since 1995, all Norwegian universities and university colleges have shared a common career structure for permanent academic positions: University/College Lecturer; Senior Lecturer; Associate Professor; and Professor (Kyvik and Smeby 2004: 312-3). There are a small minority of pre-1995 staff still employed as Assistant Professors, but this career grade is no longer used for new appointments. As Lecturer positions are rare within universities and do not require a doctoral degree, there are effectively two permanent academic career grades for Norwegian academics: Associate Professor and (full) Professor. All Norwegian professorial positions are permanently employed and guaranteed the right to undertake research. Professors and Associate Professors are expected to divide their working time equally between research and teaching (Kyvik and Smeby 2004: 318).

While the Australian and Norwegian academic career tracks for upper-level academic positions do not differ markedly, it is within the non-permanent classifications in the lower levels that comparability between the systems becomes problematic. In Norway, non-permanent academic positions are mostly utilised for research-only staff in postdoctoral positions (Post doc), short-term projects (Research assistant) and external research projects (Researcher). Doctoral students are also employed in non-permanent Research Scholar positions for three years if research-only or four years if combined with 25 percent teaching responsibilities. In Australia there are three types of employment duration for all levels of academic staff: permanent/continuous; fixed-term; and casual/sessional. Permanent positions provide an expectation of ongoing employment and career advancement until retirement and can loosely be described as “tenured”. Fixed-term positions provide regular employment for a limited period of time, while casual positions are positions paid on an hourly basis on a contract of service that can be terminated with a one day notice period. Staff across all three types of contracts are employed within the same academic classification and salary scales (Level A to E), while casual employee receive additional pro-rata wage compensation (for example 23% at the University of Western Australia [UWA]) in lieu of not receiving paid leave entitlements. Doctoral and postdoctoral positions are generally not engaged on an employment basis, unless when performing additional duties, usually Level A teaching. Postdoctoral positions and others with doctoral qualifications may also be employed within the Level A classification, but such employees commence employment at a higher base-salary increment (University of Melbourne 2009, UWA 2006).

The formal academic career commences earlier in Australia, but security in employment and the guaranteed right to engage in research is not extended to Australian academics. While Level A academic positions may be seen by some as the entry-level for an academic career, such positions do not require a doctoral degree and are often used as non-permanent appointments for persons undertaking a doctoral degree or postdoctoral research (UWA 2007: 3-4). The vast majority of Level A and B positions, particularly research-only positions, are fixed-term contracts sourced from publicly funded fellowship schemes or internal university funds and grants. Symul (2008: 3) cites the example of the Australian National University (ANU), arguably Australia's leading and most prestigious university, where 89 percent of Level A and 60 percent of Level B academics are on fixed-term contracts. The complexity of the Level A career grade led UWA to move to a four-tier ranking scale in 2009, removing Level A from the formal academic classifications. The greater number of ranks, the more linear academic career structure and the greater diversity in the separation of research and teaching duties in Australia, will be of particular importance in later analyses as differences in long-term research orientation will likely be more clearly reflected in the Australian career structure.

2.3 Promotion systems

The differences between Norway and Australia in the formal entry-level of the academic career have particular implications on the promotion systems. Appointment to a Norwegian Associate Professor position is based on open competition and requires a doctoral degree or in some cases postdoctoral experience. Promotion to (full) Professor is not dependent upon a vacant position and can be achieved based on individual performance and research competence. The competence based career model, which has been in place in Norway since 1993, differs from the traditional "competition model" which requires academics to apply and compete for the limited number of vacant higher level positions (Olsen, Kyvik and Hovdhaugen 2005: 300). In Norway, there are three possible paths towards promotion to full professorship: successfully competing for a vacant professorship; applying for a vacant professorship and being found qualified, but not offered the position; or applying for re-classification of one's existing position based on competence as determined by a national peer review committee. Reclassification is the most common and accounts for approximately 70%

of full professorship appointments (Olsen et al. 2005: 309).

The introduction of promotion based on competence has been recognised as contributing to increased research productivity and collaboration, improving the attractiveness of the academic career among younger staff and eliminating some barriers to gender equity (Olsen et al. 2005: 310-14). However, allowing academics to apply for promotion through reclassification has discouraged mobility between universities as it removes the incentive for academics to look outside their institution for promotion and alternative research opportunities (Olsen et al. 2005: 310-4). While mobility between Norwegian universities via vacant promotional opportunities was never particularly common, since the 1993 reforms such mobility has vanished almost completely. Between 1981 and 1991, 8 percent of promotions to full professor involved moving to another institution. This fell to 2 percent between 1993 and 2001 (Olsen et al. 2005: 313). While this may be argued as a “rather small” reduction in mobility in absolute terms (Olsen et al. 2005: 313), in relative terms it has seen such mobility drop to a quarter of its previous levels. Such reductions in mobility also have the flow-on effect of reducing the research steering capacity of university departments when establishing new research centres and attempting to attract new staff.

Whereas the merit-based promotion procedure in Norway is established through guidelines from the Ministry of Education and Research (Olsen et al. 2005: 304), promotion procedures in Australian universities are determined through the collective bargaining process and can therefore vary across institutions. The most common method is for Australian academics to apply for merit-based promotion by submitting an application for re-classification to a promotions and tenure committee comprising internal and external peers (UWA 2004). Successful promotion is then based on internal procedures for determining satisfactory performance in the three activities of teaching, research and service/leadership (UWA 2007: 4). The relative weights of these three key areas of performance vary both between academic ranks and across universities, with generally greater emphasis on service and leadership for higher levels (University of Newcastle 2007). While some universities emphasise both teaching and research, others allow applicants to specify weightings between the three core activities (Winchester et al. 2006: 510). Regarding research performance, peer-reviewed publications in prestigious journals generally take precedence over other forms of publication (UWA 2008). An alternative path towards promotion is an ‘out-of-round promotion’, which occurs outside normal annual promotions cycles and can be arranged in response to a ‘counter-offer’ from a competing institution (Winchester et al. 2006: 509-10).

Probably the greatest difference between Norwegian and Australian universities lies in promotional opportunities at the lower levels. A lack of permanence generally excludes casual employees from promotional opportunities and creates practical problems for fixed-term staff. While it is reasonable for university promotion policies to exclude casual employees based on the temporary nature of their positions (UWA 2004; University of Newcastle 2007), unfortunately there is an overlap between the casual and fixed-term categories, leading to a larger than formally required casual staff base. For example, an academic employed to teach tutorials every week for a semester ought to be employed as a "fixed-term" employee if the module being taught forms part of the permanent curriculum, but in practice such staff are likely employed on casual Level A contracts which exclude them from promotion opportunities. The growth and increasing reliance on casual academic staff, most of which are employed for teaching duties, also indicates that informally there is a growing number of teaching-only staff who have limited opportunities for promotion (DEST 2008; NTEU 2008).

The NTEU claims that casual/sessional academic employment may be like a treadmill whereby academics are appointed to rolling casual contracts, year after year, rather than appointed to entry-level fixed-term or continuing academic positions (NTEU 2007: 20). Fixed-term staff also face problems in eligibility for promotion as they may not have been employed for the minimum qualification period, which can require between 2 and 3 years prior service (UWA 2004; University of Newcastle 2007). Even part-time staff may have difficulties accessing promotion opportunities with around a quarter of Australian universities not specifying that part-time employees are eligible for promotion (Winchester et al. 2006: 510). Further, several Australian universities that do offer promotion to part-time academic staff restrict eligibility to only those who have a minimum 0.5 fractional full-time status (Winchester et al. 2006: 510). The differential treatment of full-time workers versus the ‘non-standard’ employment arrangements is a striking example of labour market segregation and has been labelled in the United States as the ‘academic underclass’ (Jacobs 2004: 14-5). As women are disproportionally employed on a casual, fixed-term or part-time basis, this raises significant concerns for gender equity in Australian universities.

In summary, the structures of the university sector, academic career and promotions systems differ between Norway and Australia, and these differences are likely to affect the incentives and opportunities to engage in research. In Norway, the binary separation between colleges and universities combined with the clearer and more regulated academic career structure will likely reduce the diversity of opportunity within the academic population. The merging of the college and university sectors in Australia in the late 1980s created both a hierarchy of research institutions and incorporated a large group of previously less research orientated staff into the academic community. The less clear and more highly stratified academic career structure within the Australian university sector will have important implications when examining differences in research output between men and women. The centrality of publication goes beyond production and dissemination of new knowledge, as it is also the key output that is rewarded by university systems. The link between success in publication and career advancement (or stagnation for those who do not publish) has underpinned the 'publish or perish' principle that has become increasingly part of the academic mindset. While women may disproportionally 'choose' to be in academic positions that have less security, recognition and research opportunities, gender-based pressures may also inhibit women from a successful career path. The diversity of research productivity across academia and factors associated with high productivity will now be addressed in greater detail through development of a theoretical framework and a review of existing literature on research productivity.

3. Theoretical framework and literature review

According to Turner (1991 in Blaikie 2000: 153) concepts are the building blocks of theories and it is through theories that researchers seek to explain what is happening in the social world. *Concepts* are the precise and technical definition of ideas surrounding a subject matter. It is only through the careful definition of concepts that *theories* can explain relationships between concepts. The operationalising tradition of social research is concerned with turning concepts into measurable *variables*, which can in turn be used to develop or test theories. A deductive research strategy derives *hypotheses* from existing theories and uses measurable variables to test whether hypothesised relationships exist. Thus hypotheses are developed from theories, theories are built on concepts, concepts are constructed from definitions and operationalised as variables, and variables are used to test hypotheses. Concepts must therefore be constructed precisely to ensure that when one develops hypotheses from existing theories, one examines the phenomenon in question consistently with previous researchers.

This may seem a very abstract starting point for a discussion on how men and women differ in research productivity, but there are good reasons to draw an early distinction between concepts, definitions, variables and theories. In this thesis there are numerous concepts that will need to be defined precisely and there are also various theories explaining relationships between concepts. "Research productivity" is the most important concept as it forms the dependent variable for this thesis, but other concepts also underpin the independent variables which have been theorised to affect research productivity. For this piece of research to add something to the existing knowledge base, research productivity and various independent variables must be defined and operationalised in a procedure that is clear and consistent with previous studies. Therefore the theoretical framework and review of existing literature will follow the linear structure offered by Turner (1991 in Blaikie: 154). Each concept will be defined and introduced as a variable, and statements will be made as to the relationship between each variable and research productivity. The procedures for operationalising variables used in this thesis will be follow in Section 4 Data and Methodology.

3.1 Defining 'research productivity'

Before addressing the questions over differences in research productivity, it is important to have a clear understanding of how previous studies have defined and operationalised the concepts of “research” and “productivity”. Neither research nor productivity are unambiguous and to combine the two in a higher education context raises some problems. A defining characteristic of higher education is the pursuit, investigation and discovery of new facts or information, which can quite reasonably be defined as ‘research’ (Oxford University 1995 in Lertputtarak 2008: 18). Whereas secondary education and vocational educational providers deal with the transfer of knowledge and facts, institutions of higher education are responsible for enquiry and knowledge creation, dealing with uncertain, relative and provisional knowledge (Ramsden and Moses 1992: 274). The research process can be understood as having two broad components: knowledge creation and knowledge distribution (Gaston 1970 in Lertputtarak 2008: 19). The easier of these two components to measure and investigate through deductive reasoning is distribution. Publication is the conventional physical form that allows new knowledge to be distributed and critiqued by the academic community (Fox 1983: 285). As this thesis and many studies that have come before it operationalise the concept of research through publication data, the process of knowledge creation is not considered in the dependent variable, but rather is incorporated through the choice of independent variables.

Productivity is a more difficult concept to grasp as it also incorporates how research output is created. Productivity has been utilised as one of the basic economic variables governing the production process and is operationalised by calculating the ratio of output quantity (i.e. produced goods) divided by input quantity (i.e. consumed resources) (Tangen 2002: 1-3). One common misinterpretation is to treat increased production as equating to increased productivity. This is not necessarily the case as increases in output must be viewed in light of changes to inputs. A further misunderstanding is to relate productivity directly to “effectiveness”. Effectiveness is linked to the value and demand placed on outputs by internal and external stakeholders (Tangen 2002: 3). Increasing outputs relative to inputs would not improve effectiveness if the quality of the output deteriorates or if there is little demand for the additional output. Research outcomes are often valued in terms of university or individual recognition, or increasingly from a broader societal perspective, the translation of publications into applications in industry, medicine, or other fields (Doost 1996: 13). These outcomes are not necessarily measured through simple counts of published research outputs.

Bringing the two concepts together, examining “research productivity” in academia requires a careful understanding of the various inputs and outputs academics are expected to produce. The role of academics and the tasks they undertake are shaped by both regulatory environments and norms of the academic community (Kyvik 2000: 2). Academics perform multiple and overlapping roles which includes teaching, knowledge production, administration, enlightenment of the public and extramural activities (Kyvik 2000: 5). While administration duties, external service and public engagement help define the academic profession, teaching and research are the tasks that demand the greatest amount of time and energy for most academics. The close relationship between teaching and research in the modern university is a feature that clearly distinguishes universities from other research institutions. Indeed the complimentary nature of teaching and research has been deeply embedded into the university's academic culture since the emergence of the Humboldtian university model in Germany in the nineteenth century (Smeby 1998: 5).

The importance of understanding the multiple tasks of academics is to recognise that research is only one of the many outputs expected of academics. Likewise the multiple roles of academics necessitates that research output should not be understood in isolation of individual engagement in teaching or service to the community. Hence to compare the research output of a research-only academic with another who is more heavily engaged in public service or teaching, would misrepresent the research productivity differentials. As the first is far more likely to utilise or consume more resources in the research process than the latter academic, treating research outputs irrespective of inputs would not be consistent with the classical understanding of productivity. Applying a strict definition of productivity to academia from a managerial accounting perspective, Doost (1996: 14-5) recommends a detailed cost breakdown of each of the three tasks of teaching, research and service for individual academics. However, the overlapping nature of academic work makes consistent application of such techniques problematic, though attempts are usually made to distinguish between time spent on research, teaching, administration, service and other activities.

Most studies take a particular quantitative measurement of research output and use this as the dependent variable for which they try to explain variations across the population. Unfortunately for pragmatic reasons research productivity usually recognises individual academics as the only input into the process. For example, most studies of research productivity do not differentiate between the costs of employing a junior or senior researcher, or a full-time or part-time researcher, and as a result likely overestimate productivity of higher-paid employees who consume more university resources and inputs in the research process. Therefore rather than looking at outputs relative to inputs, a common definition of research productivity in academia is: “the totality of research performed by academics in universities and related contents within a given time period” (Hattie 1997: 454 in Lertputtarak 2008: 19). In other words, what most studies investigate is the mean production of research output per academic, rather than research productivity per se. Means and standard deviations of particular groups can then be compared, indicating differences in average productivity and degree of variability or inequality across academics. Additional inputs into the research process, such as the proportion of time dedicated to research or available resources, are usually treated as independent variables that help explain differences in productivity.

While the concept of research output is not particularly abstract, operationalising the concept does require a precise definition of valid research. Not all studies define research output consistently; some include only peer-reviewed publications such as books, articles and reports, while others include conference papers, newspaper articles or other forms of publication. As there can be overlap between publication types, whereby for example conference papers may later become journal articles, there is a risk of double-counting if a broad range of publication types are included (Kyvik 1991: 36). A narrow definition of research output may avoid the problem of overlap by restricting the concept of research to the single most important publication type, usually peer reviewed journal articles. However these restrictions are problematic in gender-based studies as male-dominated scientific disciplines communicate research more frequently through journal articles, while females are more likely to be located in the humanities and social sciences which have a propensity to publish books. Therefore operationalising research productivity by measuring a single component of research and assuming this component represents all aspects of the phenomena can easily be criticised for lacking validity given the diversity of research distribution channels (Blumer 1969 in Blaikie: 135-6).

As different researchers, disciplines and fields of learning have diverse production patterns across publication types, it may be more appropriate to develop a *productivity index* as the dependent variable. Productivity indexes require clear definitions for boundaries of valid research output, but essentially include multiple definitions based on different publication types such as: authored and/or edited books or book chapters, journal articles and reports (Kyvik 1991; Kyvik and Teigen 1996; Ramsden 1994; NAHEI nd). Research productivity indexes have been demonstrated to significantly improve comparability across fields of learning while maintaining high correlation with total publication counts (Kyvik and Teigen

1996: 58).

Some studies that utilise publication data across multiple publication types are forced to take a simple sum of publications as there may be difficulty disaggregating the data by type (Xie and Shauman 1998). However, ideally a productivity index provides a weighting for each publication type separately, so that more time consuming and substantial pieces of research, such as books, are given a greater value of ‘article equivalents’ they represent. The index’s sophistication is largely determined by the source data’s detail, with more detailed data providing greater opportunity to gain more precise measures of article equivalents. Detailed publication data may also allow weightings to be placed according to multiple or single authorship, length of publication or quality of publication based on publisher prestige, or the publication’s impact through citation counts. There is no standard method for determining how much more value is placed on particular publication types, but there are established guidelines. For example, Braxton and Toombs (1982 in Lertputtarak 2008: 22) surveyed a panel of scholars on the value each placed on various publication types and found scholarly books have the highest median value, with edited books receiving equal weight to articles in high quality journals, which in turn were rated higher than articles in lower quality journals.

The distinction between high and low quality publication outlets was also taken into account in the construction of output weightings in the performance-based research funding of Norwegian higher education institutions (NAHEI nd: 5-6). Books with less prestigious publishers are given a lesser value of 5 compared to 8 for more prestigious publishers, whereas journal publications are valued at 1 or 3 depending on the low or high prestige of their journal (NAHEI nd). Prestigious publication channels account for approximately 20% of Norwegian university publications (Sivertsen 2009). Where relative quality of publication outlet is unknown, previous studies have equated one book as equivalent to between 3 to 6 journal articles (Kyvik 1991; Kyvik and Teigen 1996), with edited books or chapters treated as equal to one journal article (Ramsden 1994).

While it is generally recognised that overlap occurs between conference papers, reports and journal articles (Kyvik 1991: 36), it should not be assumed that overlap does not also exist between journal articles and books. ‘Camera-ready manuscripts’ can be quickly turned into books through cutting and pasting from prior publications. For-profit publishers are known to exploit this method of publication as it costs little to the publisher or author and only requires a minimum amount of sales in order to recoup costs (Gal-el-Hak 2004: 61). The problem of double-counting is without doubt greater in productivity indexes, but the alternative of excluding valid publication channels would entail far greater validity problems for a gender-based and multi-disciplinary study.

In summary, research productivity is usually operationalised as a dependent variable based on published output derived from either surveys or institutional databases. Such variables are better measures of knowledge distribution and outputs, than of the knowledge creation process or improved research outcomes. Measures of research output are generally reliable but may lack validity for comparisons across institutions, disciplines or staff who publish in different publication channels. It should also be kept in mind that relatively basic quantitative counts of research output, such as the method used in this thesis, do not explicitly distinguish between high quality and low quality publications. Hence academics who are less prolific publishers may actually be more efficient and effective researchers if their publications are of higher importance or if they consume fewer resources in the research process. However, such academics will always be considered less "productive" when productivity measures do not account for quality or costs associated with research production.

3.2 Research productivity in academia

Arguably one of the strongest misconceptions of academia is the belief that all academics are roughly equal in their pursuit of research (Probyn 2002 in DEST 2002: 47). The reality is that academics are diverse in their research abilities, opportunities, behaviours and most importantly, outputs. It is now generally acknowledged that research production within the academic community is heavily skewed, whereby a small proportion of researchers produce the majority of all research. To explain the pattern of research distribution, Lotka (1926 in Kyvik 1991: 90) formulated his "Lotka's law", which stated that the number of scientists producing n papers is proportional to $1/n^2$. In other words, as the number of papers per academic rises, there are increasingly fewer scientists producing that given number, to the extent that 1 percent of all scientist produce a quarter of all papers and 6 percent produce half. While subsequent studies have shown that Lotka's inverse square law exaggerated the asymmetry and skewness of research production, the general pattern of inequality holds true (Kyvik 1991: 102).

Detailed multi-disciplinary studies of research productivity in Australia are surprisingly rare. One frequently cited study is that of Ramsden (1994) who examined research productivity[2] of 890 staff at 18 Australian higher education institutions over a 5-year period. Ramsden found average research output in Australian universities to be low and heavily skewed. Within pre-1987 universities, generally Go8 and ATN universities geared more strongly towards research, nearly 20 percent of respondents were 'non-publishers' having not produced a single academic publication in the last 5 years (Ramsden 1994: 218). Such rates of non-publication have a strong influence on overall patterns of research inequality. Ramsden's study found 14 percent of academics accounted for half of all research output and 50 percent of academics produced 87 percent of all research (Ramsden 1994: 218).

The Carnegie Foundation's 1996 International Survey of the Academic Profession (hereafter the "Carnegie study") included questions on research productivity and gained responses from 1420 Australian academics. In a book chapter on this data, Sheehan and Welch (1996: 73) found that over a three-year period (1991-93) Australian academics averaged 0.2 single-authored books, 0.2 edited books, 4.3 articles and 1.2 research reports/monographs. While research participation was found to be high with around 90 percent of all staff reporting engagement in research projects, the proportion of staff reporting to have published at least one journal article over this period was substantially lower at 69 percent (Sheehan and Welch 1996: 74). Research publication was also higher among what Sheehan and Welch (1996: 63) describe as the eight "research" universities in the sample, which essentially were seven Go8 universities (ANU was not included) and Flinders University.

A more recent survey, conducted in Norway in 2001, found the proportion of academics not publishing an article, book or report was comparatively low at 6 percent (Kyvik 2003: 37). This was also far lower than a 1982 survey in which 14 percent of academics did not publish (Kyvik 1991: 47). However, while rate of non-publication is particularly low in Norway, inequalities in research output between researchers have risen. In 2001, 18 percent of all researchers accounted for 50 percent of all research production, compared to 19 percent in 1992 and 20 percent in 1982 (Kyvik 2003: 43). Indeed the shear consistency of research inequality across many different studies is quite surprising. Fox (1983) reviewed research output studies in American and British institutions and highlighted a consistent inequity in

[2] Books authored x 3, plus the sum of peer reviewed papers, edited books and book chapters

distributions of research output, with around 15 percent of researchers accounting for half of all research across many disciplines (Cole 1979; Reskin 1978; and Allison and Stewart 1974; all in Fox 1983: 286). Fox (1983: 286) concluded that, despite the centrality of publication to the academic profession, average publication output is uniformly low and heavily skewed towards a small group of prolific publishers. More recent studies on American research output have also shown skewness of research output has remained remarkably stable, with around 15 percent of researchers accounting for half of all output (Long and Fox 1995).

So far this section has discussed research output for the overall academic workforce, which has shown mean research output to be generally low and highly variable. No reference has been made to whether different categories of academic staff have higher or lower average research productivity or whether variability differs across groups. As one might expect, patterns of research output are not random, and are in fact strongly correlated with certain characteristics which form the basis of independent variables in most studies. The characteristic of most interest in this thesis is gender. However, when reviewing literature on how research productivity differs across men and women, the overwhelming problem faced is the seemingly endless subtle variations in how research output is defined and operationalised. There are of course good reasons for different definitions of research productivity, particularly regarding the choice of sample (i.e. multi-disciplinary studies generally require broader definitions of research output than single discipline studies), but it does create difficulty in offering a broad estimate of how men and women differ.

Studies that have examined differences in mean research output between men and women have invariably found men to be between 20 and 50 percent more productive than women (Cole and Zuckerman 1984; Long 1990, Kyvik 1991; Kyvik and Teigen 1996). The persistence of the gender division has been conceptualised as a ‘productivity puzzle’ (Cole and Zuckerman 1984). Studies from the early twentieth century showed women to be far less likely to be prolific publishers, largely due to their structural exclusion from scientific networks (Cole and Zuckerman 1984: 221). However, even after the removal of many formal barriers, studies from the 1960s and 1970s did not indicate any appreciable improvement in the gender differences in research output (Cole and Zuckerman 1984). More recent examinations by Zuckerman (1991 in Xie and Shauman 1998: 847) found women in the United States still averaged only 50 to 60 percent of male research output, but these findings have been contested. A study of American faculty by Xie and Shauman (1998: 863) found:

“that the female-to-male ratio of research output increased from 60 to 65 percent in 1969 and 1972, to 75 to 80 percent in 1988 and 1993.” The authors attribute this improvement to more equitable resources and structural positions within universities and concluded that the academic’s gender had very little influence on research output once indirect effects of personal characteristics, structural positions and marital status were controlled (1998: 864).

The reasons why women and men differ on mean research output are indeed complex, but given that mean is a measure of central tendency, it is worth stressing that differences in mean productivity can be affected by both the proportion of respondents well below or above the mean. Long (1992: 167) followed a longitudinal cohort of American men and women who received PhDs in biochemistry (between 1950 to 1967) and found a greater proportion of females having very few publications. The proportion of non-publishers was consistently higher among women, peaking and stabilising at around 40 percent in the 10th career year, while the proportion of male non-publishers remained steady at roughly 20 percent, rising only after the 10th career year. In Australia, Sheehan and Welch (1996: 78) found non-publication rates to be similarly distorted, with 39 percent of females being non-publishers of journal articles over a three-year period, compared to 26 percent of male academics. In Norway, the rate of non-publication (either books, articles or reports over a three year period) was smaller at 14 percent of men and 17 percent of women (Kyvik 1991: 193), but a more recent study in 1998-2000 found only 6% of all Norwegian academics did not publish in the reference period (Kyvik 2003: 37). The comparably higher rates of non-publication in Australia compared to Norway can be explained partly by the more diverse academic career structure in Australia, whereby lower ranked staff frequently do not hold doctorate degrees or may be employed primarily for teaching duties.

Lower average research productivity among female academics is also due to underrepresentation of women in the most highly prolific publishers (Cole and Zuckerman 1984; Long 1992; Sonnert and Holton 1995). In Norway, Kyvik and Teigen (1996: 61) found that 26 percent of men compared to 18 percent of women published more than 3 article equivalents per year. Unfortunately it is rather difficult to find comparable data for Australia. The most widely cited study by Ramsden (1994) did not compare men and women explicitly, while both publications by Sheehan and Welch (1996; and with Lacy 1996) indicate only the proportion of men and women who published at least one publication, rather than average productivity. Data suggests that women have lower research productivity in Australia (Burton

1997: 118), but after controlling for rank, age, and discipline, these differences disappear (Deane et al. 1996, p. 21 in Burton 1997: 22). These findings are also supported by Castleman et al. (1995 in Hawkes 1996: 58) who found that men and women in comparable positions have similar research productivity. Ramsden (1994: 219) also notes that “At first sight there is a negative effect of female gender on output, but it is attributable to the different distribution of sexes in different academic ranks, women being under-represented in the more senior positions.”

In a comprehensive review of the theories and data surrounding research productivity, Fox (1983: 298) placed the determinants of research output fall into three broad categories: individual-level characteristics (psychological abilities; work habits; demographics); environmental location; and feedback processes. While broad frameworks such as Fox’s (1983) bring together the many theories and determinants of research output derived from existing studies, general frameworks are not entirely adequate when examining differences between men and women as they fail to account for why identical choices or characteristics operate differently for males and females. For example, the choice of starting a family may more directly impact the research output of women than men. The same may be said for other environmental factors, such as the benefit of attending a prestigious graduate school or receiving feedback from mentors and colleagues on one’s research performance. Therefore, while such characteristics may be general determinants of research output, this does not account for why these determinants operate differently for men and women.

Understanding gender-based differences in research output therefore requires an examination of both the factors that influence research output more generally and how these factors are influenced by gender roles. While gender-based comparisons need to consider the distribution of men and women across ranks, institutions and employment statuses (Burton 1997: 21), controlling for these factors can also distort the problem. For example, men and women of similar ranks and institutional profiles may exhibit negligible differences in research output, but this says little about why females are more likely to be located in poorer research environments. It is perhaps more interesting to ask why *not* controlling for these characteristics leads women to perform substantially worse in research measures and whether the structural positions of women are influenced by personal choice or discrimination. Fox (1983) provides a good overview of what factors contribute towards increased research output, and other studies (such as Xie and Shauman 1998) have demonstrated empirically how some factors are correlated with gender-based research output, but this only addresses *what* factors correlate with research output rather than *why* men and women differ on such characteristics.

3.3 Theories of gender differences in research output

Zuckerman (2001) outlines four classes of explanations for why women have failed to achieve comparable career success in academia: scientific ability; social selection, self-selection and accumulated disadvantage. The scientific ability explanation is the only theory arguing that an academic's gender has specific biological and psychological characteristics which have a direct influence on research output. The three other explanations see gender-based differences as arising from socialisation and environmental factors. 'Social selection' explains how gender-based decisions made by others affect research productivity of women. For example, by directly discriminating against women for certain positions or by appraising female performance differently, decisions made by others place women at a disadvantage. By contrast, 'self-selection' examines how individual choices affect their research output. Examples of these choices such as starting a family, dedicating efforts to activities other than research or working part time are all likely to have a negative impact on research output. Cumulative disadvantage (or cumulative advantage in the case of men) theorises how each of these decisions or events, regardless of whether they are based on social or individual choice, accumulate over time and generally place women at a disadvantage.

While Zuckerman (2001) offers a convincing framework for understanding why women and men differ on career success and research output, it is a somewhat difficult to apply since the categories overlap considerably. Decisions of self-selection, such as having a family or working part-time, can also be a source of social selection whereby women (or men who place a high priority on family) may be discriminated against based on their perceived 'lack of commitment' (Drago et al. 2001 in Austen 2004: 129). Other choices of self-selection likely to correlate with research output, such as preference towards research, discipline, graduate school or even deciding whether to become an academic, may also be influenced by the expectation or experience of discrimination. Therefore it may be inappropriate to clearly distinguish between social and self-selection and not recognise the overlapping subtle practices of discouragement and differential treatment. However, recognising that many choices affecting research productivity do fall within the control of individual academics does re-emphasise the importance of not “over controlling” when comparing men and women on research productivity. If men and women on average make different choices that affect research output, such as dedicating less or more time to research or seeking employment at a research intensive institution, it would be misleading to conclude that women and men are equal in research output after these factors have been controlled or a large number of men or women are filtered out.

Sonnert and Holton (1995) take a slightly different approach and explain gender-based differences through two models: the deficit model and the difference model. The deficit model encompasses all of the structural explanations, ranging from formal to informal exclusionary or discriminatory practices. The formal barriers include institutionalised or more overt discriminatory practices, while the informal barriers refer to less tangible day-to-day practices that treat women as ‘outsiders’ from circles of influence (Sonnert and Holton 1995: 10-11). Arguably improvements in the research productivity gender-gap can be understood as derived from the removal of formal barriers, while remaining disparities are indications that informal barriers still persist (Sonnert and Holton 1995: 10). The deficit model is essentially the same as what Zuckerman (2001) labels social selection, as women have no control over these practices and are more routinely affected by them than males.

Sonnert and Holton’s (1995) difference model also has similarities to what Zuckerman (2001) describes as self-selection, but places greater importance on how social pressures influence gender-based choices. While accepting that many choices are made by the individual, rather than viewing such choices as equally free and of equal consequence to men and women, the difference model recognises subtle pressures that shape female choices differently. For example, family or school experiences may discourage women from high career ambitions in science and may subtly place greater respectability on a family caregiver role. These experiences may frame career and family responsibilities as conflicting, discouraging women from placing career interests ahead of or even alongside those of family (Sonnert and Holton 1995: 12). The deficit and difference models do not offer entirely separate reasons for why men and women differ in research outcomes, as structural deficits may result from social exclusion or a perceived lack of choice. Understanding research outcomes therefore becomes a discussion of relativity, and whether to place more or less importance on structural barriers that block women from making choices to further their academic career.

A good example of the interaction between internal and external factors is the attribution and response to success and failure. Men have been found to be more likely to attribute personal success to internal factors (personal ability or behaviours) and failure to external factors (bad luck or task difficulty) (Frieze 1978 in Sonnert and Holton 1995: 13). In this way men may have been socialised to develop greater self-efficacy from positive feedback and become more resilient to negative feedback. Cole and Singer (1991) conceptualise how the academic career is shaped by a series positive and negative environmental events or ‘kicks’. The kicks themselves are beyond the control of the individual, but how one reacts to the kicks will influence career outcomes. Within the ‘deficit model’ women arguably receive more negative kicks, while the ‘difference model’ explains why men and women may react differently to similar events (Sonnert and Holton 1995: 16-7).

Whereas both deficit/difference and social/self-selection theories seek to explain why research output of men and women is affect differently by individual events and behaviours, cumulative disadvantage theory is more interested in explaining long-term impacts of a series of smaller events. Early set-backs in female careers, whether due to structural deficits of discrimination when applying for postdoctoral funding or an individual’s choice not to apply, will have long-run impacts on research productivity. The long run impact of early events is neatly summed up by the complementary theory of the “Matthew effect”[3], which argues that those who receive early recognition will continue to receive recognition and greater funding into the future (Merton 1973 in Sonnert and Holton 1995: 5). However, according to cumulative disadvantage theory neither postdoctoral training nor any other single factor taken in isolation explains differences between men and women in research output. Following a quantitative study of career success among 699 former scientific postdoctoral fellows, Sonnert and Holton (1995) provide a wonderfully clear account of how the theory of cumulative disadvantage was reflected in their findings:

> “This quantitative method produced a variety of interesting results, but fell short of fully explaining the highly idiosyncratic career paths of our respondents. The statistical effect sizes were, although significant, mostly small. This was to be expected according to the theory of the accumulation of advantages and disadvantages. There was no single characteristic, no single choice that would have guaranteed certain success in a science career – or irrevocable failure. Science careers appeared to be shaped, to a considerable extent, by numerous idiosyncratic events and characteristics that are often insignificant by themselves but become forceful in their

[3] The Matthew effect is taken from the Biblical Gospel of Matthew 29:29: For unto every one that hath shall be given, and he shall have abundance: but from him that hath not shall be taken away even that which he hath.

accumulation." (Sonnert and Holton 1995: 123)

Sonnert and Holton's (1995) answer to the shortcomings of using quantitative regression analysis to predict factors affecting research output was to conduct 200 face-to-face open-ended interviews. The interviews indicated that considerably more women (62 percent) than men (43 percent) faced obstacles that inhibited their career (Sonnert and Holton 1995: 124). Among the most significant findings was that while women faced less overt discrimination and had similar rates of participation in social and collaborative networks, the quality of these interactions was inferior to that available to men due to gender roles and subtle exclusion from informal networks. Therefore, while genders may be equal on quantitative characteristics based on simple "yes" or "no" participation or Likert scales, connecting these factors to their effect on research productivity, or even determining causality, is very difficult without speaking to respondents directly. Unfortunately, as this thesis is restricted to quantitative analysis, connecting *what* influences or correlates with research output with *why* such variables correlate, can not come from asking respondents directly. The hypothesised influence of individual variables and their interrelationship must therefore be derived entirely from theories of previous studies. Having reviewed general theories on why men and women differ on research and career success, attention will now be given to specific determinants of research output which will underpin the choice of independent variables.

3.4 Factors affecting research productivity

Marriage, children and caring responsibilities

Marriage and domestic responsibilities have been identified as two of the most important variables explaining why women and men differ in career and research success. These are particularly difficult concepts to discuss in isolation of other factors as marriage and division of domestic labour is mediated by other variables. Traditional marriage and gender roles place a greater burden of caring responsibilities on women and these responsibilities are a major reason why women reduce their hours of work or delay the start of their academic career (Probert et al. 1998 in White 2001: 67). Such decisions have long-run effects as women who delay commencement of their academic career, whether for family reasons or otherwise, have greater difficulties gaining promotion later in their career. For example, Long, Allison and McGinnis (1993) found that for every additional year between completion of a doctorate and the first academic position, the odds of promotion decrease by 9 percent for women, but not for men. Traditional gender roles and relative ease with which married men with children can continue to work or even dedicate extra unpaid hours to research may account for one of the greatest advantages men hold in the research community.

However, division of caring responsibilities is based in gender, rather than sex or marriage. Men are becoming increasingly interested and even pressured to devote more time to family responsibilities. These pressures have many origins, but the rise of dual-income family structures has reduced the ability for men to rely on a stay-at-home partner (Jacobs 2004). More direct involvement of men in family responsibilities has been identified in broader labour market reports from the United Kingdom, where almost two fifths of fathers wish to reduce working time for family reasons (The Work Foundation 2005). Not all fathers hold such desires though as other studies from the United States have found, many men wish for longer working hours in order to provide greater financial support, or even to escape from their families (Hochschild 1997 in Reynolds 2003: 1190). Clearly great diversity exists among fathers with some continuing to uphold the traditional male breadwinner model, while others increase time dedicated to domestic responsibilities.

One factor that is likely to affect how married couples choose to divide their domestic responsibilities is the spouse's occupation. Fox (2005) closely examined the influence of marriage type and family composition on research productivity by gender. For both men and women marriage was associated with higher research productivity, but for women the type of marriage was particularly influential. Re-married women married to a fellow scientist (subsequent marriages were also more likely to be to fellow scientists) were found to be substantially more productive than those in their first marriage or in marriages to non-scientists. However, as women in subsequent marriages are more likely to be older than those in first marriages or unmarried, the positive influence of age and experience on research productivity are likely to overlap. This is perhaps best indicated by the finding that divorced and widowed male scientists were the most highly productive groups (Fox 2005: 137). More generally, women married to non-academic scientists and other professionals were found to have very high rates of productivity (Fox 2005: 138). However, even when women are married to fellow scientists or professionals, they may suffer from being the "trailing spouse", whereby priority is given to the husband's career (Sonnert and Holton 1995: 161). This could be a particular problem within the academic career given the growing importance of "cosmopolitan" research orientations and the limited ability for some women to attend conferences or participate in research projects abroad.

The presence or absence of children is a very complicated factor as the impact on research output will likely differ based on the number and age of the children, the family composition and the organisational context. Kyvik and Teigen (1996: 63) found women with children under ten years of age were 41 percent less productive than comparable men, but women with children over ten were only 8 percent less productive. Given that women were 20 percent less productive in research output overall, gender disparity associated with younger children may be temporary and weaken as children become older, though this can not be conclusively drawn from cross-sectional data. However, an earlier study by Kyvik (1990: 215) also found women with children 10 years of age or older were equally or more productive than men of similar academic ranks and family status. By contrast, women with children under the age of 10 were considerably less productive than men. Such findings generally do not support the theory of accumulated disadvantage which would argue that the impact of having children has long-run negative consequences for women. Nevertheless, the reduction in gender-based differences in research productivity amongst older academics is consistent with longitudinal studies from the United States which found that research differences begin to decrease after around the 8th year of the academic career (Long 1992).

Sonnert and Holton's (1995: 156) study of postdoctoral scientists did not find strong interrelationships between marriage, children and research productivity. Interestingly though, women were more likely than men to report that career demands influenced their choice not to get married (27% of men and 35% of women) and their choice not to have children (46% of men and 78% of women). It is not surprising that career orientated female recipients of prestigious postdoctoral positions may self-select out of having children or getting married. Long et al. (1993) found that while marriage had a strong positive effect on the likelihood of promotion, for women this is counteracted by negative effects of children during graduate training and early stages of the academic career. Long (1989) also found a strong and positive influence of marriage on research collaboration for women during the doctoral training period, but a negative impact of children. For women, marriage was found to double the odds of collaborating with one's mentor, while children under the age of six had an opposite effect whereby each additional child reduced the odds of collaboration by half (Long 1990: 13-4). The positive influence of marriage may be due to the easing of unwritten rules that govern how older male academics should interact with unmarried female staff (Long 1990; Sonnert and Holton 1995: 161).

In summary, marriage has been found to have a broadly positive influence on research productivity for men, but the type of marriage is more important for women (Kyvik 1990; Fox 2005). Likewise, while presence of children has very little impact on male research productivity, young children have a significantly negative influence on female research productivity (Kyvik and Teigen 1996: 67). However, the complexity of child rearing is often hidden in studies as female academics are also more likely to self-select out of having children or have fewer children if domestic demands can not be balanced with the work environment (Sonnert and Holton 1995: 156). The remaining group of women that choose to have children are also likely to be diverse, including early career academics and women who have delayed family choices until after establishing their career. Generalisations on such a diverse group can not easily be made. Given the stronger impact of marriage and children on female career outcomes, it is understandable to see family and marriage as factors that fragment the female academic population into smaller groups. Married women face different social pressures to unmarried women, while the choice of having children likewise impacts women differently. Men simply do not experience these divisive pressures to the same extent. Even with a growing number of men in dual-income families and taking a greater interest in domestic responsibilities, men are still likely to benefit from a "trailing spouse". Men are also far less likely to have networking and collaboration opportunities influenced by their marital and familial status.

Organisational context and culture

How well have universities reacted to the growing pressures to accommodate family responsibilities into the traditional academic career? The lack of university-wide policies for family responsibilities and the rigidity of the traditional career model are seen as key factors that still disadvantage and sub-divide the academic profession based on gender (Etzkowitz et al. 1994). In Australia, there is little doubt that the male breadwinner model still encourages career breaks for women rather than men. Australia is one of only two OECD countries (the other being the United States) without any guaranteed paid leave entitlements for parents and generally performs poorly in most international benchmarks for early childhood services (UNICEF 2008). As with other conditions of employment, leave provisions for university staff are negotiated through institutional level agreements. For example, the University of Melbourne's collective agreement (2006) entitles female staff to 14 weeks paid maternity leave after one year of service or 24 weeks paid leave after five years. Male staff are entitled to five days paid leave or up to one year unpaid parental leave in cases where they are the “primary care-giver”, which by default they are expected not to be. The picture is rather more encouraging within Norway where early childhood services are comprehensive and the social security system supports both men and women for 44 weeks of parental leave paid at full pay or 54 weeks at 80 percent wage compensation which can be divided almost equally between parents (UNICEF 2008; Norwegian Ministry for Children and Equality 2007).

Dever and Morrison (2009) in interviews with 27 female academics at leading Australian universities found that while mentoring and access to workplace flexibility schemes play key roles in enhancing research participation, a resistant workplace culture and relatively rigid promotions schemes discourage utilisation of such practices. White (2001) goes further to claim that the exclusionist male workplace culture in Australian universities is downright hostile towards women. In Hofstede’s (1984: 85) classic international research on cultural dimensions of management and planning, Australia was considered extremely individualistic and highly masculine, compared to Norway which ranked extremely low on the masculinity index. Hofstede (1984: 84) describes masculinity as “a preference in society for achievement, heroism, assertiveness, and material status. In opposite, femininity stands for a preference for relationships, modesty, caring for the weak and quality of life.” Hofestede believed that such social values permeate institutions. Given the relatively deregulated structure of Australian workplace relations, the high levels of university autonomy since the restructuring of collegial decision making in the 1980s and the typically masculine nature of higher education, it would be reasonable to conclude that masculine values still typify workplace culture in Australian universities. Lafferty and Fleming (2000) argue that shifts towards market-driven managerialism has entrenched a gendered character of university power relations in Australian universities by empowering predominantly male department heads with authority to shape academic careers and increase internal inequalities between staff.

Interestingly though, the proportion of women in higher levels within Australian universities has steadily increased over time. Between 1996 and 2005 female vice chancellors rose from 5 to 23 percent and deputy vice chancellors from 19 to 30 percent (Universities Australia 2007). By international standards the percentage of Australian women in university senior management is comparably high (Ozkanli et. al 2008). Women are still a small minority of senior academics at around 24 percent of Level D and E professors (DEST 2008), but again this compares favourably with other countries. For example, in Norway women account for just over 18 percent of all university (full) professors (NIFUSTEP Statistics Bank 2008).

White (2001: 69-70) strongly doubts whether women will ever gain a ‘critical mass’ at senior levels in academia, as even when women are promoted it is believed that they must adopt the masculine culture. Etzkowitz et al. (1994) note that senior female scientists typically share values of the traditional male culture, which keeps the number of women in higher level academic positions low and fragments the existing base of female scientists into adversarial sub-groups. Edwards (2000) also argues that simply increasing numbers of females in academia will not overcome cultural problems in the workplace whereby notions of an uninterrupted and linear career requires successful women to conform to masculine values. Etzkowitz et al. (1994: 52) describe fragmentation of females within academia as “the paradox of critical mass”. However, Sonnert and Holton (1995: 51) found that female postdoctoral fellows face fewer disadvantages in disciplines where the number of female academics is greater, such as in biology. Chesterman, Ross-Smith and Peters (2003) also point to some positive evidence that the positioning of women as outsiders within Australian universities is also changing as women become more comfortable and “normal” in leadership positions.

The organisational context is a factor that affects all staff. Ramsden (1994: 219) found that the best structural predictor of research output for Australian academics was being in a highly active research department. Both female and male academics in highly research active departments were four times more productive than comparable colleagues in less research active departments. Sheehan and Welch (1996: 76) also found research output to be positively correlated with being employed at a research intensive university for all categories of staff except Level B male academics. The pattern of research inequality was also more extreme within less elite Australian institutions where around 10 percent of the staff produced half of the research (Ramsden 1994: 218). Ramsden (1994: 219) did not address the issue of gender directly, but indirectly it seems men have more favourable organisation contexts as highly research active departments are more likely to be in one of the pre-1987 universities, located in the physical or biological sciences and have staff less strongly committed to teaching. More recent estimates by Moodie (2004) found research publications per staff member to be generally highest within the Go8 universities, but interestingly non-publishing rates were not necessarily low at these institutions, indicating conditions vary substantially within institutions and institutional groupings.

The legislative protections for all university staff and the relative equity across Norwegian universities, renders cross-institutional comparisons less illustrative in Norway. Smeby and Try (2005: 595) argue that Norway offers a “quasi-experimental design” as uncontrolled factors related to institutional differences are almost non-existent, meaning comparisons can be easily made between individual staff across different universities. While the number of publications is highest amongst the Universities of Oslo, Trondheim and Bergen, this is more reflective of the relative size and disciplinary make-up of these institutions, rather than a disparity in research opportunity (Sivertsen 2008). Further, there seems to be little difference between Norwegian institutions in terms of the average quality of publication. The percentage of publications in higher prestige “Level 2” publication channels ranges from between 15 to 20 percent amongst all universities, with only the University of Stavanger falling considerably below the others at close to 10 percent (Sivertsen 2008). However, while research opportunities and output may be broadly similar across institutions, diversity exists across fields of learning (Sivertsen 2004 in Smeby and Try: 595).

Field of learning

Comparisons of individual research productivity must take into consideration how research patterns differ across specific academic disciplines and more broadly across fields of learning. Academic disciplines differ in both average research output and how these outputs are distributed across books and articles. Articles are relatively more common in natural and technical sciences, while books are more common in the humanities and social sciences (Creamer 1998: 10; Kyvik and Teigen 1996). These differences in publication patterns across academic fields have clear implications on broader comparisons between men and women as gender representation differs across fields. As stated clearly by Creamer (1998: 11): “Average journal publication rates are highest among faculty in high-consensus academic fields where there are many journals, acceptance rates for articles are relatively high, and articles are relatively short with multiple authors.” These factors also generally place disciplines within ‘hard sciences’ at an advantage to those with less clearly codified research practices. Under-representation of women in disciplines where journal publication is high has been offered as explanation for why women on average have been found to publish less (Creamer 1998: 10). Disciplinary differences also justify use of a research index or composite sum of different publication types, rather than a simple count. Research indexes have been shown to markedly reduce disparities in average productivity across fields of learning (Kyvik and Teigen 1996).

In an examination of research productivity across 27 disciplines in Norwegian universities, Kyvik (1991: 95) found the proportion of academics responsible for half of all disciplinary output ranged from between 15 percent in languages to 27 percent in education. The pattern of research inequality across disciplines may be partly explained by the degree of codification in the discipline, whereby it is more difficult to cope with rapid changes in more codified disciplines. Thus proportions of non-producers may be higher in codified disciplines and overall research output may be concentrated among a smaller group of prolific researchers (Kyvik 1991: 95). However, the level of codification may have more influence on the extremely high publishers than the proportion of non-publishers. Studies in the United States have found the proportion of non-publishers to be quite consistent across all disciplines (Creamer 1998: 9), supporting the conclusion that research inequality across disciplines is mostly brought about by the relative proportion of high publishers rather than non-publishers. When disciplines are grouped into fields of learning, many of the differences in research inequality disappear (Kyvik 1991: 93). However, rather than viewing the grouping of disciplines within fields as a solution to the problem of comparing men and women from different disciplines, one should be cautious as diversity within fields of learning may be masked in such comparisons.

In a study of differences in acceptance rates in journal publication across fields of learning, Hargens (1988 in Creamer 1998: 11) found an acceptance rate of 91 percent in physical sciences compared to 59 percent in biological sciences and 13 percent in social sciences. This would seemingly place women at a comparative disadvantage given their greater prevalence in social sciences. However, as the number of journals varies across disciplines, with highly codified disciplines tending to have fewer journals that publish a larger share of total output, rejection rates of individual journals by discipline is not necessarily a solid measure for publication difficulty or degree of consensus within a field (Cole, Simon and Cole 1990: 153). For example, given the high rates of rejection and larger range of publication channels within social sciences, academics within these fields may simply continue submitting their articles to various high reputation journals until accepted. Therefore, the difficulty of publication may be better explained by examining the proportion of research articles that never get published, rather than rejection rates of particular journals. Unfortunately, even overall rejection rates are likely to be of little value if one does not take into account the quality of the publisher given the expansion in number of low quality and less-selective journals.

Ward and Grant (1996: 173) describe the research process as following three phases. The *prepublication* phase involves deciding on the topic, scope, collaboration style and allocation of authorship credit for a given piece of research. In the *publication-seeking* phase, decisions on potential audiences and publication outlets are made, with authors making use of mentors and networks for help in the review and edit of the proposed research. The final stage is the *post-publication* phase where after research has entered the public arena, it is either utilised or ignored by the target audience, which affects institutional rewards and individual researcher reputation. Ward and Grant (1996: 199-202) argue that it is the publication-seeking phase where researchers are likely to receive the most number of set-backs or "kicks" when trying to have their work published, particularly early in their career. As women are more likely to be in social sciences where rejection rates are higher and may attribute rejection more negatively than male counterparts, women may face additional difficulties within softer disciplines. Given that women also struggle to collaborate with mentors in male-dominated disciplines where co-authorship is most widespread (Long 1990), women may likewise fail to benefit from support and co-authorship early in their career.

Research collaboration

While what constitutes "research collaboration" can vary and the direct benefits to research are not always clear, it is generally accepted that research collaboration has a positive effect on scientific publishing (Katz and Martin 1997). Among the most easily measured research collaboration forms is co-authorship of scientific papers. Various studies have shown a positive correlation between high productivity and high levels of co-authorship (for a summary see: Katz and Martin 1997: 5). While research collaboration is an individual behaviour, motivations to collaborate are also shaped by the environment. The increasing costs of large scale scientific research, the need for interdisciplinary solutions in the age of "mode 2" science, external funding application process and a wide range of governmental and institutional incentive structures, all provide external incentives for collaboration (Lee and Bozeman 2005: 673-4). Research collaboration is also an indication of a supportive organisational context, whereby academics belonging to research teams have been found to be more productive than more isolated individuals (Rey-Rocha et al. in Smeby and Try 2005: 596).

Potential benefits of collaboration include an increase in co-authorshed publications, improvements to overall publication quality and positive reinforcement from colleagues (Creamer 1998: 55). Women are more likely than men to co-author papers (Grant and Ward 1991 in Creamer 1998: 55) and to receive greater direct benefits from collaboration on individual research productivity (Kyvik and Teigen 1996: 67). International contacts benefit both male and female research productivity (Kyvik and Teigen 1996: 67), but it is often argued that men have stronger international networks (Cole and Zuckerman 1984). Australian men are more likely to engage in external consultation and are invited to more international conferences (Ramsay 1999 in White 2001: 68). Lack of access to male dominated collegial networks has been offered as explanation for why women and other marginalised groups fail to publish to the same extent as traditional males (Creswell 1985, Menges and Exum 1983 in Creamer 1998: 54). Fox (1983: 297) also asserts that when positive reinforcement is translated into additional resources, such as when collaborations lead to large-scale external funding, this also underpins the accumulation of disadvantage against excluded groups.

Melin (2000: 34) found that the most commonly cited motivations for collaboration and co-authorship among scientists were derived from extrinsic and pragmatic purposes, such as the co-author having a special competence or access to valuable data or equipment. Most collaboration was motivated by the belief that there was something to be gained, whether that be direct gains of new knowledge or social gains of making new contacts which may be valuable in the future (Melin 2000: 38). Collaboration and networking have been identified as particularly vital for academics in countries located in the scientific periphery, who need to collaborate internationally in order to be visible within scientific centres (Kyvik and Larsen 1997: 241). While both Norway and Australia are wealthy countries with well established infrastructure and scientific ties to North America and major European centres, both countries have relatively small populations (approximately 5 million in Norway, 22 million in Australia), are geographically isolated, spend below the OECD average on research and development[4], and in the case of Norway, has a unique local language. One of the greatest benefits of international research collaboration may be that accumulation of resources and a development of a strong research profile raises visibility and attractiveness of the individual for future collaborations. International conference participation is a indicator of one's engagement with the international community and being invited to present research findings, or even simply offering to do so, is strongly associated with higher research output (Kyvik

[4] OECD average is 2.3% of GDP, Norway spends 1.6% and Australia 2% (OECD 2009)

and Larsen 1994).

The pragmatic motivations for collaboration raises the central problem of how to treat co-authorship in publication counts, as collaborative contributions can range markedly from general advice or allowing access to materials, to substantial contribution (Katz and Martin 1997: 3). While “honorary co-authorship” is considered academic fraud, individuals controlling larger amounts of resources who are sought out by others as collaborators may enjoy the subtle benefits of inflating their publication list by receiving equal credit on projects where their contribution was not equal. It would be unrealistic to assume collaborators in co-authored publications always contribute equally to the research project. However, as collaborators often are not equal in their power in the relationship, it would be reasonable to speculate that those sought out as collaborators have greater opportunities to benefit from co-authorship with minority contributions. Indeed it may be assumed by some that the more senior and recognised researcher contributed *more* to the research process than the junior partner. This process, more has also been offered as an explanation of cumulative disadvantage for women in particular whereby: “women are allowed access to scholarly careers but receive systematic underrecognition for their contributions in academic settings” (Ward and Grant 1996: 81).

Academic norms still shape much of the mentoring process of early career academics. Lee and Bozeman (2005: 693-4) found that senior faculty members were more likely to collaborate as mentors to early career scientists, with junior scientists greatly benefitting from the transmission of craft knowledge. Williamson and Cable (2003) found that early career research productivity among management faculty was positively influenced by the mentor’s research productivity, though they warn against assumptions of causality as more prominent senior researchers may also choose more capable apprentices. The benefits of supervising students is less clear and varies considerably by academic field and type of student supervised. Kyvik and Smeby (1994: 235) found an overall positive correlation (Pearsons r = 0.22) between the number of graduate students supervised and research productivity of Norwegian academics. However, the supervision of major subject students[5] was significant only in the humanities and social sciences, while doctoral student supervision was significant in the natural sciences, medicine and technology.

[5] Major subject students in Norway are final year undergraduate students who complete a substantial research project, broadly comparable to honours students in Australia.

The differences across fields and the generally more positive responses for supervising doctoral students can be understood based on the knowledge structures of the fields, whereby social science and humanities students tend to operate more independently while the "hard sciences" have greater codification, sharing of equipment and more hierarchy (Kyvik and Smeby 1994: 237). Unfortunately while women are more likely to collaborate with their mentors in the sciences (Sonnert and Holton 1995: 115), their collaborative relations can be marred by subordination and family responsibilities (Long 1992). The transition from the early career subordinate collaborative relationship to a more egalitarian collegial role may also be more challenging for females, as women have been found to collaborate less in the post-doctoral fellowship in comparison to doctoral training (Sonnert and Holton 1995: 116).

Research collaboration takes many forms and not all have direct impacts on number of publications. One of the most important benefits of collaborative research is "quality control" from having multiple academics reviewing the publication. However, this may reduce efficiency in terms of the quantity of publications, particularly in low consensus academic fields with essayistic publications where agreement on both content and style can be fraught with difficulties (Kyvik and Smeby 1994: 237). The problem may be exacerbated for women given their greater likelihood of being located at the periphery of low consensus fields. An interesting finding from Lee and Bozeman (2005: 693) was that the while simple counts of individual article publications were significantly and positively dependent upon the number of colleagues as collaborators, when the number of publications are fractionally divided based on number of co-authors, the relationship is not significant.

All scientific publishing is to some extent collaborative as it is a social process of utilising, building upon and verifying existing knowledge created by others. Research collaboration is often assumed to have an overwhelmingly positive effect on research productivity, but such research invariably has transaction costs and time delays whilst waiting for feedback from colleagues. Collaboration may improve the quality of research, but this may come at the cost of lower research productivity when quantitative counts do not adjust for quality of output. The influence of collaboration on gender-based research productivity is not very clear. Women may gain less from research collaboration due to their location in fields where collaboration is more time consuming, their underrepresentation in the higher ranks in fields where supervisor-subordinate collaboration provides advantages (Kyvik and Smeby 1994) and their lack of numbers and status as "informed outsiders" in science. Alternatively women may have less developed international research networks due more simply to their greater family responsibilities and their tendency to lack geographic mobility in relationships where they are the "trailing spouse" (Sonnert and Holton 1995). However, perhaps the greatest importance of collaboration for increasing one's quantitative research output is that which can be least easily measured; the positive feedback and motivation one receives from being identified by one's peers as someone with valuable knowledge and collaborative potential.

Age and experience

Following a review of previous studies on the determinants of research output, Fox (1983: 298) concluded: "Although the strength and particular form of the age and productivity relationship varies between studies, most investigations have shown that productivity tends to decline with age." This is a somewhat confusing conclusion, as many studies reviewed show a *gradually decelerating increase* in productivity or a "curve-linear relationship", whereby productivity rises with age initially and then commences a steady decline until retirement. Explanations the existence of this relationship between age and productivity exists are many and overlapping (Fox 1983: 290; Kyvik 1991; Kyvik and Olsen 2008). Firstly is the theory that intellectual capacity deteriorates as one gets older. Realistically this is the only theory that explicitly examines physical aging, whereas the majority of theories actually refer to the effect of experience that comes with aging or changes in the life-cycle. For example, the theory of the harmful effects of specialisation and obsolescence of old knowledge is not based on aging so much as passing of time since completing education or doctoral training. Even theories based on a lack of creativity and "fresh thinking" among older staff may be more associated with previously learned methods, rather than the physical process of aging. The argument that older staff face declining interest, demand or utility of additional research is also better understood by experience rather than aging, as accomplished researchers are also more likely to be experienced. Finally, the effects of cumulative advantage, whereby resources become concentrated among the few academics who receive professional recognition early in their career, is likewise a theory associated with experience. It is not the age at which one receives a positive or negative 'kick' that is of importance, rather it is the early timing of such events in one's career.

One of the main problems with studying the influence of age on research productivity is disentangling the impact of the age of the academic, the cohort effect (the generation to which the academic was born) and the period effect (the time when the research output is measured). Most empirical studies of research output take individuals born at different dates, observe them at different points in time and then try to separate the relationship of age, cohort and period effects on research output (Hall, Mairesse and Turner 2007: 159). Unfortunately, each of these three factors likely influence the level of research output and it is not possible to control for all effects separately. For example, cross-sectional surveys of research output tend to include academics of different generations and ask for an estimate of research output over previous years. In this case, the data may indeed show that research output rises to a peak among academics aged 45-49, then steadily declines in older cohorts and hence shows a curve-linear relationship (Kyvik 1991: 158). However, the rise or decline in research output by age cohort is due to more than simply the effect of aging.

Without longitudinal data for age cohorts, there is no way of concluding that research output declines with aging. Indeed cross-sectional data may mask a steady *increase* in research output among older generation of academics. When comparing research output of academics of different ages but at the same point in time, it is reasonable to assume that prior training or research potential would differ based on the period when the academic was recruited and trained. Therefore, if older generations commenced their careers at a time when competition for entry was lower, their research output may have increased over time, but given the lower quality of the overall cohort, it increased from a lower base or at a slower rate than more recent generations in the same dataset. A recent study by Kyvik and Olsen (2008: 454) also found that previous indications of declining research output with age may result from generational effects rather than aging. Taking cross-sectional data from 1982, 1992 and 2001 the relationship between age and output across age groups became flatter and less curve-linear in recent surveys. Differences between age cohorts also decreased, indicating that an older generation of less research orientated staff skewed previous cross-sectional studies. However, these speculations are impossible to verify with certainty, as to truly separate the effect of generational differences from the aging process one would have to observe two or more individuals at the same time who have the same age but were born in different generations (Hall, Mairesse and Turner 2007: 159). This is of course impossible.

Longitudinal studies have fewer methodological difficulties, but the problem of separating environmental factors from the aging process remains. Average publications per academic have risen over time and few would doubt that pressure to “publish or perish” is now more widespread. Therefore, a rise in publication with age within a longitudinal study will still not separate whether research output rose due to aging effects or due to the period effect of changes in the environment. Long (1992) studied the impact of experience on men and women by following publication rates of a sample of scientists who completed a doctoral degree in biochemistry between 1950 to 1967 and found that research output by the male cohort (1956-1963) grew at a rapid but declining rate in the first 8 years followed by a plateau and a slight decline at the end of the 16th year. The comparable cohort of women exhibited a slower but steady increase across the entire 16-year period, thus the large initial gap between men and women in the first 8 years slowly reduced after the male cohort stabilised in its research output (Long 1992: 163). Long's study also showed a curve-linear relationship between experience and research output, particularly within the male cohort.

Long's study contradicted the earlier findings of Cole and Zuckerman (1984) which concluded that differences between men and women increase over time due to accumulated advantages. Long's findings are supported by a cross-sectional study which indicated research differences between men and women declined within older age groups (Kyvik 1991: 192). The obsolescence theory would suggest research output would be more difficult to maintain as one aged in a highly codified and rapidly changing discipline such as biochemistry, where newer generations bring fresh knowledge and training to the discipline (Kyvik 1991: 169). While this would explain why men plateaued and declined in research output in later years, it does not support the findings for women where research output continued to rise. The steady rise of female output may more likely result from societal and family factors which delay commencement and progression of female academic careers.

Overall, an academic's age seems a poor indicator of research productivity, whether operationalised based on birth (age) or graduation (experience) in cross-sectional or longitudinal studies. While the positive and curve-linear relationship between age and output may generate a strong correlation coefficient, age is more likely a proxy for experience, academic rank and in gender-based studies, the period when family responsibilities take the greatest toll on a women's research output.

Academic rank

Perhaps the strongest factor that operates irrespectively of gender is academic rank. Full professors in the United States were found to be 20 to 40 percent more productive than associate professors, who were a further 10 to 20 percent more productive than assistant professors (Xie and Shauman 1998: 862). Sheehan and Welch found that among Australian academics, research productivity (calculated as an unweighted sum of all publications over a three-year period) rose with higher academic ranks from 1.7 publications for Level A academics to 9.9 publications for Level E academics (1996: 74-6). The same predictable trend was found in Norway whereby Professors were over 50 percent more productive than Associate professors (Kyvik 1991: 173; Kyvik and Teigen 1996: 67). However, whereas women and men of similar ranks have been found to have similar productivity in Australia (Deane et al. 1996, p. 21 in Burton 1997: 22; Castleman et al. 1995 in Hawkes 1996: 58: Ramsden 1994: 219), men and women at similar ranks are not equally productive in Norway. Women in Norway were less productive than men of similar ranks, but more productive than men of ranks immediately below (Kyvik 1991: 191). Kyvik and Teigen (1996: 67) also found that progressing to full Professor had a far greater positive influence on research productivity of men than it had for women. Therefore, differences in research output between men and women were greater among full Professors than Associate or Assistant Professors.

The influence of academic rank on research output is complex as it is both a cause and an effect of research output. Academic rank is most noticeably an *effect* of greater research output, as research performance is a key criterion for promotion in Australian and Norwegian universities, along with teaching, administration and service to the community. As men have been shown on average more prolific publishers than women, it is unsurprising that men hold a greater proportion of higher academic ranks than women. The extent of inequality between men and women in academic rank is widely recognised. In Australia the majority of male academics are employed in Level C and above, while the majority of female academics are employed in Level B and below (DEST 2008). In Norway over half of all men are in Professor or Academic Director positions whereas three quarters of women are in positions below this level (NIFUSTEP R&D Statistics Bank 2008).

If academic rank was simply an effect of research output, there would be little value in including academic rank in any study seeking to explain why academics differ in research productivity. In other words, if one was promoted based purely on research output, then whether one chose research productivity or academic rank as the dependent variable would be irrelevant, as all factors effecting academic rank would have the same influence on research output. However, research is only one of many duties of academics and academic rank is also a *cause* of research output. Higher ranking academics likely benefit from better access to internal and external research funding, and in the case of Level E academics in Australia, may have minimal teaching responsibilities and/or not be required to teach undergraduate classes.

After briefly reviewing statistics on academics ranks of women in Australia, White concluded that as women are overrepresented in lower ranks, they must therefore have fewer opportunities than men "to gain the necessary qualifications to become research active" (White 2001: 66). It may be true that academics in lower ranks have fewer chances to gain research reputations. However, this cannot be seen as a major reason for why women hold a disproportionally large share of such positions, unless the developmental and subsequent promotional opportunities are somehow worse for women than men in similar positions. It is an even less adequate explanation for differences in Norway given that equal opportunities to research are formally guaranteed for staff of all ranks (Kyvik and Smeby 2004: 318). Most studies of differences in career achievement of women instead claim that the competitive process of self-promotion discourages women from applying for promotion, rather than any structural factor holding women back (Winchester et al. 2006). Indeed women have been found to be more successful when applying for promotion than men, but are far less likely to apply for less transparent "out of round promotion" whereby promotion is granted based on a counter-offer from a competing institution (Winchester et al. 2006: 509 & 518).

Time use

The work habit that has probably received greatest attention for its impact on research productivity has been the investment of working time. If one accepts that time is a limited commodity, then time devoted to one academic activity must come at the cost of time available for competing tasks. Thus time and energy required for teaching, preparation, consulting with students and grading their work is likely to come at the cost of time available for research, which in turn will negatively impact publication rates (Milem, Berger and Day 2000: 458-9). Massy and Zemsky (1994: 2) see a strong link between incentive structures of rewarding research over teaching and desires of academics to increase research output and professional services. They describe the process by which academics increase their discretionary time to pursue research and professional goals through the loosening of institutional ties and teaching responsibilities, as the 'academic ratchet'. If universities fail to sufficiently reward academics for time dedicated to high quality teaching and instead appraise academics primarily on research output, then it could be expected that academics will spend more time on the activity which provides the greatest career advantage. Both total working time and percentage of time dedicated to research have been argued to be strong predictors of research output and major conceptual explanations for differences in research output (Creamer 1998: 48-9), but there is far less evidence suggesting a negative influence of teaching time on research output.

Unfortunately, calculating total working time and allocations between duties is notoriously difficult in academia given the professional autonomy academics have beyond teaching and administrative meeting hours. This is compounded by fluctuations in time available for differing activities during and between semesters and by the overlapping nature of academic duties (McInnis 1999: 19). However, academia has been broadly characterised as a long-hours profession whereby academics typically average around 50 hours per week regardless of country examined (Kyvik and Smeby 2004: 318; Carvalho and Santiago 2008; McInnis 1999: 19). In an examination of cross-sectional data, Goedegebuure et al. (2009) found working hours during teaching periods increased among Australian academics from 46.6 hours per week in 1977 to 50.6 hours in 2007. In Norway, Kyvik and Olsen (2008: 446) used three cross-sectional surveys (in 1981, 1991 and 2001) to find that while average working time has remained stable among older academic cohorts, at around 49 hours per week, average working hours has been reduced to 44 hours per week among the younger generation of academic staff. The authors conclude that this can be explained not only by the growing number of female staff, but also by a shift in values whereby: “female and male staff with small children no longer seem willing to sacrifice family life to long working hours” (Kyvik and Olsen 2008: 446). While this may be true, as the study did not exclusively examine staff with children, the changes could indicate a broader generational shift in workplace culture away from working long hours irrespective of whether one has children or is married. A more positive conclusion from such widespread reductions in academic working time may be that Norwegian universities have become more accommodating of staff who do not wish to work the traditionally long hours associated with academia.

Evidence of a shift in time towards research activities receives some support in Australia. Goedegebuure et al. (2009) found that teaching time dropped from 23 hours per week in 1977 to 18 hours per week in 2007, while research time has risen from 11.5 hours per week to 14.6 hours in 2007. As a proportion of working time, teaching has declined from 51 per cent of total weekly hours in 1977 to 36 per cent in 2007. In Norway there is very little evidence of academics transferring their work efforts towards research. Between 1981 and 2000, the proportion of time spent on research and teaching have remained very stable across all age groups, with the exception of the youngest group which now spend proportionally *less* time on research relative to teaching (Kyvik and Olsen 2008: 446). The relative stability in working time in Norway may be partly explained by more regulated institutional conditions, whereby all staff must contribute equally to teaching. In Australia, where departmental heads have greater freedom to implement incentive structures (Lafferty and Fleming 2000: 260), overall teaching responsibilities may have been reduced for some staff or transferred to low-ranked, casual academic staff who fall outside the target population of the survey (Goedebegeburre at al 2009).

When examining academic working time based on gender, most studies have shown that women work, on average, fewer hours than men (Kyvik 1991; Sheehan and Welch 1996; Jacobs 2004). Bellas and Toutkoushian (1999: 372) took three separate definitions of working time (paid working time at the institution; both paid and unpaid institutional working time; and all institutional working time and unpaid professional service) and found that across all three definitions men work significantly ($p < 0.001$) more hours per week than women. Interestingly when applying the strictest definition of working time (paid only hours) academics averaged 41.2 hours per week (men 42.1 hours; women 39.8 hours) whereas when the broadest definition is applied total weekly working hours rise to 48.7 hours (men 49.4 hours; women 47.7 hours). This indicates that the often reported 50 hour average working week in academia is most likely due the inclusion of unpaid overtime or professional commitments outside the institution in self-reported working time estimates.

As women have often been concentrated in institutions with stronger teaching orientations, it is unsurprising they have on average devoted proportionally less time to research than men (Creamer 1998: 49). However, it is important to draw a clear distinction between proportions and actual working hours when understanding their implications on research output for men and women. Comparisons of percentages of time spent on research and other activities can be misleading if not considered within the context of total hours worked (Bellas and Toutkoushian 1999: 367). For example, while men may average a smaller proportion of time teaching than women, men may still average more hours teaching per week if their overall weekly hours are longer. The same premise holds true for any comparisons between groups of staff of different academic ranks, institutional types, disciplines or temporal (full time/part time) employment status. After controlling for institution and rank, many of the proportional differences found between American male and female faculty across academic activities were no longer statistically significant (Russell et al. in Bellas and Toutkoushian 1999: 370). In other words, the number of hours dedicated to tasks competing with research rather than the proportion of time likely has the greatest influence on research output.

The impact of confusing proportions and total hours is demonstrated in Carvalho and Santiago (2008) where the authors attempt to investigate gender differences in research based on the time use of academics in two Portuguese universities. The authors list the "Number of hours academics dedicate to each activity by gender and academic rank", but note that "those interviewed were asked to respond on a 100-hour bases" [*sic*] (2008: 325). In practice, estimating the number of hours spent on each activity on a 100-hour basis is the same as asking for the percentage of time dedicated to each activity. This in itself will not offer much insight into how time allocation influences research as the intended comparison is between groups with likely different total working hours. However, the authors take these effective percentages of working time for men and women and conclude that "women spend more time teaching and men with research and service" (2008: 324). Further with regard to administrative duties and academic rank, the authors claim that female full professors "spend, on average, more four [*sic*] hours than men with these activities" (2008: 325). This is a rather bizarre conclusion given that the respondents were asked to report on a 100 hour basis (rather than a weekly or monthly basis), which gives no indication of actual hours spent on research.

Within the Australian university context, McInnis (1999: 21) found that women reported longer average weekly hours than men (49.6 versus 49.6 hours). More interestingly was the gender-based differences in distribution of time between tasks. Women spent slightly more hours per week than men on teaching (8.8 hours versus 8.3 hours), significantly ($p < 0.05$) more hours on teaching related activities (13.6 hours versus 11.5 hours) and significantly ($p < 0.05$) less hours on research (10.7 hours versus 12.2 hours) and thesis supervision (3.4 hours versus 4.2 hours) (McInnis 1999: 21 & 68). The different amounts of time spent on supervision may be partly explained by the increasing role that supervision plays in the latter parts of the academic career, a group in which women are underrepresented (McInnis 1999: 68). Overall, more than two thirds of Australian academics surveyed claimed that teaching loads hindered their research, with women significantly more likely than men to see teaching as an obstacle (McInnis 1999: 45). It is not clear why women spent significantly more time on teaching related activities, but this could be based on disciplinary differences whereby teaching hours are longer in the social sciences and humanities, a group where women are over-represented (McInnis 1999: 22; Singell, Lillydahl and Sungell 1996 in Bellas and Toutkoushian 1999: 370). One could further speculate that disciplinary differences and lower academic rank combine for women to weaken the already marginal benefits of teaching towards research outcomes, whereby women are more likely to be teaching undergraduates in disciplines where teaching has less direct benefits towards the research process (Smeby 1998).

The fact that women reported longer average hours per week than men was not addressed specifically by McInnis (1999), which is rather odd given that the findings strongly contradict a previous report on Australian academics by Sheehen and Welch (1996) which found men to work 47.6 hours per week, 3 hours more per week than women (44.4 hours). The longer average working hours found by McInnis (1999) more generally, and of women specifically, may be due to his reference period being during the teaching semester rather than across the entire year. This could overstate overall working hours and in particular for female academics given that time spent teaching and in teaching preparation is likely to drop over the non-teaching period. However, an earlier study by McInnis (1996: 110) found that average working hours drop by only about 2 hours during the summer, though no reference is made as to whether this drop is considerably greater for men or women. Given the greater family responsibilities of women and their over-representation in teaching positions, one could speculate that during the school holidays female academics, on average, reduce their working hours more substantially than men.

While it is accepted that women on average publish less than men and that this coincides with women spending, both on average and proportionally, less time on research, the conceptual logic of dependency between time and research output is not strongly supported in empirical research. Although time and output may be correlated, the causality between working time and research output is uncertain as investment of time may actually be a function of productivity (Fox 1983: 289). In other words, it could be that successful publication leads to more time spent researching, either due to intrinsic interest or through invitations to participate in more research projects. However, despite the ambiguous causal relationship, the correlation between the two variables is not necessarily strong. For example, in Norway the correlation between time spent on research and publication was found to be significant only in natural sciences and humanities which showed a weak correlation with total output (0.14 in both fields) (Kyvik 1991: 125). While not specifically addressing time dedicated to research, Fox and Milbourne (1999: 265) did find a significant negative correlation between average hours spent teaching and research output among Australian economists, such that an increase in teaching hours of 10% reduces research output by 20%.

From the perspective of individual academics it is not just the amount of time for research that influences output, but perhaps more importantly the quality and availability of uninterrupted time. Kyvik and Smeby (2004: 323-4) found that a lack of uninterrupted time was the most frequently stated barrier to research for Norwegian academics, with 57 percent of tenured staff reporting this as a problem. It is also reasonable to assume that greater family responsibilities also severely hampers the availability and overall quality of uninterrupted time for women. For example, in the United Kingdom increases in unpaid overtime have been accommodated by female academics by taking work home, while men have spent longer hours at the institution (Barry et al. 2003: 11). Smith (1987: 6-7 in Edwards 2000) articulated the problem of “bifurcated consciousness” whereby it is difficult for women to move quickly between the consciousness of motherhood and academic work, which requires a different “organisation of memory, attention, relevances and objectives, and indeed different presences.” While striking a balance between time spent on research and other work activities it perhaps the greatest demand for most male academics, competition for time and energy from family is an additional challenge for many female academics.

Research interest

Academics have multiple roles, of which being a researcher and a teacher are only two. Teaching and research generally receive the greatest attention as they occupy the bulk of academic working time. However, academics are also expected to be administrators, enlighteners of the public, and to conduct external service related to their discipline (Kyvik 2000). The interest and priority given to each of these roles are determined by both formal regulations and academic norms. It is often argued that men give a greater priority to research while women prioritise teaching. Carvalho and Santiago (2008: 319-20) argue that socialisation processes institutionalise traditional gender stereotypes into academic roles, whereby women are informally pressured to conform to teaching roles as it is more person-oriented, interactive and feminine. While the authors argue that “research confirms the dominant stereotypes” (2008: 320), the evidence presented is rather indirect, referring to heavier teaching and service commitments, greater time use on these tasks, and speculation that men are drawn to visible and prestigious activities (research and publishing) and use their power to impel women to focus on teaching. White (2001: 66) draws similar conclusions based on the greater likelihood of men to apply for grants and form research collaborations, and argues that the emphasis placed on research output in promotion decisions systematically disadvantages women.

As stated earlier, there is evidence that women spend more time on teaching relative to research in Australia (McInnis 1999: 68). However, it would not be appropriate to interpret greater working time as necessarily indicative of greater commitment to any particular role. Lower ranked staff spend, on average, a greater number of hours and proportion of their time teaching, while higher ranked staff tend to spend a greater amount of time on supervision, administration, service and extramural activities (McInnis 1999: 69). Overall differences between men and women in their time allocations can therefore partly be explained by their positions within the academic hierarchy. Given interactions between duties and academic rank, women may have a strong interest and commitment to their researcher role, but due to their concentration in lower ranked positions, they may spend most of their time on their teaching role. White (2004: 235-6) suggests that women may become trapped in lower-level academic positions as their excellent teaching performance may attract a heavier teaching load, blocking them from opportunities to devote time to research. As the division of family responsibilities generally favours men, some women may also be unable to increase discretionary time needed to develop a research reputation and gain promotion out of lower ranks.

While the merger of colleges of advanced education with the university sector in the late 1980s in Australia introduced many female teaching-oriented staff into a research environment (White 2001: 65), there is less reason to suggest that recent entrants into the academic profession lack preparation or interest in research. McInnis (1999: 65) found no significant differences between men and women in the strength of interest in careers focused on research relative to administration or teaching, though men were more likely to indicate a stronger interest in research (44% males; 38% females). Interestingly, older academics were more likely to have a stronger interest in teaching than in research, and these differences were statistically significant for men but not women (McInnis 1999: 65). The decreasing importance of research among higher ranked staff has also been offered as an explanation for why research output declines with age, given the increasing importance of non-research tasks or simply a declining marginal benefit of additional publications (Fox 1983).

Kyvik (2000: 60) describes how the roles of teacher, researcher and administrator have different constituents: the teacher serves the students, the researcher the academic community and the administrator the institution. Managing conflicting roles and dividing time accordingly may have become more difficult, which could have direct implication for research performance. Lafferty and Fleming (2000: 262) claim that performance management has been implemented more rigorously at lower academic ranks, as student evaluations have become more important in evaluating stakeholder satisfaction. Massy and Zemsky (1994) argue that the opposite holds true for research and in particular extramural service of senior staff, whereby these activities are almost entirely controlled by the individual with little no control from the administration. While the researcher role may have become more important, regulations that govern the Norwegian academic profession may have minimised role conflict as all staff are responsible for teaching and research and there is little evidence of increasing time pressures associated with teaching (Kyvik 2000). There may be more cause for concern among those who cherish the Humboltian teaching-research nexus in Australia, as increased use of research only and teaching focused staff may create a career structure that does not support both activities if workloads continue to increase and academics respond by specialising. However, specialisation may simply formalise what is already quite clear in the existing data on research productivity. A small group of academics will continue to produce the bulk of the research.

4. Data and methodology

This thesis relies exclusively on selected data from the Changing nature of the Academic Profession (CAP) project. The official aim of the CAP project is “to examine the nature and extent of the changes experienced by the academic profession in recent years” (University of Kassel 2008). The desired population of the CAP survey are academic “professionals in higher education institutes that offer a baccalaureate degree (Type A of the OECD classification) or higher and professional researchers in public research institutes” (Coates et al. 2008: 179). The project is survey-based and has been undertaken in 16 countries across 5 continents, of which this thesis will examine only the Australian and Norwegian data. The survey is comprehensive and includes a standard set of 53 questions across 6 sections: Career and Professional Situation (Section A); General Work Situation and Activities (Section B); Teaching (Section C); Research (Section D); Management (Section E); and Personal Background (Section F). In other words, the CAP project covers a broad range of academic staff categories (researchers, teachers and professionals engaged in both) within an equally broad higher education sector including colleges, polytechnics, comprehensive universities and research institutes. A description of the data collection, sampling techniques, potential sampling biases and the procedure for creating the sub-sample used in this thesis, are all outlined in Appendix A. Details of the precise recoding of independent variables is available in Appendix B. A copy of the complete CAP survey is included in Appendix J.

The following section will first outline the construction of dependent variable, research productivity, with the intention to explicitly inform the reader of the choices made and the limitations placed on this variable. The second part to this section will address the choice of the independent variables, their operationalisation through the CAP data and their predicted effects on research productivity based on the theoretical framework.

4.1 Dependent variable

The dependent variable in this study is individual research output over a three year reference period. The source data for the dependent variable is Question D4 from the CAP survey. This question asks the respondent for the number of publications completed in the past three years across 11 publication types: books authored; books edited; articles published; research reports; conference papers; newspaper article; patent secured; computer program; artistic work; video or film; and ‘other’. The duration of the reference period is important as there can be a long time lag between when research is completed and the final results are published. Three-year time periods are generally accepted as sufficient for cross-disciplinary studies, assuming that a relatively large number of researchers are examined (Kyvik 1991: 37). As different researchers, disciplines and fields of learning have different production patterns across these publication types, it is appropriate to develop a *productivity index* as the dependent variable.

The research productivity index will provide a weighting of 5 points per book authored, 2 points per book edited and 1 point per journal article. This will provide a total number of "article equivalents" for each academic over a three year period. To improve comparability with other studies, article equivalents will be converted to an annual basis by dividing this total by 3. The relative weightings given to each publication type is based on the limitations in the CAP data and how previous studies have valued each publication type. Most studies equate an authored book as equivalent to between 3 to 6 article equivalents and edited books as either one or more article equivalents (Kyvik 1991; Kyvik and Teigen 1996; Ramsden 1994). As the CAP data does not distinguish between journal types, account for co-authorship or restrict the publication data to peer-reviewed output, a relatively high value of 5 article equivalents has been established for authored books. Likewise the lack of assured peer-review in the CAP data has led to a value of 2 article equivalents being determined for edited books on the assumption that edited books are more likely to follow a rigorous review process.

The lack of detail on multiple authorship is unfortunate but unavoidable. This will likely overestimate general research productivity, with particular bias towards fields where co-authorship is most common, such as the natural sciences. As the natural and technological sciences have higher proportions of males within Norway, this will have the flow-on effect of biasing the index towards male academics in the Norwegian data. The increased prevalence of co-authorship among senior scientists will also likely favour males, given they are more likely to hold such positions. While the CAP survey does include questions that give indications as to the extent of co-authorship, these questions are too ambiguously phrased to be incorporated into the index. Ideally the survey would have included a simple question asking the percentage of publications that were solo published and perhaps even drawing a distinction between publication types. Such a question did not form part of the CAP survey.

The relevant question in the CAP survey on co-authorship (question D5) unfortunately asks in two separate questions the percentage of co-authorship with local colleagues and again with foreign colleagues. As many publications are co-authored with both local and foreign colleagues, the overall rate of co-authorship within one's publications is not the sum of the two responses. This became clear with a quick viewing of the CAP data which revealed many cases where the sum of co-authorship across the two questions exceeds 100 per cent. As it also fails to account for the number of authors and the differences in publication types, the questions on co-authorship can only realistically be utilised indirectly for explaining how co-authorship differs between groups. However, the results to this question are still of some relevance as co-authorship (regardless of extent) does indicate a degree of interaction and connection with one's disciplinary networks, which in itself has been offered as an explanation for differences in individual research output.

The second clear limitation of the research index is that it does not differentiate between peer reviewed and non-peer reviewed publications. Ideally the CAP respondents would have been asked to list the peer reviewed publications separately to non-peer reviewed output. A sub-question within Question D5 asks the respondent for the percentage of publications that were peer reviewed, but this question is too broad to be incorporated into the productivity index. As the preceding question (Question D4 on research output) covered 11 publication types of which the productivity index includes only journal articles and books authored or edited, the percentage of peer review is not indicated for particular publication types included in the index. Therefore, the indicated percentage of peer reviewed publications is likely to underestimate the actual rate of peer review across the book and journal categories where respondents have also published outside these channels.

There are also concerns that the indicated percentages of peer review in Question D5 for some respondents is very low, overly precise and not consistent with the preceding question on research output. For example, in the Australian data 138 respondents claimed that between 1 and 5 percent of their publications were peer reviewed, but 128 of these same respondents had fewer than 20 publications in total. As 5 per cent of 19 publications is less than one publication, it makes no sense to refer to fractions of one publication as peer reviewed. It is therefore highly likely that this question was misread by a large number of respondents who likely listed the number, rather than the percentage, of publications that were peer reviewed.

The problem of unanswered questions was an even greater difficulty in the analysis of research productivity. It is very difficult to interpret when a respondent leaves a question unanswered, as it could mean that they did not know the answer or frequently that the question was not applicable to their circumstances. These problems were identified in the survey audit of the Norwegian CAP data (University of Kassel 2008: 32), but equally applied to the Australian data. The problem faced is one of interpretation, if a respondent left a particular category of publication unanswered, this could be understood in two ways. The respondent could have chosen not to answer the entire question, for whatever reason, leading to a "missing" or "not answered" response which must be excluded from any calculations of central tendencies (ie. mean, median, standard deviation, etc.). However, if the respondent had not completed a particular *type* of publication but had completed others in the preceding three years, it is highly likely that they left some sub-questions blank, rather than writing or typing a zero into every appropriate box. This would therefore underestimate the number of persons who did not publish particular types of publications and overstate the mean output. To address this problem, the first step was to recode all "not answered" or "missing" responses into zero publications if the respondent had answered one of the sub-questions within Question D4. For example, if the respondent had claimed to have authored a number of books, articles and conference papers but left the remaining eight categories unanswered, it would be interpreted that the respondent had produced zero of the remaining publication types.

Finally, the CAP survey did not include a publication category for articles or chapters in books. While the exclusion of this publication type may have led some respondents to include such output in their estimates of journal articles or other types of publication, there is a strong possibility that these valuable research contributions will be missed in the research index. This exclusion would not ordinarily be a problem if articles and chapters in books were equally common across all disciplines, as it would underestimate research productivity but not bias the variable towards any field or gender. Unfortunately, Kyvik (2003: 38) found that articles and chapters in books are about twice as common in technology compared to all other fields. As women are underrepresented in this field in Norway, this exclusion will likely underestimate differences between men and women overall, and affect any comparisons made between technology and other fields.

In summary, the dependent variable used in this thesis has significant drawbacks in its lack of detail on co-authorship, peer review and publisher details. Co-authorship does tend to favour the sciences over humanities (and hence men over women), but it is unlikely that a lack of peer review and publisher reputation will bias the results towards either sex. To some extent it is expected that the research productivity index will minimise disparity in research output across fields of learning. The relatively higher weighting of books to journal articles should also somewhat counteract the lack adjustment for co-authorship, whereby the fields of learning with greater propensity to publish books (social sciences and humanities) are also least likely to benefit from co-authorship.

4.2 Independent variables

The unit of analysis in this study is the individual academic and their research output. The production function approach treats research productivity as a function of independent variables (Teodorescu 2001: 206). Fox (1983; 1985) identifies individual-level characteristics, environmental location and feedback processes as the key clusters of variables affecting research output. In a previous study of the 1996 Carnegie survey, Teodorescu (2001: 206) operationalised Fox's (1985) determinants by categorising the independent variables into three broad groups: individual ascriptive; individual achievement and institutional characteristics. Individual ascriptive factors are characteristics which the individual can not control, such as gender and age. Individual achievement factors refer to individual choices and engagement with the academic profession, such as the time spent on research, collaboration and academic rank. Institutional characteristics attempt to capture the influence of the employing institution on individual research productivity, such as encouraging and rewarding research performance, collegial support and institutional funding. As this study will include personal background characteristics (marital status and dependent children) which are private choices made outside the workplace and hence not "ascribed" to the individual, Teodorescu's (2001) framework will be slightly modified. Ascriptive variables will be relabelled as "individual background variables" and include choices made outside the workplace that are expected to influence research productivity.

The number of individual background variables selected in the analysis is necessarily low. As the literature review and theoretical framework showed, differences in research output have been attributed to factors other than innate ability or other characteristics determined at birth.[6]

[6] Debate was recently renewed by Lawrence (2006) that biological differences and comparative advantages of men and women account for differences in successful research careers across disciplines. However, such aptitudes are difficult to measure and have not proven significant as explanatory variables in empirical studies (Fox 1983; Kyvik 1991). Therefore, ability-based variables have not been considered in this study and indeed were not even considered for inclusion in the CAP survey.

Gender-based studies have shown that differences between men and women are better explained through direct behavioural and institutional factors. Therefore the majority of the included independent variables fall within the "achievement" and "institutional" categories.

Individual background variables

Gender is a dichotomous variable, determined by the response to Question F1. The bi-variate and multiple regression analyses will be shown separately for men and women and it is expected that gender will be insignificant as a predictor of research productivity after controlling for the achievement and institutional variables.

Age is a continuous variable based on year of birth reported in Question A1. Based on the reviewed previous studies (Fox 1983; Kyvik 1991; Long 1992; Kyvik and Olsen 2008), age is expected to exhibit a curve-linear relationship with research productivity, decreasing within older cohorts due to the deterioration of intellectual functioning; declining interest or demands for research relative to other academic activities; declining motivation to achieve; and the harmful effects of specialisation on creativity. However, while age expected to be positively correlated in the bi-variate analysis due to the effect of age on other determinants, such as rank and collaboration, after these variables have been controlled for in the multiple regression analysis, a negative effect is expected.

Marital status is based on Question F3 which asks if the respondent is married/partnered, single or "other" and Question F5 which asks if the spouse is also an academic (in the Australian survey) or has university qualifications (in the Norwegian survey). Taking "single" (based on in Question F3) as the reference group, two dummy variables have been created from Question F5 for: "married to an academic" and "married to a non-academic". Marriage has been found to have a broadly positive effect for men (Kyvik 1990) while the choice to get married and the type of marriage is of importance to women (Sonnert and Holton 1995), particularly when there are children (Long, Allison and McGinnis 1993). Marriage to professionals and non-university scientists have been found to have the most positive effect on female research productivity, while being married to an academic is a positive marriage type for men but rather neutral marriage type for women (Fox 2005). As the CAP data only distinguishes between academic and non-academic, the latter category is perhaps too broad to account for the diverse experiences of women. Based on these restrictions, it is expected that being married, and in particular being married to an academic, will have a positive effect on research output. Academic marriages are expected to be more strongly positive for men than for women.

Dependent children is based on Question F6 which asks how many children are living with the respondent. Taking “no children” as the reference group three dummy variables have been created for: “one child”; “two children”; and “three or more children”. Unfortunately this question does not differentiate between children of school age or below, as young children have been show to be strongly and negatively correlated with female productivity (Kyvik and Teigen 1996: 67). This question also does not indicate the number of children who have already left the household, which would indicate the long term or cumulative effects of raising children. As having children within the household does imply greater domestic responsibilities, and as these responsibilities fall more frequently with female parents, the number of children is expected to be negatively correlated with research output for women only.

Child and elder care is a continuous variable based on Question F7 which asks firstly if one had interrupted their employment for child or elder care reasons, and secondly (if so) for how many years. The multiple regression analysis will only use the scale data derived from the second part of the question. While this is an imperfect measure for career delays or breaks that have been interpreted as cumulative disadvantages for women (Probert et al. 1998 in White 2001: 67; Long, Allison and McGinnis 1993), the expectation is that time spent outside academia for child and elder care will be negatively correlated with research output.

Individual achievement variables

Experience is a continuous variable based on Question A4 which asks for the number of years the respondent had been employed full-time and part-time in higher education institutions. One year of part-time employment was treated as equivalent to half a year of experience. Where this question was not answered, Question A6 which asked the date at which the respondent first achieved full-time employment in the higher education sector was taken as an estimate of experience. The inclusion of this variable is because many of the theories on aging and research output are in fact more closely associated with experience. Experience is expected to show a curve-linear relationship with research output, mostly due to its effect on academic rank and linear relationship with age.

Field of learning is a nominal variable determined by the “current academic unit” of the respondent, as stated in Question A2. The variable covers 12 possible disciplinary categories which have been merged in this study into 5 ‘fields of learning’: social sciences; humanities; natural sciences; technology; and medical sciences (see Appendix F for details on the effect on the sample). As the ‘other’ category within the CAP survey is likely to contain a potpourri of miscellaneous staff, this category has been excluded. Given that the research index should minimise differences across fields (Kyvik and Teigen 1996), there is expected to be very little correlation between it and research output. However, the different distribution of staff across academic ranks will influence the bi-variate analyses. Women located in fields where they are in the minority, are expected to exhibit lower average output based on their “lack of critical mass” (Etzkowitz et al. 1994).

Doctoral degree is a dichotomous variable determined by the response to Question A1 which asks the date of doctoral completion. If the respondent did not answer the question, it is assumed they do not hold a doctoral degree. The lack of a doctoral degree is seen as a barrier for a research career, promotion, and in Australia, it may lead to increased teaching loads (White 2004). While the possession of a doctoral degree may not greatly benefit research productivity, the lack of a doctoral degree may be a large barrier. It is therefore expected that a doctoral degree will be positively correlated with research output.

Academic rank is constructed as an ordinal variable as determined by Question A10. In the Norwegian CAP data the 5 academic ranks (Professor 1; Associate professor [Foersteamanuensis]; Associate professor [Foerstelektor]; Assistant professor [Amanuensis]; Assistant professor [Universitets- & hoegskolelektor]) have been merged into 3 categories: Assistant professor (1) Associate professor (2); and Professor (3). In the Australian data the 5 academic ranks have not been merged given the larger sample size and clearer hierarchical structure: Level A (1) to Level E (5). Given that previous studies have found academic rank to be among the strongest predictors of research productivity and one of the key variables to which men and women differ on (Xie and Shauman 1998), academic rank is predicted to be strongly and positively correlated with research productivity. Women and men of similar academic ranks are not expected to differ in research output in Australia (Ramsden 1994; Burton 1997), while female Norwegian professors are expected to produce less than their male counterparts (Kyvik 1991).

Time spent on research is constructed as a continuous variable from the response to Question B1. This question asks for an estimate of usual weekly working hours across 5 academic activities (teaching; research; service; administration; and other) during 2 separate time periods (when classes are in and out of session). As the dependent variable in this thesis is research output over a 3 year reference period, the teaching and non-teaching periods have been merged. A weighting of 2 is given for when classes are in session and a weighting of 1 for when classes are out of session. Time spent on research has been identified as a significant predictor of research output in Australia (Teodorescu 2001). It has also offered as an explanation for why women produce less research than men, given their occupational segregation in teaching orientated jobs and family responsibilities (Creamer 1998: 48-9). Given the more regulated workplace environment in Norway whereby all staff are expected to be active in teaching and research, differences on this variable are more likely to be associated with personal preferences than in Australia where research time can also be a result of institutional conditions. It is expected that men will spend a greater number of working hours on research which be positively correlated with research output, particularly among the group working above and beyond normal hours.

Research preferences is an ordinal variable based on Question B2, which asks whether one's interests lie: 'primarily in teaching' (1); 'in both, but leaning towards teaching' (2); 'in both, but leaning towards research' (3); or 'primarily in research' (4). The differences in academic career structures between the two countries will likely affect how the degree of interest in research is reflected in the research productivity data. Whereas staff highly interested in research can specialise as research only academics in Australian universities, such staff may be attracted to the institute sector in Norway, as all academic staff in Norwegian universities are expected to teach and research (Kyvik 2000). Likewise the informal incorporation of teaching focused positions into the Australia academic career structure also more strongly divides the academic profession between those who research and those who teach. However, as teaching responsibilities tend to decrease at higher academic ranks in Australia, it is expected that interest in research will have a more positive influence on research output at higher ranks. In Norway it is expected that this variable will have less explanatory value as specialist teachers and specialist researchers will not be included in the data.

Research collaboration is constructed as a dichotomous variable based on a sub-question within Question D1 which asks if the respondent has collaborators in any of their research projects. As “collaboration” is a broad and self-interpreted concept, this variable is rather imprecise. Previous studies have examined the number of collaborators (Lee and Bozeman 2005) or supervised students (Kyvik and Smeby 1994) which may have been a more valid operationalisation of this concept as the level of collaboration is more precise. However, as collaborating with colleagues is generally an indication of collegial interest and the opportunity to be part of more projects and hence publications, researchers who collaborate are expected be more productive than those who do not.

International research collaboration is a more specific dichotomous variable taken from a sub -question within Question D1, which asks whether the respondent collaborates with international colleagues. As with the variable “research collaboration”, those who collaborate internationally are likewise expected to have higher research output. The reasons for the inclusion of this variable is that neither Australia or Norway are large centres for scientific research and academics in “peripheral” nations have a greater incentive to utilise international networks when developing their research careers (Kyvik and Larsen 1997). There are pressures for Norwegian staff to collaborate and publish internationally for linguistic reasons as Norwegian is a language not widely understood, while Australian staff face internal pressures from the institution as off-shore teaching and entrepreneurialism has increasingly formed part of their academic roles (White 2001: 68). International research collaboration is expected to be strongly correlated with research output.

International conference participation is a dichotomous variable based on an additional sub-question within Question A13 of the Australian CAP survey. This question asks if the respondent had attended an overseas conference in the previous year. This variable is another example of access to international networks and of particular relevance in Australia as international conference participation involves a far greater investment of time and resources given the geographical isolation. International conference participation has also been identified as an activity that particularly benefits male academics in Australia (Ramsay 1999 in White 2001: 68; White 2004: 230) and was also one of the most important correlates of research productivity for most countries in the previous Carnegie survey (though interestingly not for Australian academics) (Teodorescu 2000: 211). However, Kyvik and Larsen (1994) emphasise the benefits of presenting research at conferences rather than simply being “tourists”. International conference participation is expected to be strongly correlated with both research output and academic rank, but a particularly strong predictor of research output at lower ranks given the likely fewer opportunities for such staff to attend as tourists.

Institutional variables

Time spent teaching is constructed as a continuous variable based on the response to Question B1. This variable is constructed in an identical manner to “time spent on research”, but as minimum teaching hours are set by the institution, this is more appropriately considered an institutional variable. Teaching time has been theorised to come at the cost of time available for research and hence research output (Milem, Berger and Day 2000) and has been demonstrated to negatively correlate with research output for Australian academic economists (Fox and Milbourne 1999). The heavy teaching loads and concentration of women in teaching focused positions in Australia has been offered as one reason for women’s under performance in research (White 2004). Teaching time is therefore expected to be negatively correlated with research output, particularly for Australian women given their lack of availability of extra hours when domestic responsibilities are taken into account. The greater regulation of working hours in Norway should diminish the predictive value of this variable in the Norwegian sample.

Research funding satisfaction is an ordinal variable based on Question B3, whereby research funding at the institution is rated from excellent (5) to poor (1). While this variable clearly refers to institutional support, it is likely that research funding from outside sources will also be taken into consideration by most respondents. While research funding may be also a function of individual achievement, broad satisfaction with research funding will likely be more closely based on institutional support. Given the greater competition and larger concentration of research funding among the few universities in Australia, this variable is expected to be of better predictive value within the Australian sample and will likely also reflect the individual’s self-satisfaction with the ability to attract research funding.

Organisational type is a nominal variable, available only in the Australian CAP survey data, based on a sub-question within Question A9 which asks for the institutional grouping (Group of 8, ATN, IRU; Other) the employer institution belongs to. For the multiple regression analysis this has been recoded into two dummy variables, “Group of 8” and “ATN”, with the IRU and other universities (the least research intensive groupings) acting as a combined reference group. This variable partly overlaps with the influence of institutional funding given that the Group of 8 universities receive almost double the research funding of the other 31 universities combined (DEEWR 2008: 44). But it also represents what Ramsden (1994: 219) found was the best structural predictor of research output for male and female Australian academics. However, the experience of marginalised groups may differ from the majority within the same environment, and research conditions may also vary across fields (Creamer 1995: 52-3). While diversity no doubt exists within the organisational types, the broad degree of research intensity and access to resources will likely differ considerably across institutional categories, with the expectation that research output will be greater among the more elite institutions.

Performance orientation is an ordinal variable based on a sub-question within Question E4. This question asks the respondent on a Likert scale from “strongly disagree” (1) or “strongly agree” (5) to the statement: “At my institution there is a strong performance orientation”. Similar to the above “organisational type” variable, a high performance orientation in one’s institution is also likely to be associated with being in a highly research active department (Ramsden 1994: 219). However, the framing of this question is rather subjective and there are some difficulties interpreting causality. Highly productive researchers may create a stronger performance orientated environment, or even more problematic for this variable, be more critical of the performance orientation of their institution. The question also does not distinguish between research, teaching, service and other activities, which may differ greatly across departments and institutions. As this question also comes from a section of the CAP survey titled “Management”, there may also be a negative connotation of “performance orientation” implying “performance management” or a lack of collegial control over the research process. Further, some respondents may evaluate the performance orientation of the administration or management, rather than their department or the institution as a whole. The ambiguity of this variable certainly raises concerns, but this is understandable given that individuals affect institutions, as well as vice versa. Regardless of these limitations, this variable has been included and is expected to be positively associated with research productivity.

Performance based funding is an ordinal variable based on a sub-question within Question E6. This question ask the respondent to rate on a Likert scale from “not at all” (1) to “very much” (5) the extent of performance based allocation of resources to academic units within their institution. As with many of the institutional variables, performance based funding is likely to be of greater importance in the Australia context due to the greater institutional diversity and the restructuring of Australian universities along line management principles (Lafferty and Fleming 2000: 260). However, while Norwegian universities are broadly comparable, the establishment of Centres of Excellence, do imply a reallocation of resources to those high performing areas within some Norwegian universities. A mistrust of performance based funding could be expected from female and minority staff as a by-product of the general reward structure in academia, which arguably does not reward performance equally (Creamer 1995: 51). Given that both high and low performers are likely to be located in institutions with performance based funding, the effect of this institutional variable will mostly likely be to increase the diversity of research output. As women are arguably less rewarded for their contributions, it is expected that being a women in an institution with performance based funding will be negatively associated with research output, while for men the association will be positive.

Collegial support is an ordinal variable based on an additional sub-question within Question E4 only included in the Australian CAP survey. This question asks the respondent on a Likert scale from ”strongly disagree” (1) or “strongly agree” (5) to the statement: “At my institution there is collegial support for my research”. Women tend to be a minority within the scientific disciplines and are comprehensively underrepresented in positions of authority, leadership and decision making (White 2001). Studies have shown that women place acknowledge and place a greater importance on collegial and supervisor support, even though they may receive less collegial support overall (Sonnert and Holton 1995: 140-1; Ward and Grant 1996). Unfortunately this variable fails to describe the type of collegial support that is of importance to research productivity. Of particular interest and importance for gender studies, is whether one is satisfied with the collegial support of peers or superiors, and whether receiving collegial support implies adopting the dominant (generally masculine) culture (Etzkowitz et al. 1994). While this variable lacks detail, it is expected that female staff will show a greater diversity in their responses on this measure, with satisfaction being more positively associated with research output for women than men.

5. Analysis

As this thesis involves examining differences in research output between men and women, it seems appropriate to start by stating that women account for 461 of the 934 respondents in the Australian CAP sample (49.4%) and 160 of the 533 respondents in the Norwegian sample (28.9%). Given that women are 41.6% of all academics at Australian universities (DEST 2008) and 31.4% of all tenured academics at Norwegian universities and specialised universities (NIFUSTEP 2008), women are overrepresented in the subsample of Australian CAP data and slightly underrepresented in the Norwegian data. The simple fact that the Australian academic population and sample has a higher proportion of women than in Norway will influence any study that seeks to compare the two countries based on average individual research output. As studies have invariably shown that males on average produce more research output than females, the greater proportion of males in the Norwegian academic population will likely overstate the differences between Australia and Norway if gender distribution is not taken into account.

While the proportional representation of men and women differs across the two national samples, the majority of the analyses made in the following section will focus on within country analyses between men and women. Therefore, the differences in proportions of men and women will not have a large impact on most of the findings. The analysis will begin with an examination of individual research output for all staff, based on measures of central tendency and research disparity for each country. This will be followed by the introduction of gender and the independent variables, whereby bi-variate analyses will be conducted between each variable and research output for men and women in both countries. The section will conclude with a multiple regression analysis on selected independent variables, separately for men and women in each country.

5.1 Research productivity all staff

Mean research productivity equalled 3.82 article equivalents per year in Norwegian sample and 2.88 article equivalents per year in the Australian sample. In other words, Norwegian academics published on average one more article equivalent per year than their Australian counterparts. As expected, the main publication channel for communicating research was through journal articles. Authoring or editing books is more than twice as common amongst Norwegian academics and this is the key variable that accounts for differences between the two countries in article equivalent research output. The importance of the research index is clear as had this study simply summed all publication types or placed a lower weighting on books, the overall difference in research output would have been substantially smaller. In terms of the 'other publications' not included in calculation of article equivalents, Norwegian academics once again averaged greater overall output at 3.5 publications per year versus 3.1 in Australia.

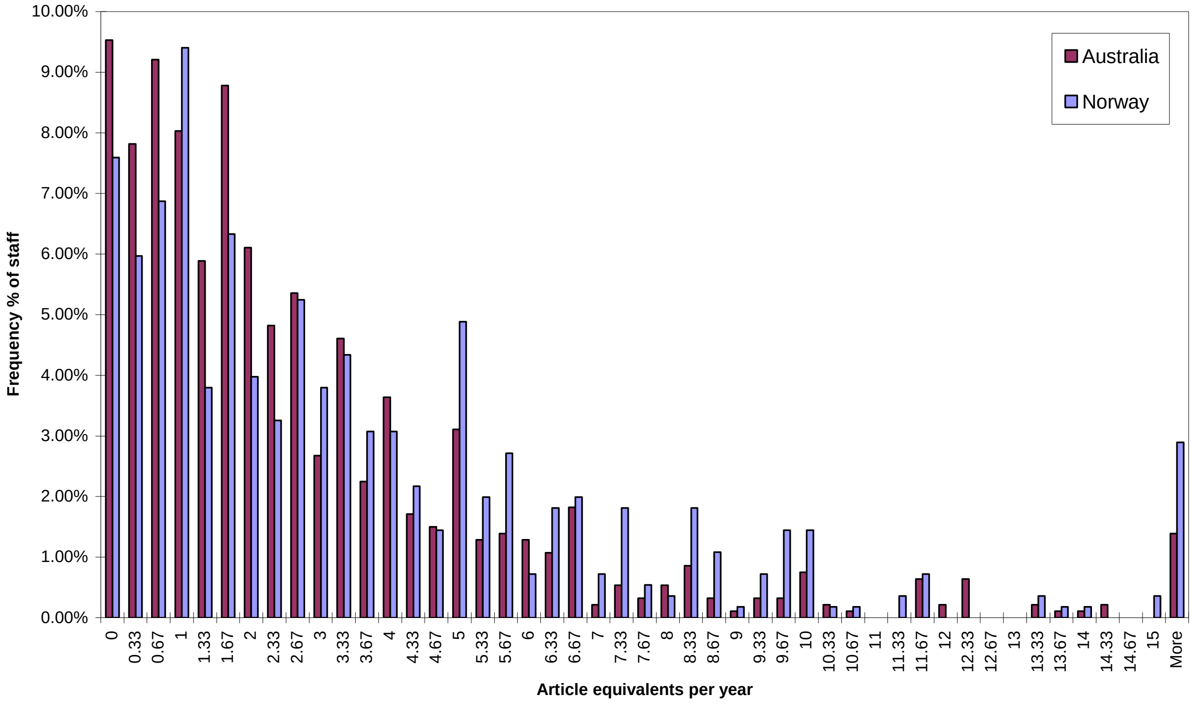
Table 1: Research output per year by type, Norway and Australia

	Norway		**Australia**	
	Mean	*Std dev*	*Mean*	*Std dev*
Books authored	0.24	0.42	0.09	0.21
Books edited	0.12	0.30	0.06	0.19
Journal articles	2.35	3.10	2.30	2.84
Other publications	3.51	4.86	3.16	3.97
Article equivalents[7]	3.82	4.13	2.88	3.30

Drawing conclusions based on mean output can be misleading if the dispersion of scores are not taken into consideration. As shown in Table 1, in both countries and across all publication types the standard deviations are greater than the mean, indicating that research output is highly variable across academics. The extremely high standard deviation relative to the mean in book production shows that this is an activity that is particularly concentrated within a minority of academics. High standard deviations across all publication types was to be expected given that previous research has shown that research output is positively skewed towards a small group of academics. The extremely high standard deviation in book publication is also as expected given that books are the key publication output within a relatively small range of disciplines, mostly within the social sciences and humanities, whereas journal article publication is prevalent across all fields of learning.

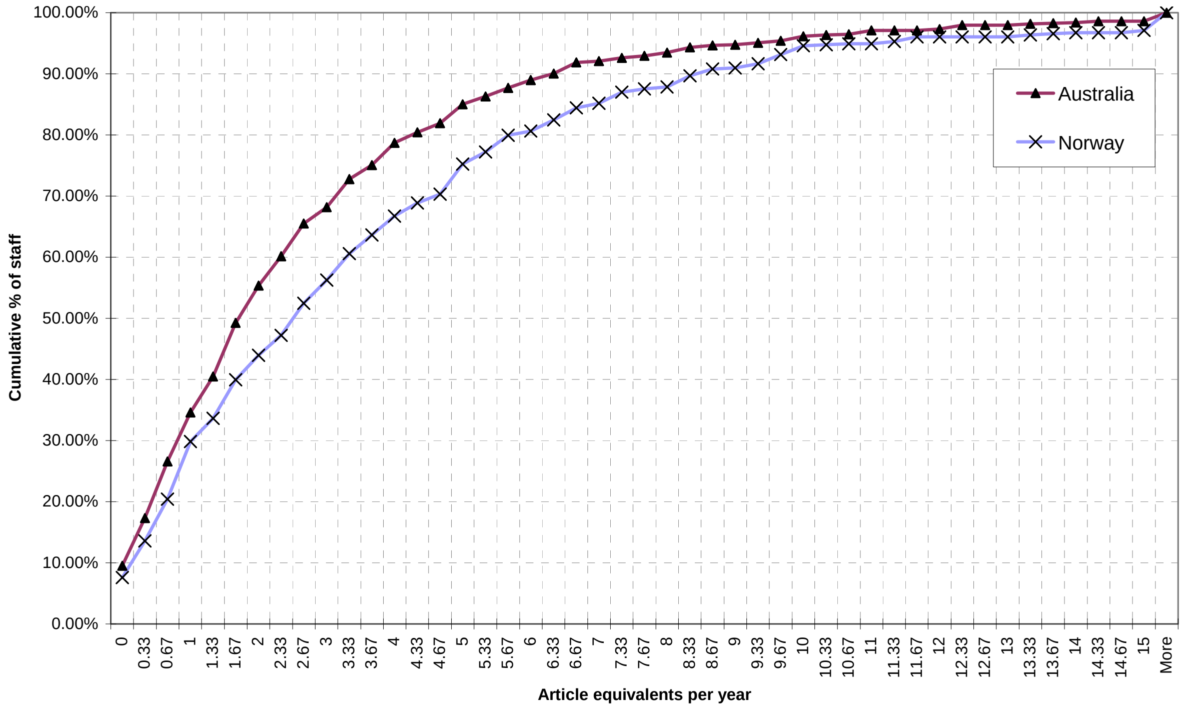
[7] Authored books are 5 article equivalents, edited books are 2 article equivalents and journal articles are 1.

Figure 1: Research productivity (article equivalents per year), all staff, Norway and Australia



Examining the dispersion of research output in further detail, Figure 1 shows the frequency (as percentage of all respondents) of reporting a given number of article equivalents per year. From this figure it is clear that in both Norway and Australia research output is positively skewed, whereby most staff report relatively low annual research output, with a small group reporting very high output. There are proportionally more academics producing over 15 article equivalents per year in Norway (2.9%) than Australia (1.4%), but the proportion of staff reporting relatively low research output (below 1 article equivalent per year) is consistently greater among the Australian sample. The percentage of non-publishers, those reporting publishing no articles or books over the 3 year reference period, is also substantially higher within the Australian academic sample at 9.5% compared to 7.6% in Norway. Previous studies in Australia (Ramsden 1994: 218) showed close to 20% of staff reporting no publications over a five year period, indicating that the rate of non-publication in the Australian data is low by comparison. A similar survey of Norwegian staff in 1998-2000 found that 6% of academics did not publish an article, book or report in the reference period (Kyvik 2003: 37). Given that the data used in this study excludes reports from the research index calculation, the rate of non-publishers in the Norwegian sample is very consistent with this previous study.

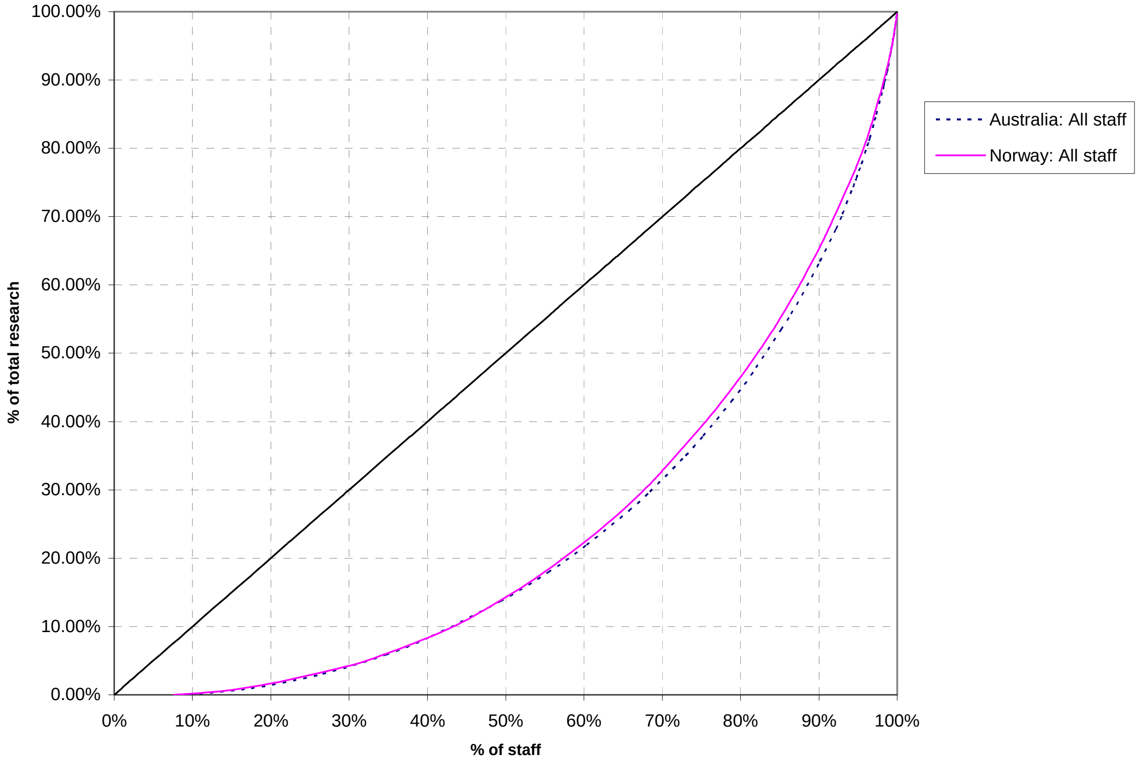
Figure 2: Research productivity (article equivalents per year), cumulative % of all staff, Norway and Australia



More clearly illustrating the skewness of research output across the sample is the cumulative distribution of research output. Figure 2 shows the cumulative percentage of staff reporting a given number (or fraction) of article equivalents, per year. Over a third (34.6%) of all Australian respondents averaged one article equivalent or fewer per year, compared to less than a quarter (24.7%) of all Norwegian respondents. Given that mean output of article equivalents is lower in Australia (2.88) compared to Norway (3.82) this is not surprising. The percentage of staff with below average research output is slightly greater in Australia (66%) than in Norway (64%). This indicates the degree to which the average research output is positively skewed towards the minority of prolific researchers is similar in the two countries. However, what is perhaps the most noticeable difference between the two countries is that the gap in research production is greatest amongst the middle cohort of staff. In other words, the steeper rise in the Australian curve in the middle 50% of staff (between the 25% to 75% points) indicates that the middle cohort is on average less productive and exhibits less variation or range than the comparable cohort in the Norwegian sample. This could be reflective of the different career structures in the two countries, whereby all Norwegian academics are engaged in teaching and research, while Australian academics do not always need to always be active in both activities and can specialise.

Another way of illustrating the inequality in research output is to rank staff by total research output and show the cumulative percentage of staff responsible for a cumulative percentage of research. This is illustrated for Norway and Australia in Figure 3 (below). A state of total equality between researchers would mean, for example, that the least productive quarter of staff were responsible for a quarter of total research. Perfect equality would be represented by the 45 degree straight line, whereby the size of research output rises perfectly in proportion to the rising proportion of staff. In reality not all researchers are equal in their pursuit of research publication and publication is heavily skewed towards a small group of prolific publishers. The more the curve of research productivity deviates from the 45 degree line, the greater the overall research inequality (Kyvik 1991: 92-4).

Figure 3: Research output (article equivalents) differences between researchers (as a % of total output) Australia and Norway



The degree of research inequality for Norway and Australia is similar, with the least productive 50% of staff contributing to about 14% of total output in both countries. Half of total research output is produced by 18% of staff in Norway and 17% of staff in Australia. 'Lotka's law' of research output - that the number of scientists producing n papers is proportional to $1/n^2$ to the extent that 1% of all scientists produce a quarter of all papers and 6% produce half - again receives some support from these findings, though the extent of research inequality is somewhat less. The finding that half of all output is produced by 18% of staff in Norway is consistent with the earlier study by Kyvik (2003: 43), whereby the proportion of staff responsible for half of all output reduced from 20% in 1982, to 19% in 1992 and again to 18% in 2001. Methodological differences mean the Australian data is less comparable with the earlier study by Ramsden (1994: 218), but the findings are somewhat consistent as Ramsden found 14% of all staff accounted for half of all research.

5.2 Bi-variate analysis of gender-based research output

Examining mean research productivity for each country based on gender shows, as expected, a clear divide. Male academics in Norway averaged 4.1 article equivalents per year compared to 3.2 article equivalents among female academics. In Australia the productivity divide was even greater, with male academics averaging 3.3 article equivalents per year compared to an average of 2.4 for females. In other words, females achieved 79% of average male production in Norway and 74% in Australia. Such findings are consistent with the earlier study of Norwegian academics by Kyvik and Teigen (1996) which also found women to be 20% less productive. Unfortunately such comparisons are not possible with previous Australian studies given an unavailability of data. As with research productivity in the combined sample (see Table 1), greater propensity for Norwegian academics to author and edit books is the clearest difference between countries. Within both countries, the only publication type where differences between men and women in mean research output is statistically significant ($p < 0.01$) is journal article publication, as well as overall article equivalents.

Table 2: Annual research output per year by type and gender, Norway and Australia

	Norway				**Australia**			
	Male		**Female**		**Male**		**Female**	
	Mean	*Std. Dev*	*Mean*	*Std. Dev*	*Mean*	*Std. Dev*	*Mean*	*Std. Dev*
Books authored	0.24	0.41	0.25	0.45	0.10	0.22	0.08	0.20
Books edited	0.13	0.32	0.11	0.26	0.07	0.21	0.05	0.17
Journal articles	2.60*	3.47	1.73	1.79	2.67*	3.31	1.91	2.18
Other publications	3.63	4.97	3.21	4.57	3.24	4.06	3.06	3.87
Article equivalents	4.07*	4.45	3.20	3.17	3.31*	3.81	2.44	2.63

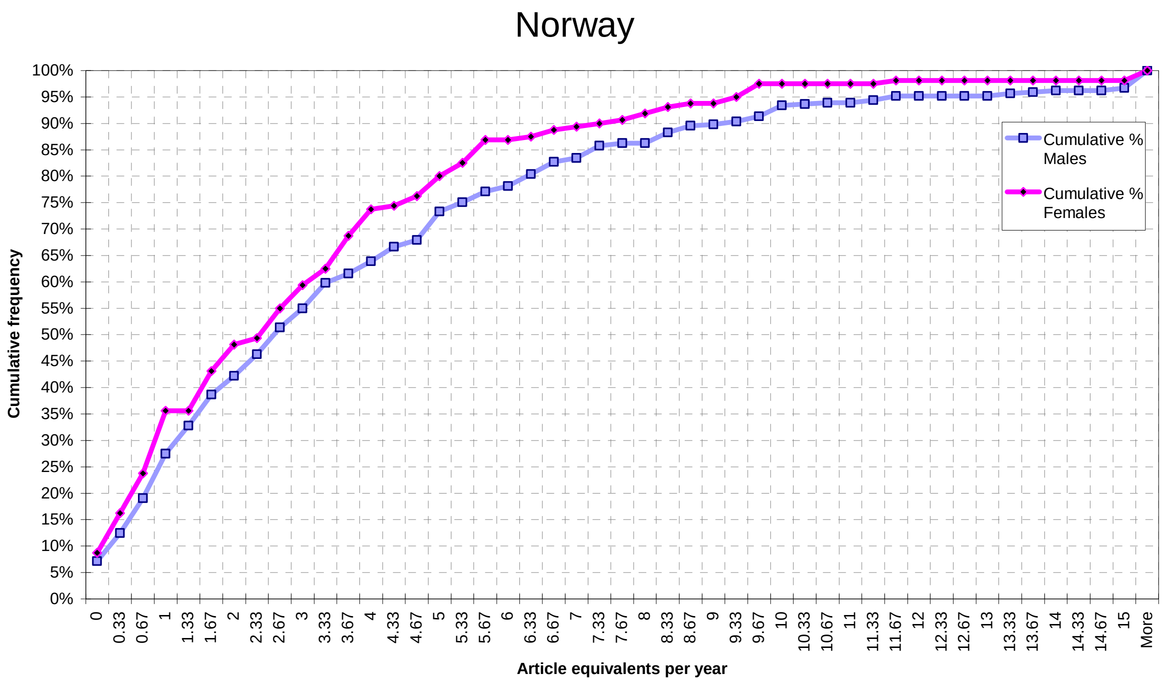
* Statistically significant ($p < 0.01$ independent sample t-test) difference between men and women

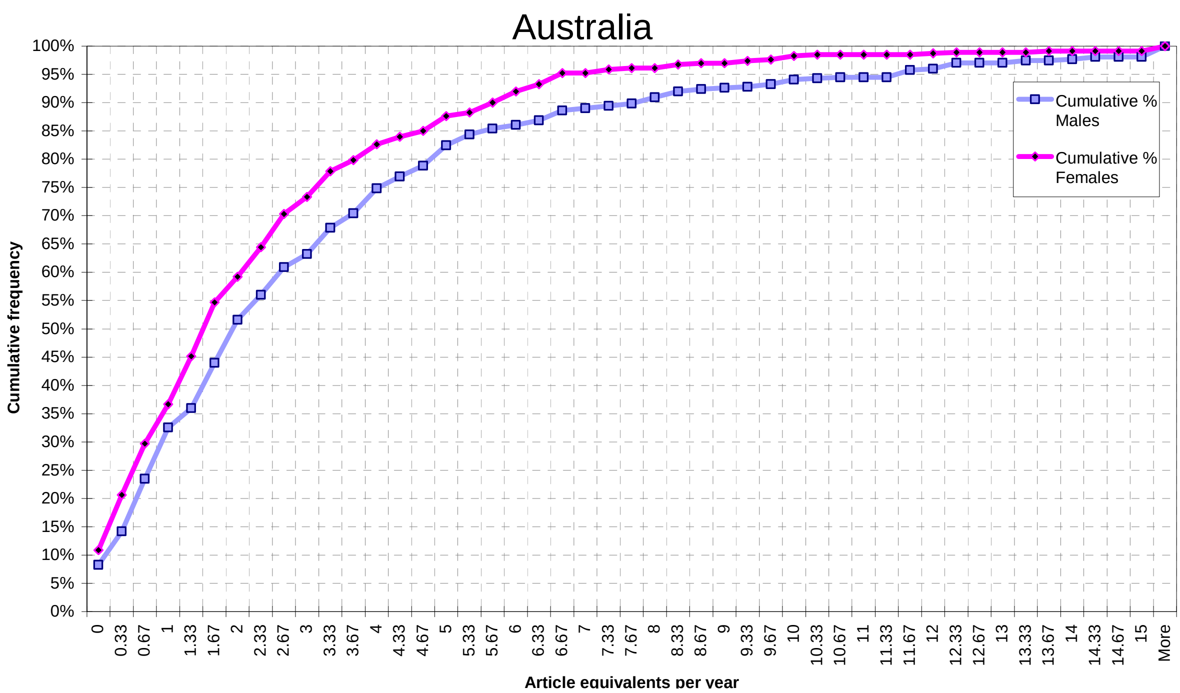
While journal article publication is clearly the key publication type that differentiates men and women, construction of the research index remains important. Relative to other publication types women have a greater propensity to publish books and ‘other publications’. For example, in journal article publication in Norway and Australia, women average only 66% and 72% of male productivity respectively. However in books authored, Norwegian women achieved marginally higher levels of output than men while Australian women achieved 80% of average male output. As differences between men and women in publication types other than journal articles are not statistically significant, the inclusion of books authored and edited reduces overall disparity between the sexes. In other words, had this study included only journal articles in calculation of research output differences between men and women (as in numerous earlier studies), overall differences between men and women would have been far greater. Interestingly, differences between men and women in ‘other publications’ is relatively small, with women achieving 88% and 94% of average male output in Norway and Australia. The relative importance of non-traditional publication channels may therefore be of greater importance when understanding female research patterns.

Another indicator of differences between men and women illustrated in Table 2 is that males have larger standard deviations across most publication types in both countries. While this is to be expected in nominal terms as the means are also higher, the size of the standard deviation relative to the mean is also greater for men. Male standard deviations for article equivalents are 109% and 115% of their respective means in Norway and Australia, whereas for female standard deviations are 99% (Norway) and 108% (Australia) of mean output. Clearly the standard deviations for both men and women are very high, but the relatively smaller standard deviations within the female samples indicates that female publication patterns may be slightly less skewed towards extremely prolific or limited publishers.

Looking at dispersion of research output in further detail, Figure 4 shows the cumulative frequency (as percentage of all men and women within the sample) reporting a given number of article equivalents per year. This figure indicates clearly that while both male and female research output is positively skewed, the proportion of non-publishers is greater amongst female academics (8.8% in Norway and 10.9% in Australia) than males (7.1% in Norway and 8.2% in Australia). Low levels of research output are also more prevalent among women, with 35.6% of Norwegian and 36.7% of Australian women reporting one or fewer article equivalents per year, compared to 27.5% of Norwegian and 32.6% of Australian men. It is also clear the vast majority of academics with 10 or more article equivalents per year are male (89% in Norway and 74% in Australia). As a proportion of the entire male sample, these high producers account for 7.6% of all males in Norway and 5.9% in Australia. Only 2.5% of females in Norway and 1.7% of females in Australia achieve such levels of productivity. The finding that exceedingly prolific publishers are overwhelmingly male is consistent with many previous studies (Cole and Zuckerman 1984; Long 1992; Sonnert and Holton 1995).

Figure 4: Research productivity (article equivalents per year), cumulative frequency (as a percentage of all gender)





The prevalence of low publication amongst female academics is to a large extent based on differences in mean article equivalents. However, Figure 4 also shows how variations in men and women reporting a given number of article equivalents increases across the middle cohorts. For example, in the Norwegian sample the proportions of men and women reporting 3 or fewer article equivalents per year are similar at 55% and 59% respectively, but the gap widens when examining proportions of staff publishing 6 or fewer article equivalents. This group constitutes 74% of all women but only 64% of men. In other words, while similar proportions of women and men publish in the lower and middle bands of average output (0 to 3 article equivalents per year), it is across the middle to upper bands (3 to 10 article equivalents per year) that gender differences are most pronounced. In the Australian sample the widening gap between men and women occurs earlier, at around the 1 article equivalent per year threshold. This is to be expected given that overall differences in male and female productivity are greater in Australia as are the standard deviations (relative to the means).

While distribution of research output around the mean does not differ substantially by gender, there are indications that male research output is more skewed towards the most prolific publishers. The most prolific 15% of academics in Australia accounted for 48% of all male output, but only 45% of all female output. The corresponding group in Norway accounted for 45% for males and 43% for females. While generally high levels of inequality in research production is expected, it is somewhat surprising that research inequality in both countries is greater within the male group. Previous studies in Norway (Kyvik 1991: 193) and the United States (Cole and Zuckerman 1984: 225-6) found the opposite to be true; female research output was slightly more skewed than male output towards the most prolific publishers.

Table 3: Research participation (% of staff with at least one publication) in the last three years, by gender, 1993 and 2007

Australia									
	1991-1993			**2004-2007**			**Change**		
	Male	**Female**	**Difference**	**Male**	**Female**	**Difference**	**Female**	**Female**	**Difference**
Books authored	21	12	-9	22	20	-2	+ 8	+ 8	+ 7
Books edited	15	9	-6	14	11	-3	+ 2	+ 2	+ 3
Articles published	74	61	-13	90	87	-3	+ 26	+ 26	+ 10
Research reports	44	35	-9	39	42	+3	+ 7	+ 7	+ 12
Papers presented	78	67	-11	90	90	0	+ 23	+ 23	+ 11
Newspaper articles	35	26	-9	27	31	-4	+ 5	+ 5	+ 5
Patents	2	1	-1	8	2	-6	+ 1	+ 1	-5
Computer programs	9	3	-6	8	3	-5	0	0	+1
Artistic works	6	7	-1	6	6	0	-1	-1	+1
Videos/films	9	8	+1	4	4	0	-4	-4	-1
Other	8	11	+3	2	4	+2	-7	-7	-1

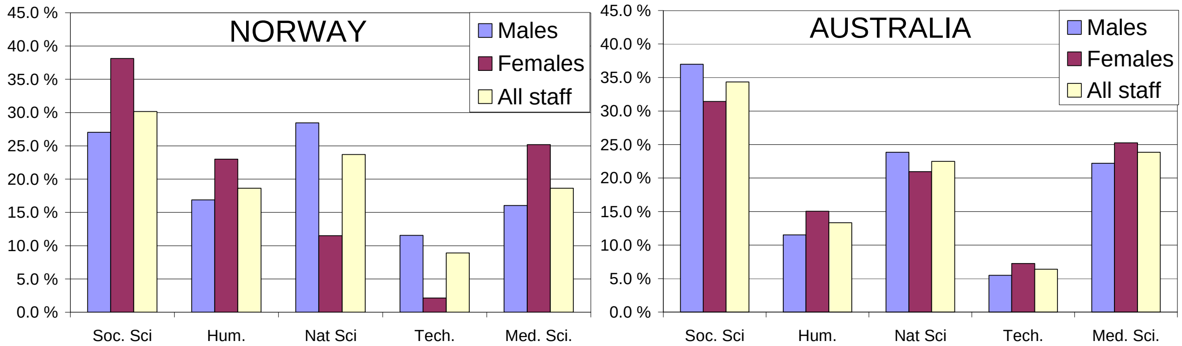
Source: Sheehan and Welch 1996

As the CAP survey used identical publication types to the 1993 Carnegie survey administered in Australia, evidence of how patterns of gender-based research productivity have changed over time is illustrated in Table 3. Comparing participation rates of men and women across various publication types, it is clear the proportion of non-publishers dropped dramatically since the Carnegie survey. Across all traditional publication channels, female participation has risen and the gap between men and women has fallen. This is particularly the case for journal article publication, where the proportion of female non-publishers in Australia dropped from 39% in 1993 to 13% in 2007. The dramatic decrease in non-publication in Australia is likely the long term result of integration of the college sector into the unified higher education system in the late 1980s, whereby the previous survey (Sheehan and Welch 1996) would have captured a large number of staff who only recently commenced research careers (White 2001: 65). While the genders now participate in research at similar rates, large differences in mean productivity remain due to underrepresentation of women publishing at higher levels.

Field of learning

Women and men are not equally distributed across disciplines and the relatively small number of respondents in each category (particularly in the Norwegian data) justifies re-categorisation of the CAP disciplines into the fields of: social sciences; humanities; natural sciences, technology; and medical sciences.[8] Figure 5 illustrates how women and men (as a percentage of each gender) are distributed across fields of learning, where discipline was revealed by respondents.

Figure 5: Percentage of sample by gender and field of learning



Even when disciplines are collectively grouped into fields of learning, Norwegian males are far more likely than women to be located in the natural (28% of all men versus 10% of all

[8] For details of the reclassification and the distributions before reclassification, refer to Appendix D

women) or technological sciences (11% versus 2%) and comparatively less likely to be located in the social sciences (27% of versus 38%), humanities (17% versus 23%) or medical sciences (16% versus 25%). In the Australian data there are few noticeable differences between genders across fields of learning. The greatest percentage difference is in the social sciences where 37% of all men are located compared to 31% of all women. The different gender distribution across fields of learning is important as the research index does not account for multiple authorship, which is generally more common in natural and technical sciences, a group where women are underrepresented in the Norwegian data.

Table 4: Annual research output by field of learning

Norway										
Field of learning	**Social sciences *n*=149**		**Humanities *n*=92**		**Natural sciences *n*=117**		**Technology *n*=44**		**Medicine *n*=92**	
	Mean	*Std Dev*	*Mean*	*Std Dev*	*Mean*	*Std Dev*	*Mean*	*Std Dev*	*Mean*	*Std Dev*
Books authored	0,32#	0,46	0,38*	0,49	0,11*	0,35	0,17	0,25	0,27	0,46
Books edited	0,17#	0,39	0,20*	0,35	0,04*	0,12	0,07	0,15	0,10	0,29
Journal articles	1,79*	1,88	1,51*	1,35	2,72	3,03	1,58	1,87	3,84*	4,66
Other	3,34	4,63	3,17	4,93	2,92	3,91	4,38	4,55	4,24	6,59
Article equivalents	**3,71**	3,40	**3,83**	3,28	**3,37**	3,51	**2,55#**	2,50	**5,38***	6,09

Australia										
Field of learning	**Social sciences *n*=252**		**Humanities *n*=98**		**Natural sciences *n*=164**		**Technology *n*=47**		**Medicine *n*=175**	
	Mean	*Std Dev*	*Mean*	*Std Dev*	*Mean*	*Std Dev*	*Mean*	*Std Dev*	*Mean*	*Std Dev*
Books authored	0.08	0.17	0.12	0.26	0.09	0.21	0,09	0,20	0,08	0,18
Books edited	0.07	0.20	0.08	0.20	0.05	0.15	0,02	0,08	0,07	0,21
Journal articles	2.24	2.63	2.54	2.94	2.63	3.33	2,57	2,96	1,96#	2,54
Other	3.61	4.78	3.00	3.39	3.10	4.27	3,46	3,86	2,94	3,25
Article equivalents	**2.79**	2.99	**3.30**	3.42	**3.18**	3.82	**3,04**	3,33	**2,48**	2,94

Note: $^{\#}p < 0.05$; $^{*}p < 0.01$; Statistically significant difference between [field] (1) and other fields (0)

The use of the research index was expected to minimise differences in research productivity across fields of learning and was broadly effective. When comparing research output across fields based on publication type, books are generally more common in the social sciences, humanities and medicine compared to the natural sciences and technology. These differences are statistically significant in the Norwegian sample. By contrast, journal articles are less common in the social sciences and humanities, again statistically significant in the Norwegian sample. Interestingly, research productivity in medical sciences differs considerably between countries. Medicine is the most productive field in the Norwegian sample in both journal articles and article equivalents (both statistically significant), but the least productive in the

Australian data. The Norwegian results are consistent with previous studies which found overall publication rates and co-authorship to be among the highest in medicine, while rate of non-publication was also lowest in this field (Kyvik 1991: 46, Kyvik and Teigen 1996: 58; Kyvik 2003). Low levels of productivity in medical sciences in Australia may be partly due to the broad disciplinary category used in the CAP survey: “Medical sciences, health related sciences, social services.” Unification of the Australian higher education system consolidated a diverse range of subjects into the medical sciences (e.g. nursing, physiotherapy, and human movement) which remain in the college sector in Norway. These disciplines likely have less pressure to publish scientific articles given their more vocational focus.

The exclusion of “other” publication types from the index does raise a few concerns. The technological sciences average significantly fewer article equivalents than other fields of learning in the Norwegian sample. This is strongly inconsistent with previous studies in Norway, which found technology to have the highest rates of publishing due to its extremely high rate of article publication in books and reports (Kyvik 2003: 38). Articles and chapters in books were not included in the CAP survey, and reports were excluded from the productivity index (due to their lack of peer review and overlap with journal articles) and this may account for why technology performs relatively poorly in the index. The number of respondents in technology is rather low and for some calculations, technology will be merged into the natural sciences, but as this group is almost entirely male in Norway this may underestimate overall gender differences in research output. The differences between fields on article equivalent production are important to keep in mind, but as will be shown shortly, these differences are often the result of differences in academic rank, which will be controlled for in later analyses.

One theoretical expectation was that the pattern of research inequality would be greater in more codified fields, generally found within the sciences (Kyvik 1991: 95). When examining standard deviation in relation to mean research productivity, greatest dispersion is found in the medical sciences, natural sciences and technology. In both countries, the social sciences and humanities have the smallest differences across researchers. The rate of non-publishing is consistent across fields in Norway at around 7%, with the exception of the humanities (3%). In Australia there is more diversity across fields with natural sciences having the lowest rates of non-publishing staff (5%), followed by technology (6%), humanities (8%), social sciences (10%) and the medical sciences (14%). The high rate of non-publishing in medicine in Australia can again be explained by the vocational nature of some disciplines within this field.

Given that the rate of non-publishing does not explain the higher standard deviations in the sciences (with the exception of medicine in Australia), it can be assumed that more highly codified fields have a relatively higher concentration of research output among a smaller number of academics. However, as research productivity is greatly affected by other factors, such as distribution of staff across ranks, and degree of codification varies within each field, these tentative findings can not be confirmed or generalised in isolation from other factors.

Table 5: Research output by field of learning and gender

Norway										
Field of learning	**Social sciences**		**Humanities**		**Nat. sciences**		**Technology**		**Medicine**	
	Male *n*=96	Female *n*=53	Male *n*=60	Female *n*=32	Male *n*=101	Female *n*=16	Male *n*=41	Female (*n*=3)	Male *n*=57	Female *n*=35
Books authored	0.30	0.36	0.43*	0.30	0.12*	0.08	0.17	0.11	0.28	0.25
Books edited	0.16	0.19*	0.22*	0.16	0.05*	0.02	0.07	0.00	0.15	0.01#
Journal articles	1.94#	1.51	1.70#	1.16#	2.72	2.71#	1.63	0.78	4.73*	2.39*
Other	3.36	3.32	3.13	3.25	2.83	3.50	4.53	2.33	5.03#	2.95
Article equivalents	**3.73**	**3.68**	**4.28**	**2.98**	**3.41**	**3.17**	**2.63#**	**1.33**	**6.44***	**3.65**
Female/Male %	99%		70%		93%		51%		57%	

Australia										
Field of learning	**Social sciences**		**Humanities**		**Nat. sciences**		**Technology**		**Medicine**	
	Male *n*=135	Female *n*=117	Male *n*=42	Female *n*=56	Male *n*=86	Female *n*=78	Male *n*=20	Female *n*=27	Male *n*=81	Female *n*=94
Books authored	0.09	0.07	0.18*	0.07	0.10	0.08	0.07	0.10	0.07	0.08
Books edited	0.09	0.05	0.06	0.09	0.05	0.04	0.00	0.04	0.08	0.05
Journal articles	2.65	1.77	3.61	1.74	2.99	2.24	2.75	2.43	2.46	1.53
Other	3.93	3.24	3.60	2.55	3.22	2.96	3.47	3.46	2.86	3.01
Article equivalents	**3.29**	**2.21**	**4.65#**	**2.28**	**3.60**	**2.72**	**3.08**	**3.00**	**2.99**	**2.04**
Female/Male %	67 %		49 %		76 %		97%		68%	

Note: #$p < 0.05$; *$p < 0.01$; Statistically significant difference between [field] (1) and other fields (0) by gender

The broad range of disciplines within each field, and the different distributions of men and women across disciplines, makes drawing gender-comparisons across fields rather difficult. Table 6 indicates how females and males differ in research productivity across fields of learning. Keeping in mind that females average 79% of male productivity in Norway and 74% in Australia, it is interesting to note that the gender disparity varies across fields of learning. For example, in Norway within the social sciences and the natural sciences, fields with vastly different representations of women, the difference between genders is negligible (though the number of female respondents is also small in the natural sciences). In Australia, where women and men are more equally distributed across fields of learning, the research inequality is greatest in the humanities, while technology is the only field with gender parity.

Explaining differences between men and women based on academic field is difficult but there are some observations that can be made based on previous studies and theory. It may be that women have achieved a "critical mass" in disciplines within the social or natural sciences, consistent with what Sonnert and Holton (1995: 51) found in biology. However, it is not possible to ascertain this from the broader academic field data. Deconstructing fields back into disciplines or narrower fields raises its own problems due to the relatively small number of respondents and the broad default categories, such as "behavioural and social sciences" and "life sciences". However, within the more narrow categories where women are in roughly equal numbers to men, such as "teacher training and educational sciences", gender differences are not smaller. A better explanation for why the natural and technological sciences may have some of the smallest gender differences is that successful women within male-dominated fields may share the masculine culture, while unsuccessful women leave or simply choose not to enter these fields (Etzkowitz et al. 1994).

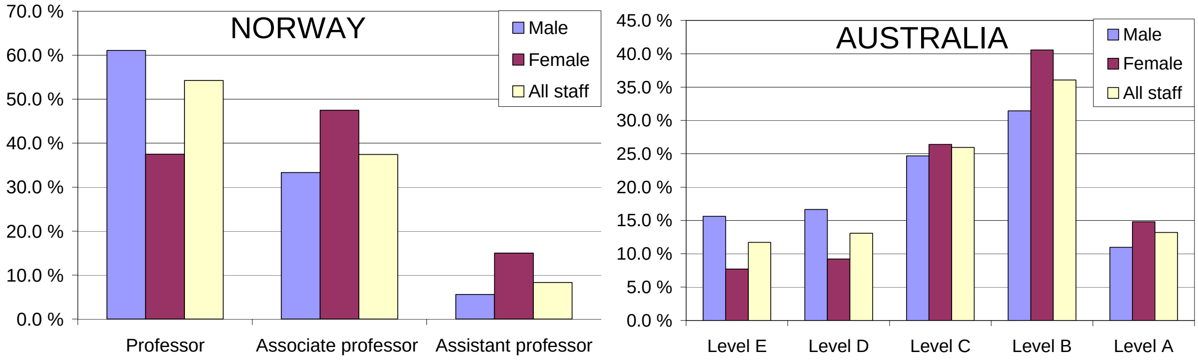
Finally, the difference in female and male productivity across fields is mostly based on diversity in male productivity, rather than female productivity which is more stable. Generally, fields with the greatest gender disparities are those with the highest average male research productivity. Examining differences in article equivalent output across fields within each gender group, it is only in the male sample that differences are statistically significant. Norwegian men in the medical sciences are significantly more productive than other men, whilst men in the technological sciences are significantly less productive. The large gender differences in the humanities in Australia, where female productivity is less than half of male productivity, is due to significantly higher productivity of men within this field rather than low female output.

Academic rank

Many of the observed differences between academics across fields of learning, and between men and women, are connected to differences in the proportion of highly ranked staff. Access to research resources such as time and funding, are likely to increase as one gains promotion up the academic hierarchy. Higher ranked academic staff have greater access to external funding opportunities, and the additional prestige attached to academic rank increases visibility and influence at the departmental level (Kyvik 1991: 180). Academic rank has been offered as an explanation for why women fail to establish a research reputation, as women are chiefly located in lower ranks and have less access to professional development (White 2001: 66). However, the causality of rank on productivity is not clear, as academic promotion is both a consequence and a cause of research productivity (Xie and Shauman 1998: 852).

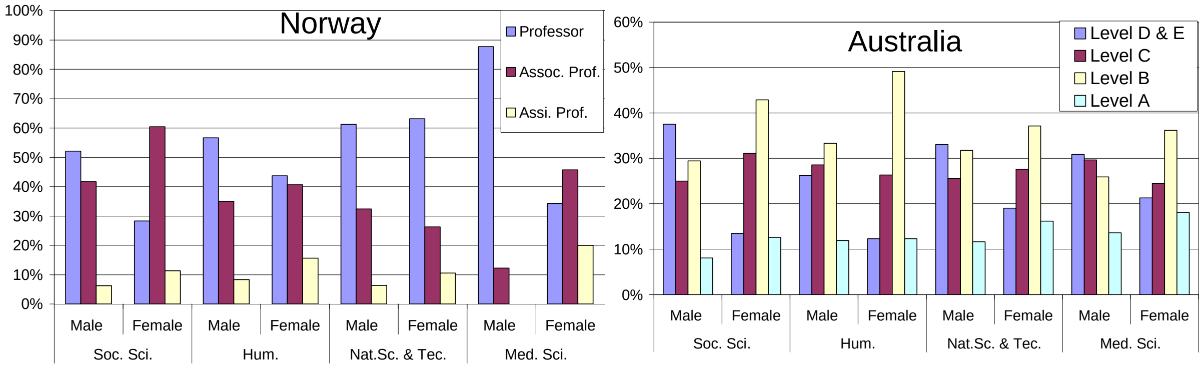
Comparability between the two career structures is quite difficult given that Norway has effectively only two career grades (Professor and Associate Professor), whereas Australia has five. What is clear from Figure 6, which shows distribution of genders across academic ranks, is that the majority of men are located in higher ranks, while the opposite is true for women. The increasingly smaller percentage of women in higher academic ranks has been described as the 'leaking pipeline' in academia (White 2007: 64). Also quite apparent is the difference in staffing structures between the countries, with a more top-heavy structure in Norway. It should also be noted that while men and women are represented in roughly equal numbers in the Australian data, this is not the case in the Norwegian sample where women constitute less than a third of the academic population. The importance of this is that even though close to half of all women in the Norwegian sample held associate professor positions (compared to a third of all male academics), females are still a minority (37%) of all associate professors.

Figure 6: Percentage of sample by gender and academic rank



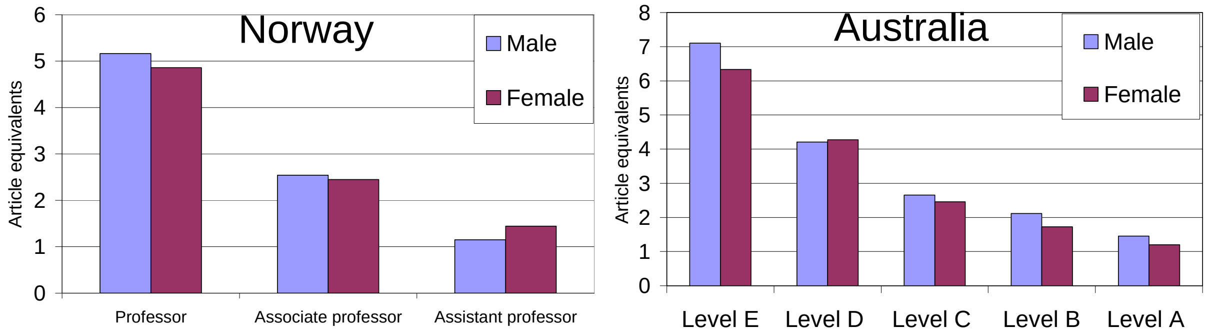
Norwegian and Australian women are more likely than men to be in the lowest academic grades across all fields of learning. However, while Norway has a 'top heavy' distribution of academics across ranks, Figure 7 (below) shows the Norwegian pattern is relatively more diverse across different academic fields compared to Australia. For example, Level B is the most frequent rank for women across all fields in Australia, while in Norway the distribution varies by field. This is somewhat expected as academic rank is partly an effect of greater research productivity, meaning fields where women are most productive are also likely those where they are rewarded with higher ranks.

Figure 7: Percentage of sample by gender and rank, across disciplinary groups



As expected, academic rank is strongly correlated with research productivity with a correlation coefficient of 0.50 for females and 0.45 for males in Australia, and 0.40 for females and 0.31 for males in Norway.[9] The larger correlation coefficients in the Australian sample are likely due to the greater number of career grades, the overlap of Level A positions with doctoral training and perhaps most importantly, the greater ability for high ranked Australian staff to opt for research only status or reduce their teaching responsibilities. The linear relationship between academic rank and research productivity is illustrated in Figure 8. Norwegian professors are about twice as productive as associate professors, who in turn are also about twice as productive as assistant professors. The influence of rank is more dramatic within the Australian data, given the very highly productive Level E academics.

Figure 8: Research productivity (article equivalents per year) by Academic Rank and Gender



In the Australian sample, men are generally more productive at lower levels and at the highest rank. However, none of these differences are statistically significant, which is consistent with

[9] A complete table of the bi-variate correlation coefficients can be found in Appendix I.

previous studies (Ramsden 1994; Deane et al. 1996: 21 in Burton 1997: 22; Castleman et al. 1995 in Hawkes 1996: 58). The strong correlation coefficient and comparability between men and women of similar rank may be due to an increasing importance placed on research productivity in promotion decisions and a more deliberate use of publication as a measure of research performance. This is not to argue that promotion procedures are gender neutral in either country simply because the criteria may now be clearer. Research is only one performance indicator and promotion reflects past research rather than current work roles. If women are more likely to prioritise teaching, or if they receive greater teaching responsibilities at middle levels (White 2004: 235-6), then the uniformly strong correlation between research productivity and academic rank may indicate gender bias.

Table 6: Research productivity (article equivalents per year) by field of learning, academic rank and gender [10]

Norway												
Academic Rank/ Gender	Social sciences			Humanities			Natural sci. & Technology			Medical Sciences		
	M *n*=96	F *n*=53	*F/M %*	M *n*=60	F *n*=32	*F/M %*	M *n*=101	F *n*=19	*W/M %*	M *n*=57	F *n*=35	*F/M %*
Professor	5.27	5.27	100.0 %	5.08	4.40	86.7 %	4.01	3.39	84.5 %	6.98	6.97	99.9 %
Assoc. Prof.	2.08	3.06	147.6 %	3.76	1.90	50.4 %	2.05	2.54	124.0 %	2.57	2.44	94.8 %
Assis. Prof	1.89	3.00	158.8 %	1.07	1.80	168.8 %	0.96	0.67	69.8 %	N/A	0.71	N/A
All Ranks	3.73	3.68	98.8 %	4.28	2.98	69.6 %	3.19	2.88	90.3 %	6.44	3.65	56.7 %

Australia												
Academic Rank/ Gender	Social sciences			Humanities			Natural sci. & Technology			Medical Sciences		
	M *n*=134	F *n*=116	*F/M %*	M *n*=42	F *n*=56	*F/M %*	M *n*=105	F *n*=105	*F/M %*	M *n*=81	F *n*=94	*F/M %*
Level E	6.15	7.30	*118.7 %*	5.25	6.67	*127.1 %*	9.69	6.39	65.9 %	7.36	5.33	*72.4 %*
Level D	3.72	4.33	*116.4 %*	10.67	4.60	*43.1 %*	3.86	2.88	74.6 %	3.31	2.87	*86.7 %*
Level C	2.45	1.78	*72.6 %*	3.50	2.11	*60.3 %*	3.36	3.32	98.8 %	2.26	2.45	*108.4 %*
Level B	2.20	1.61	*73.2 %*	3.24	1.94	*59.9 %*	2.06	1.85	89.8 %	2.05	1.33	*64.9 %*
Level A	1.30	1.09	*83.9 %*	2.47	0.89	*36.0 %*	1.00	1.47	147.0 %	1.24	1.22	*98.4 %*
All Ranks	3.29	2.20	*66.9 %*	4.65	2.28	*49.0 %*	3.51	2.79	79.5 %	2.99	2.04	*68.2 %*

It is difficult to make wide generalisations from the relatively small subsamples, but female research productivity does not seem to be affected by the number or proportion of women in

[10] Female research productivity as a % of male productivity (F/M%) across "all ranks" is generally below within rank gender comparisons because women are more common in lower ranks. Even though women may be more productive than men across all ranks in some fields, such as in the social sciences in Norway, on average women are less productive as they are far more likely than men to be in lower ranks.

higher ranks within one's field. One of the reasons offered for why women may produce less at lower ranks is that they lack role models, mentors and other higher ranked women to collaborate with (Winchester et al. 2006: 507). There is very little evidence from the data supporting the theory that more highly productive women in higher ranks improves productivity of lower ranked women in the same field. The only trend evident from Table 6 in both countries is that women perform comparably well in the social sciences across all ranks. Lower ranked women in the natural sciences and technology are also equally productive as their male counterparts, but this is not the case at higher ranks.

Age and experience

Perhaps the greatest difference between the Norwegian and Australia samples is that Norwegian staff are older and more experienced. Female academics in Australia have a mean age of 46 with 11 years experience, while men are on average 47 with 14 years experience. By contrast, female staff in Norway have a mean age of 50 with 16 years experience and male staff are on average 54 with 22 years experience. These are considerable differences and in many ways reflect the greater proportion of higher ranked staff in Norway and perhaps the greater overall productivity of Norwegian academics. As the CAP survey data is not longitudinal, there are significant difficulties when trying to separate the effect of age from cohort and period effects (Hall, Mairesse and Turner 2007). Therefore, when viewing Table 7, it is not possible to know whether individual research productivity was affected by aging. All that can be interpreted is how older staff compare with younger staff for the reference period of 2004 to 2007.

Table 7: Research productivity (article equivalents per year) by age group and gender

Norway														
	< 35		35-39		40-44		45-49		50-54		55-59		60+	
Gender	M	F	M	F	M	F	M	F	M	F	M	F	M	F
	n=12	*n*=5	*n*=18	*n*=12	*n*=39	*n*=25	*n*=54	*n*=27	*n*=73	*n*=34	*n*=64	*n*=29	*n*=122	*n*=27
Mean	1.94	1.20	2.41	2.33	2.86	2.49	3.66	3.11	3.61	3.43	5.44	3.68	4.69	3.59
Std. Dev.	2.80	0.61	2.25	2.37	2.96	2.36	2.63	2.35	4.33	3.59	5.59	3.33	5.08	3.90
Median	1.00	1.00	1.83	1.00	2.00	1.67	3.00	2.67	2.33	2.50	3.17	3.33	3.33	3.00
F/M	62%		97%		87%		85%		95%		68%		77%	

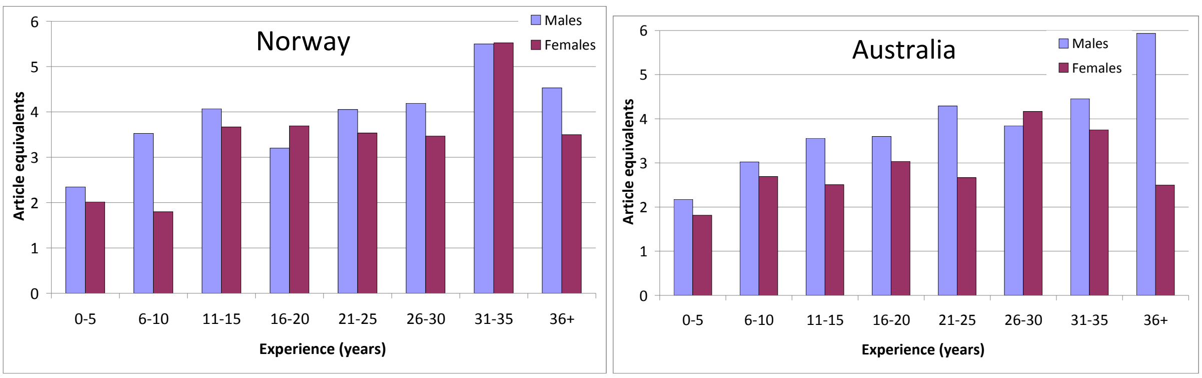
Australia														
	< 35		35-39		40-44		45-49		50-54		55-59		60+	
Gender	M *n*=46	F *n*=58	M *n*=68	F *n*=71	M *n*=78	F *n*=66	M *n*=74	F *n*=68	M *n*=78	F *n*=85	M *n*=63	F *n*=65	M *n*=64	F *n*=39
Mean	2.04	1.92	3.39	2.58	2.81	2.15	3.43	2.75	3.48	2.71	4.41	2.51	3.36	2.32
Std. Dev.	1.58	1.80	3.90	2.48	3.05	2.09	4.48	3.20	3.99	2.81	4.66	2.87	3.50	2.92
Median	1.67	1.50	2.17	1.67	1.67	1.50	1.67	1.67	2.67	1.67	2.67	1.67	2.00	1.67
F/M	94 %		76 %		76 %		80 %		78%		57%		69%	

Table 7 suggests male and female productivity increases with age, generally peaking around the 55 to 59 age cohort, before moderately declining. This relationship is similar to what has been found in previous studies (Kyvik 1991; Fox 1983). However, it also confirms Kyvik and Olsen’s (2008) recent suggestion that the relationship between age and research productivity may be more linear than first thought, as the generational effect of a large cohort of productive academics now entering their late career are not showing signs of declining research output. Further evidence of this trend is that median output does not decline and standard deviation (as a proportion of the mean) does not rise considerably among older staff. The decline in research amongst the oldest academics is slightly more pronounced in the Australian sample, but still quite moderate as the oldest cohort is above average in productivity for both men and women. Given the more linear relationship between age and productivity in Norway, it is not surprising that the correlation coefficient is higher for Norwegian men (0.18 versus 0.11 for Australian men) and women (0.19 versus 0.07 for Australian women). Overall there is little support for the harmful effects of aging or declining interest in research, at least among the under 60 age group (Fox 1983).

It is clear from mean age and experience that men generally have more experience than women at similar ages. Setting aside experience for the moment, Table 7 suggests overall differences between men and women appear relatively stable in the 35 to 54 age groups. Within the Norwegian sample it appears overall research inequality is rather small among middle cohorts and does not support cumulative disadvantage theory, which would be expected to show increasing inequalities based on early career disadvantages. Further evidence that women perform well in Norway compared to men of similar ages, is their median output is comparable to males, even in older age groups where mean differences are greatest. Smaller female standard deviations also indicate that higher mean productivity of older males tends to result from a small group of highly prolific men, rather than changes in female productivity. Equality of men and women of similar ages in the Australian data is less clear. Median output is very stable for women across older age groups, while mean output declines and standard deviations increases with age. It appears men and women follow a similar trend in Australia, whereby some older staff increase research output, but most remain fairly stable.

The theory that older staff suffer diminishing marginal benefits of research or face knowledge obsolescence (Fox 1983; Kyvik 1991: 115) is perhaps better understood by examining experience rather than age. It is also a better indicator of gender differences in productivity as it controls for the effect of career breaks. As shown in Figure 9, the influence of experience is rather less linear than what was found for age, as research output tends to stabilise during the middle stages of one's career. It is also noticeable that Norwegian women do not experience rapid early career improvements in research productivity compared to men. This finding is particularly important as it supports Long's (1992) discovery that gender differences increase over the first decade, before reducing during the second decade of employment.

Figure 9: Research productivity (article equivalents per year), by experience and gender

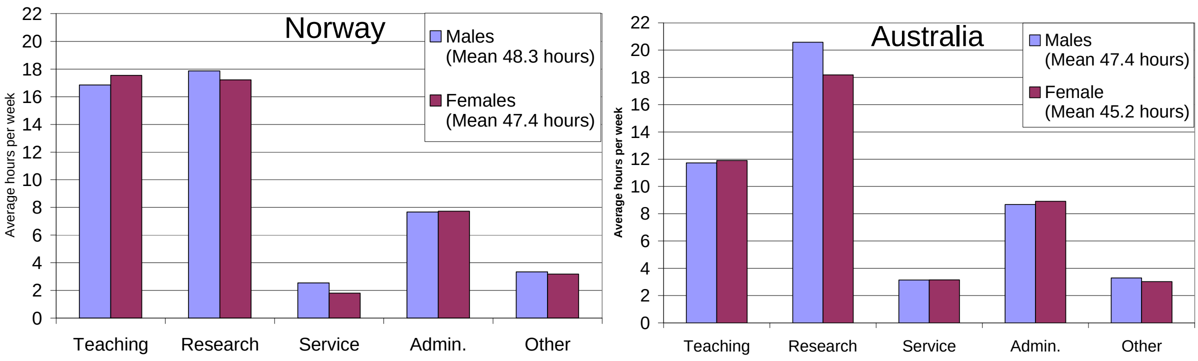


Another reason why women in Norway may more slowly increase research output compared to men is they are more likely located in the social sciences and humanities. Kyvik (1991: 164) found that while the natural sciences showed a steady decline in research productivity in older cohorts, professors in the humanities and social sciences had an "end spurt" in productivity late in their careers. One explanation presented was natural scientists may have greater difficulties maintaining research productivity in their late career due to stronger effects of knowledge obsolescence, while it takes humanists and social scientists longer to reach the knowledge frontier (Kyvik 1991:168). This study provides some support for this, as academics in the social sciences and humanities continue to increase their research output later into their careers (details in Appendix G). However, as the different quality of cohorts can not be controlled for in cross-sectional analysis and the sample sizes are small, the earlier decline in the natural sciences can not be directly attributed to the different effects of experience across fields.

Time spent on research and teaching

The division of working time has been offered as a powerful predictor and explanation of research output (Teodorescu 2001; Creamer 1998), but no method of working time data collection can entirely overcome the ambiguity of what exactly constitutes working time. This is particularly the case for professionals and academics who are truly engaged in their work. As pointed out by Robinson and Godby (1997 quoted in Jacobs 1998: 43) “People think they know how many hours they work – that is, until they actually try to figure it out.” In other words, there may be errors in the accuracy of one’s estimation of usual working hours and differences in how one interprets unpaid overtime, lunch meetings, conferences and background reading. Studies comparing self-reports to other methods, such as diary keeping or even electronic monitoring devices, have not shown substantial differences in results (Jacobs 1998), which indicates self-reported data is reasonably accurate. Bellas and Toutkoushian (1999) also found no evidence of systemic over or under reporting of working time due to gender or race-based interpretations of working time, making it less likely that men and women will interpret working time differently in the CAP survey. However, if usual working hours have changed during the reference period this could raise some concerns. Given the more equal division of work responsibilities across ranks in Norway, this is of greater concern in the Australian data.

Figure 10: Average hours per week on academic activities, by gender



As shown in Figure 10, men work on average 48.3 hours per week in Norway and 47.4 hours in Australia. Women work 47.4 hours per week in Norway, while Australian women work 44.7 hours. Gender difference in total working hours is only significant within the Australian sample ($p < 0.01$). Examining average time spent on each activity, men and women spend roughly the same number of hours per week on each activity in Norway, but in Australia the longer working week of males translates into an extra 2.5 hours per week spent on research. Research hours in Australia is the only difference that is significant ($p < 0.01$). The extra hour per week that men work in Norway is mostly accounted by an extra 0.7 hours per week spent on service, but men also spend an extra 0.7 hours on research and 0.9 hours less on teaching. None of the gender differences in the Norwegian sample are statistically significant.

Table 8: Working time by gender and academic rank

Norway

	Teaching			Research			Service			Admin			Other			Total		
Rank	M	F	All	M	F	All	M	F	All	M	F	All	M	F	All	M	F	All
As. P	18.8	16.1	17.4	13.2	17.4	15.4	3.1	1.8	2.5	6.7	5.2	5.9	2.6	2.3	2.4	44.4	42.8	43.6
Ac. P	18.8	17.9	18.4	15.4	15.5	15.4	2.0	1.8	1.9	6.3	7.2	6.6	3.2	3.3	3.2	45.5	45.8	45.6
Prof.	14.5	16.5	14.9	19.5	18.7	19.3	2.8	1.9	2.6	9.2	10.2	9.4	4.1	3.7	4.1	50.1	51.1	50.3
All	16.2	17.1	16.4	17.8	17.1	17.6	2.5	1.9	2.4	8.0	8.1	8.1	3.7	3.3	3,6	48.3	47.4	48.0

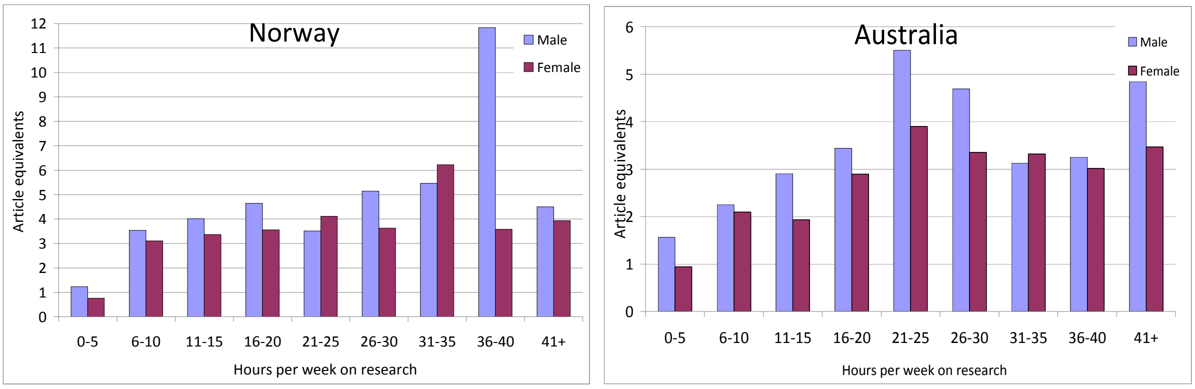
Australia

	Teaching			Research			Service			Admin			Other			Total		
Lev.	M	F	All	M	F	All	M	F	All	M	F	All	M	F	All	M	F	All
A	5.4	7.8	6.7	29.7	22.2	25.5	1.2	2.7	2.0	5.1	5.5	5.3	2.5	2.0	2.2	43.9	40.3	41.9
B	13.8	13.8	13.8	19.9	17.4	18.5	2.7	2.6	2.6	6.3	7.5	6.9	2.9	2.7	2.8	45.5	43.9	44.6
C	13.6	13.4	13.5	16.5	15.5	16.0	3.5	4.2	3.9	9.8	10.8	10.3	3.0	3.6	3.3	46.4	47.5	46.9
D	12.9	9.6	11.8	19.2	19.0	19.0	3.1	3.4	3.4	10.5	11.7	11.7	4.1	4.2	4.2	49.7	47.9	47.9
E	7.8	7.4	7.7	23.0	22.4	22.8	4.8	3.2	4.3	12.5	12.9	12.6	4.2	3.6	4.0	52.4	49.5	51.5
All	11.7	11.9	11.8	20.5	18.1	19.4	3.1	3.2	3.1	8.7	8.9	8.8	3.3	3.0	3.2	47.3	45.2	46.3

Overall differences between men and women in weekly working hours are largely reflected in greater concentrations of women in lower academic ranks. Average total working time rises with academic rank peaking at around 50 hours per week in both countries for highest ranks. Time spent on service, administration and other activities also steadily rises with academic rank. Interestingly, while administration is an activity that on average occupies between 8 and 9 hours per week, the distribution is substantially more skewed across Australian ranks with Level E staff spending on average 12.6 hours per week on these activities. In both countries teaching hours reduce with higher academic ranks, but the decline is particularly sharp in Australia where Level E staff spend only 7.7 hours per week or 15% of their working time, compared to lower ranks who spend between 11.8 and 13.8 hours per week or 24% to 31% of their time teaching (except for Level A staff who are quite unique given they are likely to be doctoral or postdoctoral researchers). A similar pattern is found in the Norwegian data, though to a lesser extent as Professors spend 14.9 hours per week or 30% of working time teaching, compared to Associate Professors who average 18.4 hours per week or 40% of their time.

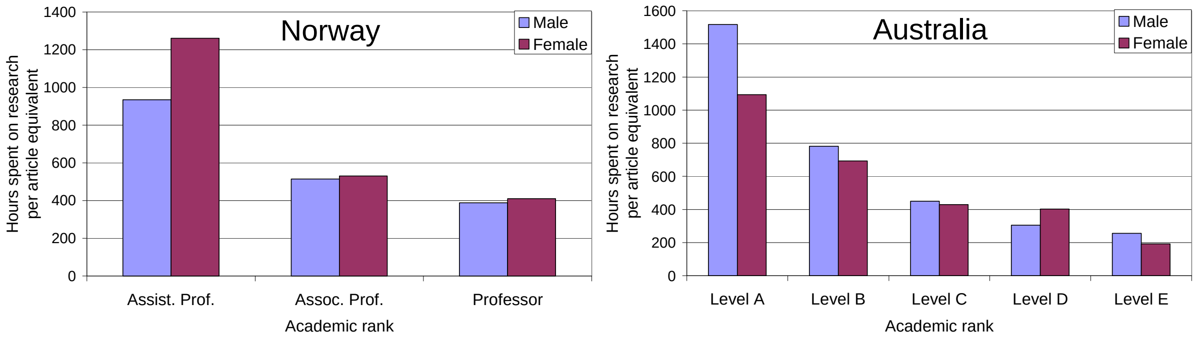
The relatively fewer hours spent by Australian academics teaching may be partly explained by the inclusion of research-only staff in the Australian sample. The greater diversity within the Australian sample is also reflected in the larger standard deviations for teaching (9.8 hours) and research (13 hours), compared to Norway (9.1 hours and 10 hours respectively). The apparent occupational segregation of Australian women in teaching orientated jobs (White 2004) does receive some support as Level A females spend 2.4 hours more per week on teaching and 7.5 hours less on research compared to equivalent males. This is an important finding, as it indicates that Level A positions operate differently for men and women, with women more likely to be teaching rather than engaging in concentrated research. However, perhaps the strongest indication of a broader inequitable distribution of tasks is in administrative work, where women spend more hours than men across all ranks.

Figure 11: Research productivity (article equivalents per year) by research time and gender



As shown in Figure 11, the relationship between time spent on research and published output is positive. The correlation coefficients are reasonably high across all groups (Norwegian women 0.15, men 0.23; Australian women 0.29, men 0.21), but the relationship is not linear beyond the 21-25 hour per week threshold. While time spent on research may be a reasonable predictor of research output (Teodorescu 2001), its effectiveness is somewhat limited in Australia as academics that spend the greatest amounts of time on research tend to be the lowest and highest ranked staff. It does not appear that the relationship between research hours and output differs between genders, but women in both countries tend to publish less than men spending comparable amounts of time on research. While the fewer hours women spend on research may explain some of the overall gender gap in productivity, the availability of research time is influenced by rank. Given the more regulated workplace environment in Norway, whereby all staff are expected to be active in teaching and research, differences on this variable are more likely associated with personal preferences than in Australia where time available for research may be based more on employment status. The expectation that those who choose to spend above average hours on research are substantially more productive receives little support, even though a small group of 10 male academics in Norway who worked between 36-40 hours were extremely productive.

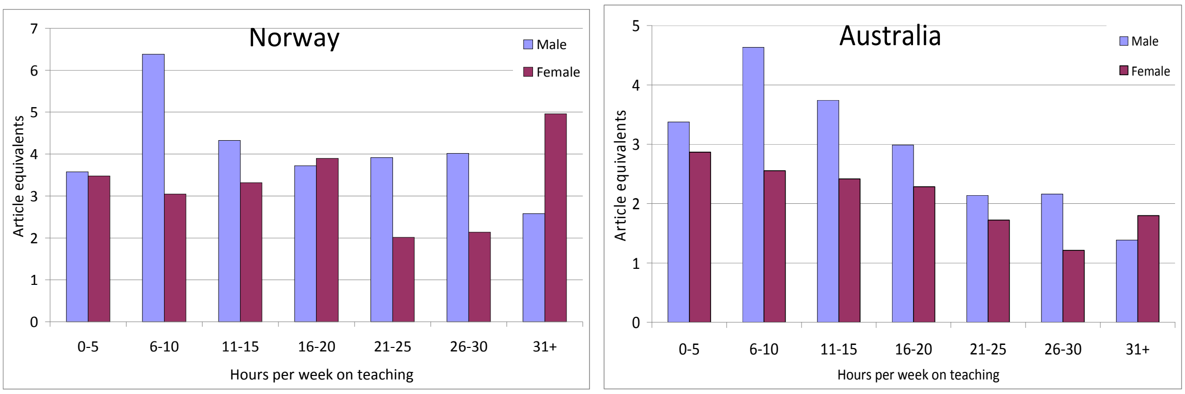
Figure 12: Research hours per article equivalent, by gender and rank



Another interesting way of illustrating the relationship between hours spent on research and overall productivity is shown in Figure 12. Converting weekly hours on research into an annual estimate[11], and comparing this to annual research productivity, provides a very rough estimate of the number of hours it takes each academic to produce one article equivalent. As might be expected, higher ranked staff tend to be more "efficient" with their research time, particularly Level E staff in Australia who average some of the longest hours on research and take the least amount of time to produce an article equivalent. This perhaps indicates the shortcoming of Figure 11 as both the most efficient and least efficient groups average long hours on research. Excluding Level A staff from the Australian sample increases the correlation coefficient of research time for both women (0.32) and men (0.27).

[11] This assumes that academics spend 6 weeks per year not working.

Figure 13: Research productivity (article equivalents per year) by teaching time and gender



Previous studies have demonstrated (Fox and Milbourne 1999) or hypothesised (White 2004) that heavier teaching loads negatively affect research performance. While the correlation coefficient is insignificant in Norway, teaching time is negatively correlated with research output for Australian women (-0.16) and men (-0.13). A problem with this variable is that in Australia teaching responsibilities vary greatly across ranks, with Level A and Level E spending roughly half as much time on teaching as other ranks. As each of these two groups have extremely different levels of research productivity, it somewhat diminishes the effect of spending very few hours teaching. Removing Level A academics from the sample increases the negative coefficient for women (-0.20) and men (-0.17), but this likely overestimates the effect of teaching on research productivity as most Level D and E staff spend comparably few hours on this activity. Overall it is very difficult to draw conclusions from teaching hours in isolation of other factors, in particular whether one is employed primarily to teach or research.

Doctoral degree

Holding a doctoral degree is one of the most important and strongly correlated variables in this study, with a correlation coefficient of 0.34 for women and 0.27 for men in Australia, and 0.26 for women and 0.14 for men in Norway. Australian academics are slightly more likely to be without a doctoral degree (23%) compared to academics in Norway (21%). Women are also overrepresented in the group of academics without a doctoral degree, accounting for a quarter (25%) of all female academics in the Norwegian sample and over a quarter (28%) in the Australian sample. By comparison, just under one fifth of male academics (19% in Australia; 18% in Norway) do not have doctoral qualifications.

Staff without doctoral qualifications have lower research productivity and are more likely to be located in lower ranks. Female academics without a doctoral degree achieve only a third (33%) of the productivity of women who have such a degree in Australia, while Norwegian women without a doctoral degree achieve half (49%) the productivity of women with doctoral qualifications. The effect of being without a doctoral degree is slightly greater for males in Australia who achieve 31% research productivity compared to males with doctoral qualifications, while male academics in Norway compare more favourably, achieving 64% productivity.

Table 9: Research productivity (article equivalents per year) by gender and doctoral status

	Norway				**Australia**			
	Male		Female		Male		Female	
	Mean	*n*	Mean	*n*	Mean	*n*	Mean	*n*
Without a PhD	2.81	74	1.79	40	1.19	88	1.02	129
With a PhD	4.36	319	3.67	120	3.79	385	3	332
All staff	4.07	393	3.2	160	3.31	473	2.44	461

While the effect of this variable on productivity appears to be similar for men and women in Australia, there are some interesting contrasts when examining staff based on rank and hours of work. Compared to men without a doctoral degree, comparable women spend on average more hours per week on research (14.7 versus 12.5) and less on teaching (13.8 versus 14.8). However, among Level A staff without a doctorate, women spend fewer hours on research (15.6 versus 20.8) and more hours teaching (10.1 versus 7.0). This indicates that men in Level A positions are perhaps more likely to be working towards a doctorate qualification, while women in these positions are working heavier teaching loads. This gives some support to White's (2004) claims that:

> "Women tend to take on full- or part-time teaching as lecturers and become caught in a difficult spiral – their teaching loads are heavy and they have little time to do postgraduate research. And the more they are cast into a teaching only role, the less time they have for research. In this downward spiral they become trapped, unable to afford to take leave without pay to complete their thesis and unable to be promoted because they do not have a doctorate. (White 2004: 230) "

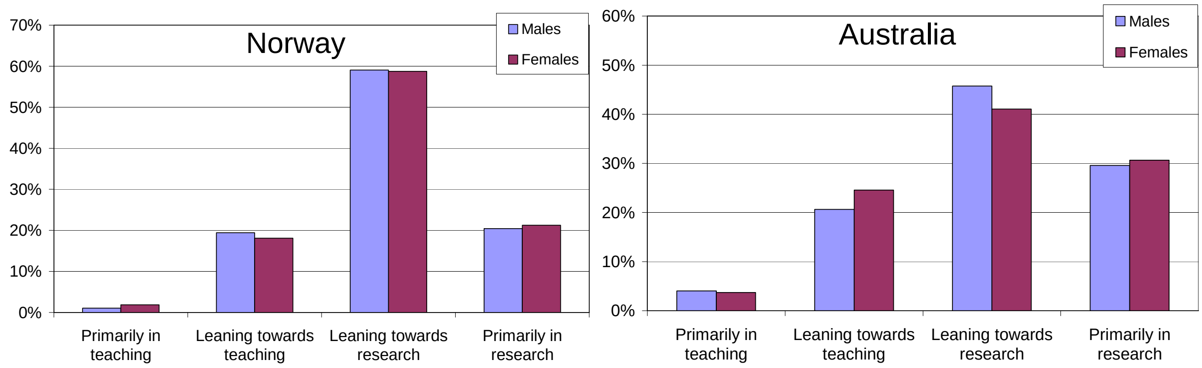
What receives less support is that the effect of not having a doctorate operates differently based on gender, and that such women have heavier teaching loads and fewer opportunities for promotion than men. In Level B positions, the rank to which half of all staff without doctoral degrees are located within the sample, women spend less hours teaching than comparable men (15.5 versus 19.0) and more hours on research (14.3 versus 12.1). Further, women without a doctoral degree in such positions produce only 27% of the mean output for all Level B staff. Men without a doctoral degree in Level B positions perform better by comparison, achieving 44% productivity at this rank, despite apparently heavier teaching loads. Winchester et al. (2006: 510-11) note that Australian universities often specify qualifications, usually at doctoral level, as a prerequisite for promotion. However there are no sector wide regulations prohibiting non-doctoral staff from gaining promotion from within one's institution or through moving to another institution.

The majority of staff without a doctoral degree (81%) are located above Level A, indicating that not all staff without doctoral qualifications are ineligible or have not achieved promotion. When examining the average number of years since appointment or promotion to current rank at their current institution, women at Level B (n= 61) had spent 6.0 years, while men (n=42) had spent 8.4 years at this position. At Level C, women (n=25) had spent 4.4 years while men (n=23) had spent 6.3 years. Compared to those staff with a doctoral degree, those without such qualifications had spent on average more years at their current rank (5.6 versus 3.7 years), indicating that doctoral qualifications may be a factor that is considered in promotion decisions. However, the data suggests that it is the negative effect on research productivity of not having a doctorate, rather than the heavier teaching loads or the lack of formal doctoral qualification, that are the more likely barriers for men and women in promotion decisions.

Research preferences

The dominant stereotype is that women have a greater interest in the interpersonal and communicative tasks of teaching, while men are attracted to the competitive and masculine domain of research (Carvalho and Santiago 2008). White (2001: 65-6) agues that emphasis placed on research over teaching in promotion decisions disadvantages women as literature has shown women are less interested in this activity. While it is difficult to disentangle the socialisation processes that informally encourage men and women to give primary interests to each of these roles, the working time data showed women spend slightly more hours teaching than men and a greater proportion of their total time on this activity. It is also clear that men and women of similar ranks spend roughly the same amount of time on each of these activities, while research occupies more time for higher ranked staff.

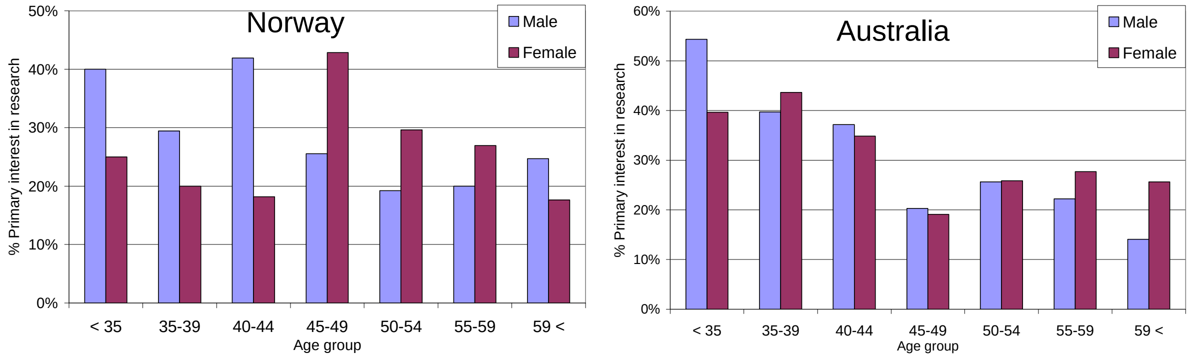
Figure 14: Preferences towards teaching and research, by gender



As shown in Figure 14, this study does not provide a great deal of support for gender-based differences in research interest. In Australia, women are marginally more likely than men to indicate a primary interest or to lean towards teaching (28% versus 25%), but in Norway men and women are equally likely to have a main interest in teaching (20%). Academic staff in both countries tend to have a stronger interest in research (72% in Australia and 80% in Norway), but this may actually understate the primacy of research amongst Norwegian academics. Examining this variable based on academic rank (see Appendix H) shows assistant professors are equally divided between research and teaching, meaning this group skews the overall sample towards teaching. Among Norwegian associate professors, 79% of females and 69% of males identify more strongly with research, while this is the case for 95% of female and 88% of male full professors. In Australia, interest in research declines from 78% among Level A staff to 67% among Level B and C, before rising again to 81% and 92% at Levels D and E.

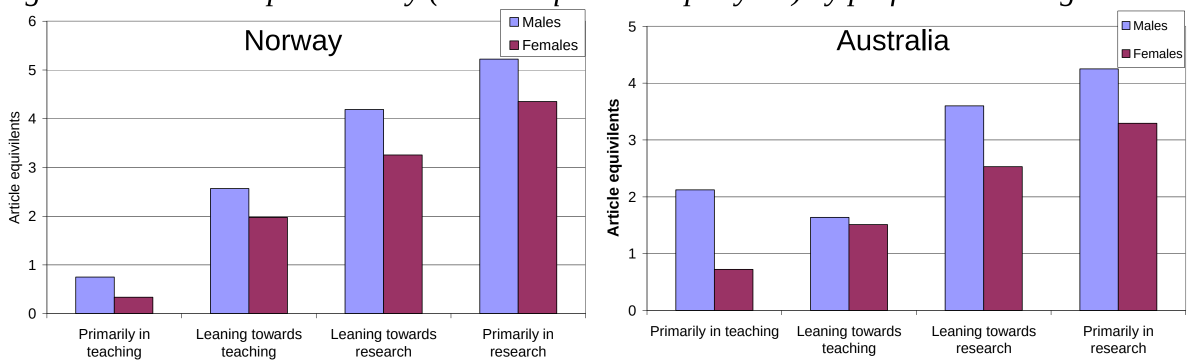
Fox (1983) offered the explanation that older staff may have a declining motivation to undertake research as the benefits of additional publications diminish later in one's career. While the general theory of declining productivity with age received no support from the data (see Table 7), the declining interest in research does receive support. Men and women in both countries are less likely to have a primary interest in research in older age cohorts. Overall interest in teaching (not shown) also increases from the under 35 to over 65 age groups, from 17% to 31% in Australia and from 18% to 28% in Norway. Another rather noticeable trend in the Norwegian data is that primary interest in research increases dramatically in the 45-49 age group. While cross-sectional data can not attribute this to the direct effect of aging, as indicated in Figure 9 and in Long's (1992) study, research productivity also rises considerably in the second decade of the female career, which may coincide with this increased interest in research for Norwegian women.

Figure 15: Primarily interested in research (%), by gender and age group



When examining research interest in conjunction with working hours (see Table 8), average levels of interest in research in Australia follow the same trend as working time divisions. Research hours and interest in research are greatest amongst Levels A and E, while teaching hours and interest in teaching are highest in Levels B and C. The relationship between interest in research and working time is less relevant in the Norwegian context as teaching responsibilities do not vary greatly across ranks. However, it is interesting to note that the greater time Norwegian academics spend on teaching, compared to academics in Australia, occurs despite a stronger interest in research.

Figure 16: Research productivity (article equivalents per year) by preferences and gender



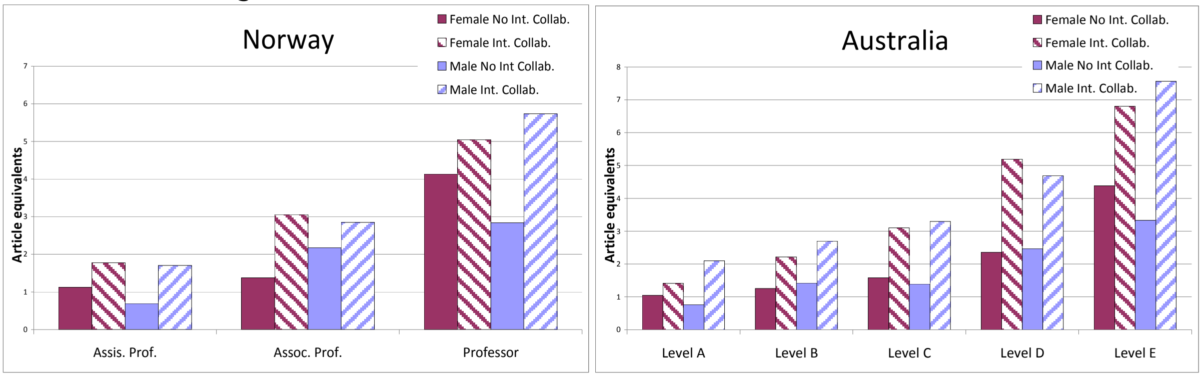
Treating this variable as a scale measure of interest in research generated a correlation coefficient of 0.28 for women and 0.23 for men in Australia, and 0.27 for women and 0.20 for men in Norway. These coefficients likely overstate this variable's importance, as the majority of staff with a stronger research interest are in higher ranks and spend more hours on research, particularly in Australia. In the Norwegian context there is also the influence of assistant professors, which are overrepresented in teaching categories. However, in pure bi-variate terms a greater interest in research is one of the strongest predictors of research output amongst most groups.

Research collaboration and conference attendance

Research collaboration generated a fair correlation coefficient with research productivity for Australian and Norwegian women (both 0.11) and Australian men (0.16), but was not significant for Norwegian men. By comparison international research collaboration was a far stronger indicator of research productivity, with a significant and higher coefficient for all academics (Australian men and women 0.34; Norwegian men 0.25 and women 0.28). Collaboration rates were very similar for Norwegian women (91%) and men (89%), as was international collaboration (79% women; 78% men). Research collaboration was also similar for men and women (both 89%) in Australia, but international collaboration was more common amongst Australian men (67%) than women (57%). Clearly these two variables overlap considerably, as 64% of Australian men and 76% of Norwegian men participated in both forms of collaboration, compared to 55% of Australian women and 73% of Norwegian women.

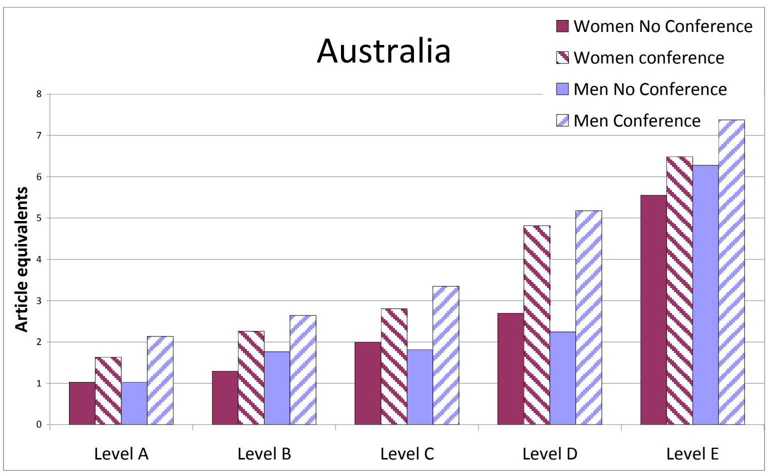
Academics who collaborated were more productive than those who did not. In Australia, women were 57% more productive and men 134% more productive than non-collaborating academics of the same gender, while in Norway women were 59% more productive. The relationship between international collaboration and research productivity was even more dramatic. Compared to academics who did not have international collaborators, productivity was 92% higher for Norwegian women and 116% higher for men. In Australia, where international collaboration is less common, women who collaborated internationally were 116% more productive and men 176% more productive. The importance of international collaboration is consistent with previous multi-variate Norwegian studies (Kyvik 1991; Kyvik and Teigen 1996), but the extent of its effect when controlling for other factors is not yet clear. The minority of staff who do not collaborate (nationally or internationally) likely exhibit other characteristics that may negatively affect their research productivity. It is also not possible to determine whether the strong association between productivity and collaboration is capturing the effect of co-authorship, which is not accounted for in the research index. However, the effect international collaboration is very strong across all ranks of staff, particularly in Australia where those who collaborate internationally are at least as productive as staff one rank above them and in many cases two ranks above.

Figure 17: Research productivity (article equivalents per year) by international research collaboration and gender



The additional Australian variable of international conference attendance is also one of the most strongly correlated variables with a coefficient of 0.29 for men and 0.32 for women. Just over half (52%) of all academics attended an international conference in the previous year, but attendance was strongly associated with academic rank, rising from 33% among Level A staff to 56% at Level C, and to 78% at Level E. Women were marginally less likely to attend an overseas conference (51%) compared to men (54%), but compared to men of similar ranks women were generally more likely to attend. The only exception to this was at Level A where 29% of women but 38% of men attended a conference. This again indicates that Level A positions tend to be less research and internationally oriented for women. While the nature of the conference attendance is not clear from the data, based on the proportion of women and men who attend international conferences it does not appear that men are any more likely to attend international conferences (Ramsay 1999 in White 2001: 68).

Figure 18: Research productivity (article equivalents per year) by international conference attendance and gender



International conference attendance was associated with increased research output across all ranks and does not appear affected by gender. Level D staff who attended a conference were more than twice (112%) as productive as those who did not attend. The lowest proportional increase was among Level E staff (16%), but as indicated in Figure 18, this is mostly due to their overall high productivity. Men and women from Level A to D who attended an international conference were more productive than academics in ranks immediately above who did not. Along with international collaboration, this is one of the strongest findings among the independent variables, but caution again must be stressed as to an ambiguous causal relationship. It is just as likely that higher productivity leads to international conference attendance as vice versa.

Marriage, children and caring responsibilities

With the exception of age and experience, all other background variables included in this study encompass marriage and the family lives of academics. While marriage may have a positive effect for men (Long et al. 1993), the type of marriage is believed to be more important for female productivity (Fox 2005). Family responsibilities are frequently offered as an explanation for lower female productivity (Creamer 1996: 26). Data shows that women are more likely than men to be single in Norway (women 20%, men 12%) and in Australia (women 23%, men 9%), which is consistent with other studies of the academic profession (Long et al. 1993). The Australian survey data found that marriage to a fellow academic is more common for Australian male academics (22%) than female (17%), while the corresponding question for the Norwegian survey found that men and women were equally likely to be married to someone with a university education (women 61%, men 59%).

Table 10: Research productivity (article equivalents per year) by marital status and gender

	Norway						**Australia**					
	Male			Female			Male			Female		
Family status	Mean	% male mean	n	Mean	% female mean	n	Mean	% male mean	n	Mean	% female mean	n
Single	3.51	86 %	46	2.77	86 %	27	2.42	73%	44	2.45	102%	102
Married to academic*	4.13	102 %	231	3.90	122 %	96	4.29	130%	101	3.19	133%	77
Married to non-academic*	4.12	101 %	111	1.91	60 %	30	3.07	93%	320	2.26	94%	271

Note: * “Academic” in the Norwegian CAP survey referred to university-level education, not whether the spouse was also employed as an academic as in the Australian CAP survey.

The effect of marriage on research productivity appears positive as males in both countries research productivity was lowest among unmarried men. However, the effect of marriage type appears to be more important for women. In Australia, women who were married to someone other than a fellow academic were, on average, less productive than unmarried women. In Norway, marriage to a spouse without university-level qualifications was associated with substantially lower research productivity. While these findings are consistent with Fox's (2005) study, without controlling for other factors such as age, there is relatively little that can be concluded. For example, Fox (2005) found divorced and widowed men to be the most productive groups, but in this analysis such men would be classified as "single" in the same manner as a young entrant into the academic profession.

Table 11: Research productivity (article equivalents per year) by children at home and gender

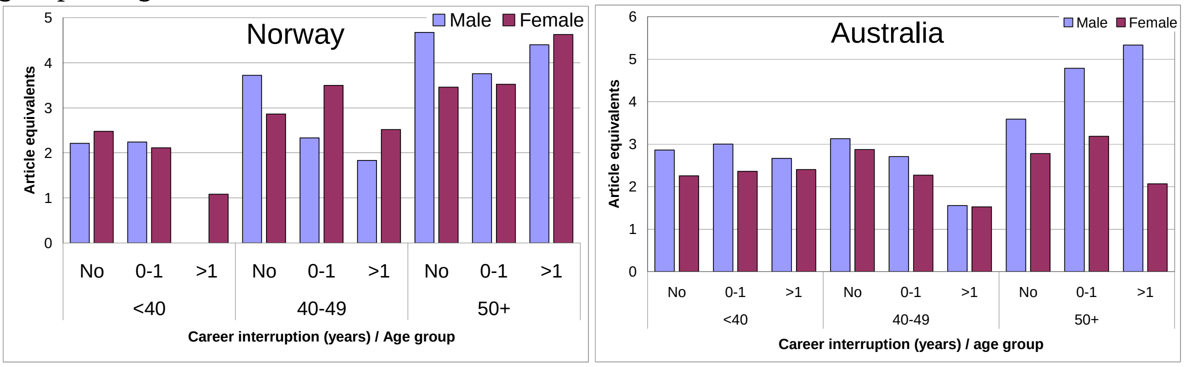
	Norway						**Australia**					
	Male			Female			Male			Female		
Number of children	Mean	% male mean	n	Mean	% female mean	n	Mean	% male mean	N	Mean	% female mean	n
None	4.43	109 %	201	3.54	111 %	75	2.96	90%	197	2.51	105%	246
1	3.78	93 %	70	3.58	112 %	23	3.54	107%	94	2.33	97%	88
2	3.62	89 %	71	2.93	91 %	41	3.45	104%	139	2.22	93%	84
3 or more	3.51	86 %	46	2.47	77 %	17	3.62	110%	35	2.72	113%	33

Long et al. (1993) speculate that positive effects of marriage for women may be offset by the negative effects of children. Table 11 indicates how research output varies based on the number of children in the family home. This measure is imperfect as it does not indicate the age of the children and previous studies have shown that older children have far less impact on research output than those under ten years of age (Kyvik and Teigen 1996). The measure also does not indicate the total number of children the respondents had parented. Therefore a respondent who never had children would be treated the same as one whose last child recently left home. These two categories of staff, particularly with regard to women, are very different in terms of how cumulative disadvantage theory would explain research productivity differences. If having children negatively influences research output through less collaboration (Long 1990), delayed or interrupted careers (Probert et al. 1998 in White 2001: 67) or simply a lack of time for research, then those with children would have negative long term implications on research output not visible in the data. For example, the higher proportion of male academics reporting no children in the home in Norway is more likely due to that sample's greater average age relative to Australia, rather than a greater propensity to not have children.

While the category of staff reporting no children is likely too diverse to draw conclusions, it is reasonable to assume that dependent children within the home imply greater domestic responsibilities. From Table 11 there is little evidence suggesting negative impacts of having children within the home in Australia, but some support in Norway. Australian males with children are 18% more productive than those without, while women are 8% less productive. In Norway, males with children are 18% less productive than men without, while women are also 15% less productive. The Australian findings were expected as women generally have greater access to paid parental leave than men (University of Melbourne 2006) and Australia's masculine culture (Hofstede 1984) may encourage the male breadwinner model. The stronger negative association of children and research output in Norway is not as expected given the extensive family care provisions available. However, this may simply be the result of a far older academic population, meaning those with children are far less experienced than those whose children have already left the family home.

A more direct method of identifying the effect of family responsibilities on research productivity is the "child and elder care" variable. This indicates the number of years of career interruption due to caring responsibilities. 48% of Norwegian women had interrupted their careers (mean 1.20 years) and 19% of Norwegian men (mean 0.18 years). In Australia, 44% of women had interrupted their careers (mean 1.70 years) and 10% of men (mean 0.17 years). In both countries though, the standard deviations are high for women (Norway 3.5 years; Australia 3.7 years). The number of years of interruption to one's career was expected to be negatively correlated with research productivity. However, the correlation coefficient for this variable is relatively weak for Australian women (-0.09) and Norwegian men (-0.09).

Figure 19: Research productivity (article equivalents per year) by career interruption, age group and gender



The low correlation coefficients are likely due to the imprecise nature of the question used to operationalise this variable. No indication was given for when the career interruption occurred or whether it was a series of career interruptions or a single break. The other problem is the high standard deviation. In an attempt to partly overcome these problems, Figure 19 shows career interruption as three variables (no interruption; 0 to 1 year; greater than 1 year) for men and women by age cohort. Career interruptions amongst older staff will likely be due to elderly care or child care many years earlier. These interruptions are theoretically important as cumulative disadvantage suggests early career interruptions will have long lasting implications. The younger cohorts likely reflect more recent interruptions for child care. While this is still very imprecise, there is a noticeable negative relationship between interruptions and productivity within the middle age group, but it must be remembered that men are far less likely to have such an interruption. Without a more precise indication of the nature of these interruptions, it is very difficult to draw conclusions on why mid-career interruptions seem to have a greater effect on research productivity.

Organisational context and culture

Research funding satisfaction, institutional performance orientation and performance based funding were included as contextual variables with the intention of understanding the influence of the work environment on research performance. Two additional contextual variables were included in the Australian data, institutional grouping (Go8, ATN, other) and perceived level of collegial support. Overall, the institutional variables had very low correlations with research productivity, with the exception of the Australian institutional grouping variables. In fact, for Norwegian males none of the variables were close to achieving significance. The responses on the Likert scale variables were nearly identical for men and women within countries, but differed marginally between countries. This is not particularly surprising and nor is it relevant, as the purpose of these variables was not to determine mean levels, but to see whether those satisfied with research funding or working in environments with strong performance practices, had higher levels of productivity. Table 12 shows mean research productivity for individuals at each response level for the institutional variables. For illustrative purposes, mean responses have also been included with the correlation coefficient.

Table 12: Research productivity (article equivalents per year) by institutional variables (Likert scale), country and gender

	Research Funding				**Perform. Orientation**				**Performance Funding**				**Colleg. Sup.**	
	NOR		**AUST**		**NOR**		**AUST**		**NOR**		**AUST**		**AUST Only**	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F
1 Poor	4.08	3.79	2.59	2.57	3.78	0.75	2.98	2.51	4.94	2.46	3.31	1.89	3.15	2.60
2	3.93	2.53	2.82	2.23	3.78	4.33	2.97	3.37	4.71	3.96	3.39	2.76	2.81	2.28
3	4.15	2.82	3.62	2.41	4.52	3.51	2.90	1.87	3.45	2.32	3.12	2.42	2.97	1.98
4	4.74	3.79	3.72	2.60	3.82	2.34	3.39	2.59	4.18	3.29	3.30	2.73	3.63	2.58
5 Excl.	3.10	2.22	6.56	3.12	3.46	3.76	3.69	2.55	3.69	4.24	4.11	2.34	4.15	2.92
Mean Resp.	*2.4*	*2.2*	*2.5*	*2.5*	*3.4*	*3.6*	*3.8*	*4.0*	*3.4*	*3.6*	*3.4*	*3.4*	*3.2*	*3.2*
Correl. Coeff.	-	-	*0.20*	-	-	-	-	-	-	*0.12*	-	-	-	-

Research funding satisfaction was expected to be positively associated with productivity and this was the case for males in Australia with a relatively strong correlation coefficient of 0.20. Australian men were not necessarily more satisfied with their institution’s research funding, but those that were more satisfied tended to be more productive. Teodorescu (2000) found the amount of research funding received by academics in Australia had a positive effect on research productivity, but the measure used in this thesis is rather imprecise. Academics who receive more funding are not necessarily more satisfied as expectations for funding may increase as one becomes more research active. While this variable clearly refers to institutional support, the most productive male researchers likely receive outside funding which they may have incorporated into their responses by offsetting dissatisfaction with institutional support. The linear nature of this variable for Australian men probably reflects performance based funding arrangements in Australia, as it is the only variable where the mean productivity of respondents is very high.

A higher level of performance based allocation of resources was also associated with higher research productivity among Norwegian women, with a moderate correlation coefficient of 0.12. It was expected that performance based funding would have been more prevalent in the Australian universities given the more extensive implementation of new public management (Lafferty and Fleming 2000). A general mistrust of performance based funding was also expected more from females as it has been argued universities do not reward performance equally for women (Creamer 1995: 51). While there is no significant correlation between this variable and research productivity in Australia, it is interesting to note that Australian males in universities with high levels of performance based funding had greatest average productivity, while the opposite is true for Norwegian males. This is expected given the different approaches to funding concentration in Australia and diversification in Norway. However, it may be that there is a perception of performance based allocation of resources among highly productive Norwegian women, while highly productive Norwegian men feel they are not rewarded for performance.

Performance orientation and collegial support can be discussed together as neither had any relationship with research productivity. Both variables were based on questions with “strongly disagree” to “strongly agree” scales which effectively ask for a personal judgment on these criteria. Unfortunately highly productive researchers may be more critical of the performance orientation of their institution and this seems to be the case in the data, whereby the mean response is rather high, but those providing strong support are not the most productive academics. Collegial support did not generate a strong correlation coefficient and this probably reflects the inappropriateness of trying to measure the effect of this variable on a Likert scale. It was expected that female academics would place a greater importance on collegiality and benefit from environments that provide such support. However, as noted by Sonnert and Holton (1995), women who fail to receive support may also develop more quickly due to independence. Also, women who are productive researchers may receive recognition and support from some colleagues within or outside their institution, but receive little recognition from the higher level staff within their own institution. However, perhaps the clearest drawback of this question was the tendency for less productive staff to give a middle response as the question may not be relevant if they are not research active.

The institutional grouping dummy variables applied only to the Australian data. Employment at a Group of 8 university was positively correlated with research productivity for men (0.16) and women (0.13), employment at an ATN university was not correlated with research productivity, while employment at a university outside these two groupings was negatively correlated for both men (-0.13) and women (-0.12). This is precisely what would be expected given the relative concentrations of funding. These universities are also where Ramsden (1994: 219) noted most of the highly active research departments were likely located. It does not appear that the institutional group affects women differently to men, even though they may be a minority group within their institution (Creamer 1995: 52). However, as the most productive researchers are likely attracted to research intensive and international universities, this factor is also probably an effect of high research productivity rather than a cause.

5.3 Multiple regression analysis on research productivity determinants

Regression analysis is a statistical tool used to measure relationships between variables. In this thesis the dependent variable, annual research output, and numerous independent variables, which are loosely grouped into individual background, achievement and environmental variables, have been introduced to explain variations in research productivity between academics. As many of the independent variables overlap, basic bi-variate analyses are insufficient to give a true indication of how each variable affects research. Multiple regression allows an estimate of how an increase in each independent variable affects or correlates with research output, while holding all other variables constant.

Unfortunately, the independent variables do not have identical units of measurement. For example age is calculated in years, research funding on a Likert scale, doctoral degree is a dichotomous (dummy) variable, while academic rank is an ordinal scale that differs across countries (3-point scale in Norway, 5-point scale in Australia). Therefore, all variables were standardised (with a mean of zero and standard deviation of one), so that the effect of each independent variable on research output can be compared. The standardised coefficients range from -1 to +1, with the sign and size of this coefficient indicating the effect on research output (in standard deviations) of one standard deviation increase in a given independent variable. The second coefficient of interest is the R^2 which ranges from 0 to +1 and indicates the proportion of variation in research productivity explained by all independent variables included and the proportion of variance remaining unexplained.

Four separate regression analyses were completed, one for each gender in each country. Not all independent variables from the bi-variate analyses have been included. “Experience” was excluded as it strongly overlaps with “age”, had more non-responses and is a less reliable measure, given it is a composite of two questions. “Collaboration” has been excluded as it overlaps closely with “international research collaboration”, is generally less significant than the alternative variable and had a relatively large number of non-responses. “Academic field” was also excluded as the research index accounts for most of the variation across fields and for pragmatic reasons based on non-responses and to avoid four additional dummy variables.

Table 13: Multiple regression analysis standardised coefficients for independent variables by country and gender.

		Norway		Australia	
		Men	Women	Men	Women
Individual background	Age	**0.12**$^{\#}$	0.13	**-0.10**§	**-0.10**§
	Married to an academic	0.01	0.05	**0.17**$^{\#}$	0.00
	Married to a non-academic	0.05	-0.10	0.10	-0.08
	One child	-0.02	0.03	0.02	**-0.08**$^{\#}$
	Two children	-0.02	-0.08	0.00	-0.01
	Three or more children	0.03	-0.03	0.04	0.03
	Career interruption for caring	-0.05	-0.02	0.01	-0.05
Individual achievement	Doctoral degree	0.00	-0.08	0.04	**0.12***
	Academic rank	**0.18***	**0.34***	**0.45***	**0.49***
	Time spent on research	**0.10**§	0.03	**0.16***	**0.16***
	Preferences towards research	**0.17***	0.08	0.01	**0.09**§
	International collaboration	**0.18***	**0.22***	**0.13***	**0.09**$^{\#}$
	International conference	N/A	N/A	**0.08**§	**0.10**$^{\#}$
Institutional	Time spent teaching	0.05	0.01	0.06	0.00
	Research funding satisfaction	-0.03	-0.01	**0.12**$^{\#}$	-0.03
	Group of 8 university	N/A	N/A	0.04	0.08
	ATN university	N/A	N/A	0.03	0.04
	Performance orientation	-0.08	0.00	0.01	**-0.08**§
	Collegial support	N/A	N/A	-0.02	0.04
	Performance-based funding	0.01	**0.17**$^{\#}$	-0.01	-0.02
	R^2	**0.14**	**0.21**	**0.31**	**0.42**
	n	**344**	**134**	**404**	**369**

Note: Statistically significant: § $p < 0.10$; $^{\#}$ $p < 0.05$; * $p < 0.01$

The results of the regression analyses are listed in Table 13. Many variables identified in the bi-variate analyses as significantly influencing research productivity lose significance in the multiple regression analysis. The degree to which the collection of independent variables explains overall variance in research productivity is revealed in the R^2 values. The regression model explains considerably more of the variation in research productivity in Australia than in Norway, and more for women than it does for men. This is consistent with previous studies in the two countries. The R^2 values of 0.21 for women and 0.14 for men in Norway are similar to what was found in earlier studies (Kyvik 1991: 233; Kyvik and Teigen 1996), the more recent study found R^2 values of 0.22 for women and 0.16 for men. While no directly comparable previous gender-based study in Australia was found, the R^2 values found in this thesis (0.42

Australian women, 0.31 men) are comparable with Teodorescu's (2000: 221) findings for journal publication among Australian academics in the 1993 Carnegie survey ($R^2 = 0.30$).

Academic rank is clearly the independent variable with the greatest effect on research productivity when all other variables are held constant. It is the only variable significant across all four groups. This is again consistent with previous studies (Kyvik 1991; Kyvik and Teigen 1996; Teodorescu 2000), but the effect size of this variable is more than twice that of the earlier Australian study, and to a lesser extent from the study in Norway. This could be due to increased benefits of higher rank for research productivity, or simply because omitted variables in this study resulted in academic rank absorbing effects of other unmeasured variables. However, the number of significant variables in the Australian sample is greater than those found by Teodorescu (2000). The relationship between rank and research output is not necessary causal as higher research productivity is also rewarded with promotion and is an effect as well as a cause (Kyvik 1991: 228). Therefore, the greater effect size of academic rank may also be due to a stronger link between research productivity and promotion in Australian universities.

International research collaboration and the overlapping variable *international conference attendance,* are the next most important determinants of research productivity. International collaboration achieved particularly strong significance and large effect sizes in the Norwegian sample. The smaller effect sizes and significance in the Australian sample are likely due to the inclusion of the international conference participation variable in the Australian regression analysis. These two variables do not entirely overlap as international conference attendance represents both an opportunity to develop future collaborations and also an outcome of the research process, when the purpose of attendance is to present a conference paper rather than attending as a "tourist" (Kyvik and Larsen 1994: 166). The bi-variate relationships between research output and both international variables were very strong, partly due to their association with rank. It is therefore a very important finding that both variables remain significant determinants of research output after controlling for rank. The is particularly the case in the Norwegian sample, as it is the only variable other than academic rank that is significant for men and women. The significance of international contact after controlling for rank and other variables is consistent with previous studies in Norway (Kyvik 1991), as is the greater importance of collaboration for women in Norway (Kyvik and Teigen 1996). It must be stressed though that regression analysis can not determine causality. High productivity likely improves the probability of collaborating internationally and attending conferences. In other words, the relationship between international contact and research productivity is most likely reciprocal.

Time spent on research is equally as important as international contact in the Australian sample, but less so in Norway. The relationship between working time and research output is perhaps one of the clearest positive effects identified in the Australian data and is consistent with Teodorescu's (2000) study. The lack of significance and smaller effect sizes are also consistent with Kyvik's (1991) Norwegian study which found no significance for either gender. It is not surprising that the relationship is less linear in Norway where all staff are guaranteed a minimum amount of time for research. In Australia, the amount of time spent on research, even below the 20 hour threshold, may be partly an effect of research competence. Prolific researchers in Australia may be able to use external research funding to free up additional time for research or to become research only academics. Staff in combined teaching and research positions likely face diminishing marginal benefits of additional research hours as they can not substitute research for teaching. In this way, the more diverse employment arrangements in Australia may accommodate staff working longer research more hours than in Norway. Unfortunately the accommodation of research intensive staff in Australia poses a problem for this analysis as lighter teaching loads may be a reward and an effect of proven research competence.

Age is the only remaining variable that was significant in both countries. Interestingly, age is negatively associated with research productivity for men and women in the Australian sample, but has a positive effect for men in Norway. Age had one of the strongest positive correlations in the Norwegian bi-variate analyses, so it is less surprising that it remains positive for Norwegian men. The effect of this variable is difficult to interpret in the Australian sample as age was not particularly strong in the bi-variate analyses (0.11 for Australian men and insignificant for women) and the effect was positive. While older staff in Australia are more productive than younger staff (see Table 7), the positive relationship with age mostly occurs up to the 45-49 age group before flattening and slightly declining in the oldest category. Decline in research productivity with age is almost nonexistent in the Norwegian data, with the 60+ age group being the largest and second most productive cohort.

There are some good reasons why age may be negatively related to research productivity in

Australia after controlling for other variables, while remaining positive in Norway. The clearest explanation for the positive effect of age in Norway is the smaller effect of academic rank. While older more productive academics in Australia will continue to gain promotion, in Norway there is less differentiation between older male academics based on rank as the majority are professors. Another likely explanation for the differences between the countries is that Norway has maintained a binary system, while unification of Australia's higher education system in the late 1980s brought vocational educators into the university sector. New entrants to the academic profession since unification are more likely to be doctoral trained researchers in younger cohorts, while older cohorts may include academics without doctoral degrees who transferred into the university sector at middle ranks. Therefore there are greater generational effects in Australia and greater diversity in older cohorts.

Preferences towards research achieved a particularly strong coefficient for Norwegian men, and a smaller but still positive effect for Australian women. The strong effect of this variable for Norwegian men is likely due to the relatively small effect of academic rank as the majority of men are professors. Whereas a preference towards research may be reflected in longer research hours, fewer teaching hours, and a Level E position in Australia, research focused Norwegian academics will remain in professorial positions with teaching responsibilities. Therefore this variable probably better captures the underlying interests of Norwegian academics than in Australia where the effect on rank is clearer.

Marital status is a significant predictor of research productivity for male academics in Australia. When the marriage is to a fellow academic the positive effect is significant, but marriage to a non-academic was also positive for men. This reinforces what Fox (2005) discovered for male academics in the United States, that marriage has a positive association with male productivity and that the effects of having an academic spouse are slightly more positive. While detail on marriage type is inferior to Fox's (2005) study, the fact that it is significant after controlling for effects of other variables is important, as Fox's study did not control for age or rank. Australian males may benefit more from marriage than other groups due to a more traditional division of family responsibilities in this country. As the construction of the independent variable for *dependent children* was imprecise, and only significant for Australian women with "one child", it is likely that some negative influences of child care may have been absorbed into the marriage variable for women. As children are expected to counteract the positive influence of marriage for women but not for men (Long et al. 1993), this could be a reasonable explanation for why Australian men maintain the positive influence of marriage found in the bi-variate analysis, while the positive effects of marriage and the negative effects of children are mostly small and insignificant for women.

Doctoral degree sustained a strong positive effect for Australian women, but was insignificant for all other groups. While doctoral degree was one of the most important independent variables in the bi-variate analyses, it was particularly important for female academics in Australia. In earlier analyses, Australian women without doctoral degrees generally achieved very low levels of productivity when compared to staff of comparable rank with doctoral qualifications. In other words, the effect of not having a doctoral degree was relatively smaller for Australian women than other staff groups, whose lack of qualifications tended to be more closely reflected in their academic rank. Therefore when controlling for other variables, most notably rank, which is the most important variable in the regression analysis, it is less surprising that the effect of doctoral qualifications remained stronger for Australian women.

Given the consistently low bi-variate correlations for most institutional variables, it is not surprising that very few of these variables gained significance in the regression. *Performance based funding* achieved a rather strong effect size for Norwegian women, while *research funding satisfaction* also maintained strong significance for Australian men. The strong satisfaction that highly productive Australian males have with their research funding, may be partly the result of performance-based funding in practice, whereas the performance based funding variable likely reflects the positive perceptions of such funding schemes on research productivity. *Performance orientation* was statistically significant for Australian women and negative in its effect, despite not being significant in the bi-variate analysis. This could be simply an anomaly in the data as the significance was only just below the 0.10 threshold, but perhaps it also illustrates diverse interpretations of “performance”. This study examines only research productivity, whereas academics have multiple roles and Australian universities have different areas of focus. It is conceivable that given the greater number of women in teaching focused universities, performance orientation towards teaching may come at the cost of research performance when other institutional factors are held constant.

Overall, the regression analysis was effective at separating the effects of most of the independent variables and in particular, decoupling the effect of academic rank on age, research time and international collaboration. Age showed a reasonable negative effect in

Australia, despite a slight positive correlation with research in the bi-variate analyses. The effect of research time appears more robust after controlling for the career stage in the Australian sample, whereby time spent on research is greatest in the lowest and highest ranks. Perhaps the most important finding are the positive effects of international collaboration and conference attendance, as these variables are consistently strong for academics of all ranks and operate independently to the amount of time dedicated or available for research.

6. Discussion

A major objective of this thesis was to describe gender differences in research productivity and examine the evidence of changes over time. It is now worth discussing what this study has found. In the Norwegian data there is little evidence of a reduction in the gap between men and women in research productivity. Over the 2005 to 2007 reference period of this study, Norwegian women averaged 21 percent less article equivalents than men. In a similar study covering the period 1989 to 1991, Norwegian women published 20 percent less than men (Kyvik and Teigen 1996). While the overall differences between men and women appear very stable, this hides some more subtle trends within the data. The stability is partly due to an increase in productivity among a small group of males, while the gap between the majority of men and women has narrowed. The proportion of non-publishers in Norway has reduced from 11 percent of women and 9 percent of men in 1991 (Kyvik and Teigen 1996), to 9 percent of women and 7 percent of men in 2007. More importantly though, the percentage of women who accounted for half of all female research has remained stable at 19 percent, while the percentage of men responsible for half of all male research has reduced from 21 percent in 1981 (Kyvik 1991), to 20 percent in 1991 (Kyvik and Teigen 1996), and to 17 percent in this study. This indicates that differences between the more typical Norwegian male and female academics have reduced, while the most prolific male publishers have dramatically increased their output over time. When comparing the middle 80 percent of men and women based on research productivity, women are only 12 percent less productive than men.

It is far less clear how differences in gender-based research productivity have changed over time in Australia. One of the goals of this thesis was to identify the precise size of the gender-based productivity differences in Australia. The best estimate from this study is that women published 26 percent less than men over the 2005 to 2007 period. The overall proportion of non-publishers has reduced substantially since the 1991 to 1993 Carnegie study and this reduction has been most dramatic among women. While comparisons can not be made on overall productivity, the proportion of women without journal article publications dropped from 39 percent in the Carnegie study to 13 percent in this study, while for men the corresponding reduction has been from 26 percent to 10 percent (Sheehan and Welch 1996). The large increase in female publishing participation would imply that the gap between men and women may have reduced over this period, but an alternative interpretation would be that non-publishing academics have left the academic profession. The more equitable distribution of female productivity also indicates that differences between typical male and female academics are slightly less than what the overall average may suggest. However, when comparing the middle 80 percent of Australian men and women, women are still 22 percent less productive.

It is difficult to answer the gender-based “productivity puzzle” completely through a quantitative analysis. The data suggests that gender differences in Norway are more concentrated at the upper and lower end of the productivity curve, while in Australia the divide runs deeper and may be more systemic. Sonnert and Holton (1995) found that women see many of their private choices, such as marriage and children, as having a stronger effect on their research careers. In response to this, women may self-select out of situations where subtle discrimination may be expected or where their private responsibilities are incompatible with rigid workplace culture and practice. This raises a problem for quantitative and comparative studies as overall rates of gender inequality may stabilise or even increase over time, despite an improvement in institutional conditions. Women who previously chose not to enter or remain in academia may slowly become accommodated, yet the broader comparisons to male research productivity may show few signs of improvement. Future studies need to identify whether fewer women are now self-selecting out of academic career paths, or if the previously overt discrimination practices have simply given way to subtle forms of exclusion.

The data from this study does not refute the often claimed lack of significant differences between Australian men and women in research output after controlling for rank, age, and discipline (Deane et al. 1996, p. 21 in Burton 1997; Castleman et al. 1995 in Hawkes 1996: 58; Ramsden 1994). However, some concerns over these claims should be raised. To gain statistically significant results for whether men and women differ after controlling for each of these three variables, would require a very large sample given the number of disciplines and complexity of controlling for age in cross-sectional studies. However, controlling for academic rank poses some methodological issues which were made clear throughout this thesis. Academic rank had the strongest bi-variate correlation coefficient and effect size for all academic groups. This is partly because of the reciprocal relationship between research productivity and promotion. Academic rank acts as a signal of research productivity as well as a cause. If promotion decisions become increasingly tied to research performance, then academic rank will lose some of its explanatory value. Academic rank may increase in its predictive value, as anyone who occupies a high level position must have at least historically high research productivity, but it will be increasingly difficult to explain gender-differences in research productivity through this variable.

However, one should not quickly discount the causal effects of academic rank on research productivity. The most likely explanation for the strong effect of rank is that both the causal and the signalling effects have increased. The Australian literature already points to inequitable opportunities for research at lower academic ranks and how the structure of academic promotions inhibits those without research credentials from reaching the positions that support research (Lafferty and Fleming 2000). It is likely the different academic career structures, reflected primarily in academic rank, explain why the regression model accounted for more of the variance among Australian academics. Indeed removing academic rank from the regression analysis lowers the R^2 in Australia (from 42 to 26 for women and from 31 to 21 for men) to a greater extent than Norway (from 21 to 16 for women and from 14 to 13 for men). Given that Norway has a flatter hierarchy and less diversity across academic positions, the problem in Norway may be how to interpret causality from the effect size of academic rank, as all academics have roughly equal access to the resources for research.

A goal of future research should be to improve the selection and operationalisation of independent variables, rather than simply seeking to explain more of the variation in research productivity with a heavy reliance on academic rank. While the regression model in this thesis explained considerably more of the variance in research productivity compared to previous Australian studies (Teodorescu 2000) the validity of the R^2 is questionable, not only because of rank, but because of associated individual variables. In the Australian context, greater time available for research and access to research funding may also have strong signalling effects. Teodorescu found that research funds received was the second strongest correlate of research productivity after rank. The construction of this variable was imprecise in this thesis, but it did generate a reasonable effect size for Australian men. However, if research funding is tied to a reputation of producing research publications, then it is difficult to claim that differences in research funding causes differences in productivity.

Given the greater institutional diversity in Australia, it was expected that the regression analysis would capture more of the variation within this sample. However, when examining the institutional variables, it appears that most failed to capture a direct influence on research productivity. While the overall model explains a great deal of diversity, the effects of institutional diversity are likely to be absorbed in other variables included in this study. For example, international collaboration, preferences towards research or time spent on this activity may reflect the research opportunities available within a university or department. Again the reciprocal nature of these individual achievement variables probably indicates that those in stronger research environments may become more interested in research, while those in environments where research is not prioritised may fail to benefit from collegial interest and collaboration.

A challenge for future studies of gender differences in Australia will be how to treat different statuses of employment. The CAP survey excluded casual staff and this study also removed part-time staff from the sample. This is appropriate as such staff can not be expected to have the same level of research as full-time staff. However, if these positions are inferior to full-time positions and comparable to an ‘academic underclass’ (Jacobs 2004), and if the gender-balance in such positions are not representative of the broader academic population, then removing this group would misrepresent the overall differences between men and women. One could speculate that poor research performance leads to increased teaching loads, whereas poor teaching does not lead to greater research demands or research-only status. It is difficult to know how to treat less research engaged academics in individual research productivity comparisons, as it may be viewed as a self-selection out of a research career and opting into a more teaching oriented career track. However, if the research career holds more prestige and requires extremely long hours, then the structure of the academic career may indirectly segregate academics based on gender if part-time options are mostly available in teaching positions.

Every study is limited to some extent by the quality and detail of the data. In this thesis the greatest limitation was probably the lack of information on publication quality. If universities demand more publications for career progression, then there is little doubt academic staff will oblige. While it may encouraging that academics respond to the incentives offered by the university, if a steady stream of publications becomes a perfunctory paper exercise, then overall research outcomes may diminish. Basic quantitative publication counts are practical, as it is far simpler and more objective to count published outputs than to read publications and judge their value. But in the end it is the value of the published output that truly counts, rather than the counts of the published outputs.

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Appendices

Appendix A: Survey and sampling

Institutional sampling

Participation in the Australian CAP survey was voluntary and not all universities chose to participate. This raises the potential for institutional bias within the CAP sample. However, as 22 of the 39 universities did participate, a considerable proportion of the university sector is represented in the survey. Further, despite the potential bias of over-representation of particular groupings within the Australian university sector, universities across all of the different formal and informal groupings were present. The only exceptions were the lack of participation from one of the two private universities or a university from Tasmania. The Innovative Research Universities (IRU) were also under-represented as only one of the six member institutions participated. Despite these minor shortcomings, the institutional diversity within the given sample should be considered as representative of the 17 institutions that did not participate (Coates et al. 2008: 191). Further details of the institutions participating in the CAP survey are in Appendix C.

Achieving an institutionally representative sample of Norwegian universities was less of a factor given the lack of diversity, hierarchy and research inequality within the sector. It was also unnecessary as all Norwegian universities and the vast majority of specialised universities volunteered to participate in the survey. The Norwegian sub-sample included all seven universities (the Universities of Agder, Bergen, Oslo, Stavanger, Trondheim, Tromsø and Ås) and the largest of the specialised universities (the Oslo School of Architecture and Design [AHO], Norwegian School of Economics and Business administration [NHH], Norwegian School of Sport Sciences [NIH], Norwegian School of Veterinary Science [NVH] and Norwegian Academy of Music [NMH]). While it is important that the institutional populations are represented in the secured sample, of greater importance is that the academics within these institutions are sampled proportionally based on the key background characteristics.

Individual-level sampling

An important issue that must be addressed in any survey-based study is the representativeness of the sample to the population one intends to draw generalisations. The standard method for determining representativeness is to examine how closely the sample of respondents reflects the population on characteristics common to both groups (Oppenheim 1999: 38). Background characteristics were taken into consideration within the sampling frame of the original CAP survey in both countries to ensure that the random selection of academics surveyed did not create a selection bias. The processes used in the selection of the CAP samples in Australia and Norway are outlined in the CAP Survey Audit (Loewenstein and Schomburg 2008). Analyses of biases in response rates were also described for the Australian CAP data in Coates et al (2008) and for the Norwegian CAP data in Vabø and Ramberg (2009). While the sub-sample used in this thesis will not be identical to the CAP samples examined in the aforementioned studies, there is no reason to believe that the technique that will be used to create the subsample in this study will severely bias the sample on any of the key variables such as gender, discipline, academic rank or institution. Therefore the additional biases in the process of creating the subsample will be analysed with reference to how the subsample differs from the original CAP data, rather than to the target population as a whole.

To address the problem of sampling bias, the CAP surveys used explicit and implicit stratification techniques in order to create a proportionate stratified sample. Explicit stratification involved taking a list of all academics in the population, dividing this group based on multiple individual-level strata, and randomly sampling these subgroups. For the Norwegian CAP survey, the population was classified based on gender, academic rank, discipline, age, education and institution/department. Four source files were then created for random sampling: male and female research institute staff; and male and female university staff (Kassel 2008: 20). The sampling design for the Australian CAP survey did not use explicit individual-level stratification, though the target population was initially divided based on each of the participating 22 institutions. The academic staff lists for the participating institutions were then sorted based on the implicit strata of: sex, appointment fraction, term of appointment, academic classification/level, work sector and academic function (Coates et al 2008: 186). Probabilistic random sampling was then conducted on these 22 institutional populations. The sorting of the institutional populations based on the implicit strata sought to remove the possibility of sampling error due to the default ordering in the target population lists (Coates et al 2008: 186).

Simply sending the CAP survey to a representative sample of the population does not entirely overcome the problem of gathering a representative sample, as the response rates between sub-groups of the population are also likely to vary. As the Norwegian CAP survey used explicit stratification, a detailed analysis of response biases within the secured sample for the university sector was conducted across the strata of gender (2), rank (4) and discipline (6) (Vabø and Ramberg 2009: 82). This sampling analysis revealed only a few minor biases between the secured sample and the general population on these categories. For example, the only groups to be over or under-represented in the CAP sample by 2% or greater (in comparison to their proportions in the whole academic population) were: female professors (2% overrepresented) and assistant professors/lecturers in the humanities (2.1% underrepresented); and male professors in the medical sciences (overrepresented by 2.9%). Examining the sample based purely on discipline (by grouping the men and women of all academic ranks together), revealed that the only disciplinary bias of greater than 2% lied in the technological sciences, who were underrepresented in the secured sample by 2.3%. Further details of the sampling biases for the Norwegian CAP data on each strata is available in the Appendix D.

As the Australian CAP data did not use explicit individual-level stratification of the population, it is more difficult to go into detail in the response analysis. The entire CAP sample can be compared to the overall population on the implicit strata of gender, academic rank, institution, etc. but it is not easy to compare the sample with the population within these strata. For example, as shown in Coates et al. (2008: 192, also available in the Appendix) females comprise 50.5% of the respondents in the CAP sample relative to 42.3% in the target population, but it is not clear how this distribution compares with the target population within particular institutions, ranks or disciplines.

While it is possible to answer some of these questions by comparing the Australian CAP sample to the target population by reviewing the Australian Government statistics on the academic workforce, there are a number of severe limitations. Firstly, the Australian Government statistics do not separately disaggregate the university populations on gender and rank, and information on discipline is almost non-existent. Secondly, even determining the distribution of the CAP sample across these strata is problematic as many of the respondents in the provided CAP data file did not answer the relevant questions. Without information connecting the respondent IDs (which is restricted for confidentiality purposes) to these background criteria, it is impossible to conduct a detailed response analysis that would add to what is published in Coates et al. (2008). Therefore one must simply assume for the sake of this study that the representativeness or degree of bias within the CAP sample does not significantly vary across individual strata.

To summarise what was revealed in the response analysis (Coates et al. 2008), the following conclusions can be drawn. Once again, women are overrepresented in the sample by 8.3%. The sample population is broadly representative across the institutions and institutional groupings, with the Group of 8 universities slightly underrepresented in the sample population (42.7% compared to 45% in the population). Limited term staff are over-represented in the sample (50% compared to 40%), while tenured staff are underrepresented (37.7% compared to 46.1%). This is likely to be connected with the overrepresentation of women in the sample as it is known that women are more likely to be in untenured positions. Finally, across the academic ranks there is an underrepresentation at the highest and lowest ranks (Level E is underrepresented by 1.4% and Level A by 2.3%), with a corresponding overrepresentation (of 2.4%) in Level B respondents. Further details of the comparison between the population and the Australia CAP sample can be found in the Appendix E.

Selecting the subsample

While the desired population of the CAP survey is quite broad, not all higher education institutions or categories of staff included in the desired populations of the national CAP surveys will be of relevance to this study. Therefore a sub-sample will be created from each of the national CAP samples to ensure that the data used in this thesis is representative of the population and appropriate for generalising findings. As this thesis will use cross-sectional data to analyse differences in research productivity between men and women over time, it is important that information on gender and research output is available for each case and that the selected sample is comparable with the previous national studies that have examined this topic. The additional element of international comparisons between Australia and Norway also necessitates sample comparability across the two countries.

Given the differing university and career structures in the two countries, significant tradeoffs need to be made when making sample selection decisions. It is not always possible to enhance the within-country cross-sectional comparability *and* the international comparability in sample decisions. However, as gender differences in research productivity has been addressed in previous nationally-based studies, greater benefit can be gained by examining changes over time and ensuring that the sample is representative of these previous national studies.

Therefore, when choices are made on restricting the CAP data into a sub-sample for this study, the positive and negative consequences of these choices for both the cross-sectional and international comparisons is made as explicit as possible. This will ideally serve two purposes, it will help justify the sampling choices and outline how these choices will affect conclusions and generalisations on research productivity.

The Australian online survey was distributed to the 5,496 academics from the target population list and generated a response rate of 23% and 1,252 valid responses. The Norwegian survey was mailed out to 5,000 academics who had the option to complete the paper survey or complete it online. Approximately 1,800 completed and returned their questionnaire, achieving a response rate of 36%. However, as the target population of the CAP survey does not match the target population of this study, a number of restrictions have been made which brings the number of valid responses down significantly from this level. The first and most straightforward sample restriction is to ensure that only the institutions responsible for both teaching and research are examined. As the Australian CAP survey includes all universities but excludes the non-university sector and research institute sector, institutional restrictions do not need to be applied to the Australian data. In the case of Norway, the CAP data includes the research institute sector which is not responsible for teaching. Therefore the Norwegian CAP sample needs to be restricted to academics at universities and specialist universities. This restriction brought the number of valid responses in the Norwegian CAP data down from 1,680 to 1,011 respondents.

As this thesis is a comparative study between two countries with different academic career structures, it is similarly important that the categories of academic staff are as comparable as possible. The second restriction of the CAP sample was to restrict the sample to academic professionals employed within the formal classifications of the academic career. Following the removal of post doctoral, doctoral and other researchers from the Norwegian data, the number of valid responses was reduced to 612. Within the Australian CAP data, 4 respondents claimed to be employed on a career track outside the academic classification scales and were therefore removed, while 3 that did not disclose their academic rank remained included in the sample of 1,248. While the original Australian CAP sample was more targeted than the Norwegian survey (it excluded casual/sessional staff, honorary academics, administration staff, executive staff and the entire research institute sector) the Australian academic employment classifications cover a wider range of staff than in Norway and do not easily allow for separation within academic ranks. Unfortunately for the international comparability, Australian data included specialist research-only staff at universities and potentially teaching-only staff, such as doctoral students and others without a doctoral degree employed on fixed-term contracts in Level A or other academic positions.

Clearly these differences in career structures raise problems for international comparisons between the two countries. As discussed previously, it is arguable whether Level A positions constitute the entry-level to the academic profession in Australia, particularly where the position does not require a doctoral degree, is fixed-term in duration and is primarily for the purpose of teaching or tutorial work. It would certainly improve the international comparability to exclude the majority of Level A respondents from the Australian CAP sample as such positions can not be considered as equivalent to the Associate Professor entry-level in Norway. This was strongly considered, but to remove such cases would pose even greater problems for the within-country cross-sectional analysis. In practice, Level A academic positions are very active researchers, even if such positions in themselves do not mark the beginning of a career within the university. Further, as it is also well documented that the women are overrepresented in lower ranked positions and especially Level A, to exclude such respondents from the CAP sample would not be appropriate for a gender-based study such as this. Therefore Level A staff remained in the subsample to enhance comparability with previous Australian studies, while accepting this comes at the cost of reducing comparability with Norway.

A final problem with the selection of the subsample was the prevalence of unanswered questions within the survey. As there was no information in the data file on matching identification codes with gender, all respondents who did not answer the Question F1 on gender had to be permanently removed. In the Norwegian CAP data, 20 respondents did not give an answer for gender, while in the Australian CAP data 359 did not answer. This brought the number of valid responses in the sub-sample down to 592 in Norway and 1,018 in Australia.[12]

The second unanswered question which affected the selection of the subsample was Question

[12] The reason why the removal of the 359 cases resulted in 1,018 valid responses rather than 897 was that the CAP data file was ‘unclean’ and included 1,381 respondents, rather than the 1,252 cases mentioned in the official CAP documents. The larger data file will have no impact on the results as the filtering of incomplete cases should account for those removed also from the official CAP studies.

D4, the dependent variable. There were 39 respondents in the Norwegian CAP data (6.6% of the sample) and 73 in the Australia CAP data (7.1% of the sample) that did not answer D4. In the Norwegian data 19 of these 39 respondents went on to answer other questions in Section D and in later sections of the survey, and likewise this applied to 31 of the 73 Australian respondents. It would be reasonable to assume that persons who purposefully skipped question D4 are not likely to be typical of the general population of academics in terms of their research production. One could speculate that some of these respondents had left the question entirely unanswered because they had not produced a publication of any type. In a similar survey, Kyvik (1991: 33-4) estimates that productivity among none respondents was between 25 and 30 percent lower than those who did respond. Therefore, excluding these groups would likely underestimate the proportion of inactive researchers in the relevant populations. However, to include and recode their answers into zeros could have even greater impacts on the calculation of central tendencies. Taking into consideration the trade-offs involved, it was decided not to manipulate and recode the data, instead these cases were simply removed. In doing so one must accept the implication that the given CAP sub-sample will perhaps overstate participation in publication activity. Following the removal of the 39 and 73 cases from the Norwegian and Australia CAP data files, the sample sizes were reduced to 553 and 945 respectively.

A third restriction was made based on the number of hours worked based on the response to Question B1. As the Norwegian CAP sample had already removed part-time workers who reported very few hours, respondents in the Australian sample reporting fewer than 15 hours per week were removed. This applied to 9 respondents, reducing the Australian sample to 936. A final consideration in the selection of the sub-sample was how to treat outlier cases on the dependent variable. In the paper-based survey there was an effective upper limit of 99 for the maximum number publications in each type completed in the preceding 3 years as there were only 2 boxes for inputting numbers. However, one male respondent to the Australian CAP survey entered a value of 250 for journal article publications, which is beyond the numerical limit placed on the question. This could have been an error of data input or a misreading of the question, but for the sake of avoiding the impact of extreme outliers, this case was removed. The treatment of less severe outliers required greater subjective judgement based on what could conceivably be published over a 3 year period. Another case of a female academic in the Australian CAP data indicated to have completed 4 authored books, 4 edited books, 99 journal publications and 99 conference papers. While this falls within the numerical limits of the question, even taking into consideration the possible influence of co-authorship and overlapping publication types, the combined output is considered too extreme and more likely to be the result of misreading the question. Therefore these two cases were also removed from the subsample, leaving an Australian CAP sample size of 934 and a Norwegian sample size of 553.

Appendix B: Recoding of independent variables

Marital status

Where a respondent did not answer Question F5 because they were single, their missing responses were coded into “no” for the partner-based dummy variables. Where a respondent reported to be “single” or “other” in Question F3 but reported an academic spouse in Question F5, their response for Question F5 was used. Where a respondent did not answer Question F5 because it did not apply as they were single (based on Question F3), their missing responses were coded into “no” for the partner-based dummy variables.

Child and elder care

This required some recoding as some respondents seemed to take career breaks for less than one year, but were unable (at least in the electronic survey) to indicate fractions of a year. Where the respondent had claimed not to have taken a career break, the number of years was treated as zero. Where the respondent had not answered “yes” to the first part of the question, but left the second part unanswered, these values were recoded to 0.25 years. The reason for doing so is particularly important in the Australian context as many employees are unable to take paid parental or carer’s leave for one year. To treat such cases as zero years (the same as if one had never taken a career break) would under-represent the likely gender-based impact of caring responsibilities, while to apply a higher value could have seriously compromised the variable for male staff in particular, given their often minimal parental leave entitlements. There were also two outlier cases within the Norwegian data claiming 95 and 51 years of career in interruptions. These cases were recoded to a more reasonable maximum of 30 years.

Time spent on research and teaching

distinction between teaching and non-teaching periods is not relevant. To calculate average weekly hours spent on each activity across the entire three year period, the individual responses for the different sessions have been averaged, with a weighting of 2 for when classes are in session and a weighting of 1 for when classes are out of session. This is based on the assumption that the teaching period is roughly twice as long as the non-teaching period. If the respondent answered for one of the sessions but not the other, then the answered session is treated as usual working time across the entire year.

'No answer' or 'missing' responses for individual activities been recoded into zeroes if the respondent answered other categories within the question but left a particular activity blank. For example, if a respondent claimed 15 hours teaching, 20 hours research and 10 hours administration but left the 'service' and 'other' categories blank, it is assumed that the respondent spends zero hours on service or other activities. As some respondents claimed extremely long weekly hours, several cases exceeding 100 hours per week and one case claiming in excess of 150 hours, the maximum number of weekly hours was capped at 70. The relative time spent on each activity remained in proportion, but the numeric value for each activity was scaled and recoded. For example, if a respondent claimed a total 90 hours per week across the five different academic activities, each activity reduced to 78 percent of its original value (70/90 hours) so that total hours did not exceed 70.

Research funding satisfaction; performance orientation; performance based funding and collegial support

These variables utilised Likert scaled questions and needed to be recoded as the original questions assigned a value of 1 for excellent/very much and 5 for poor/not at all. These values were inversed so that positive responses or agreements on the criteria were associated with positive values.

International research collaboration

These questions had the problem of interpreting "unanswered" responses. Where a respondent answered one of the preceding sub-questions "yes" but left all other responses blank, the unanswered responses were recoded into "no". Where there were no answers on the preceding sub-questions or a mixture of "yes" and "no", the responses remained as unanswered.

Appendix C: Institutions participating in the Australian CAP survey

State	**ATN (5)**	**Go8 (8)**	**IRU (6)**	**NGU**	**Non-affiliated / Regional**
WA (4)	Curtin University of Technology	University of Western Australia			
NT (1)					Charles Darwin University
SA (3)	University of South Australia		Flinders University		
VIC (8)	RMIT University	University of Melbourne		Victoria University Deakin University University of Ballarat	
NSW (10)		University of Sydney		University of Western Sydney Southern Cross University	Charles Sturt University University of New England University of Wollongong
TAS (1)					
ACT (2)				University of Canberra	
QLD (8)	Queensland University of Technology	University of Queensland		University of Southern Queensland University of the Sunshine Coast	

Source: Coates et al 2008 & Williams and Van Dyk 2004

Appendix D: Norwegian universities and universities of applied sciences observed bias in sample

		Bias (percentages) (sample-target population)		
FIELD OF SCIENCE AND TECHNOLOGY	**ACADEMIC LEVEL**	Women	Men	Total
1HUMANITIES	Professor	**2,03**	**0,36**	***0,96***
	Associate professor / senior lecturer	-0,26	0,36	0,13
	Assistant professor & University/college lecturer	***-2,13***	***-1,66***	***-1,80***
	Research fellow	-0,75	0,27	-0,08
2SOCIAL SCIENCES	Professor	-0,08	1,31	0,70
	Associate professor / senior lecturer	*1,35*	0,56	0,88
	Assistant professor & University/college lecturer	-0,18	-0,76	-0,49
	Research fellow	-0,14	-1,59	-0,93
3NATURAL SCIENCES	Professor	0,40	0,87	0,57
	Associate professor / senior lecturer	-0,71	*1,25*	0,42
	Assistant professor & University/college lecturer	0,51	0,56	0,53
	Research fellow	***-1,74***	**-0,63**	***-1,07***
4TECHNOLOGY AND ENGINEERING	Professor	-0,30	0,41	0,07
	associate professor / senior lecturer	-0,40	-0,59	-0,56
	Assistant professor & University/college lecturer	0,26	-0,38	-0,14
	Research fellow	**-0,73**	***-2,18***	***-1,68***
5MEDICAL AND HEALTH SCIENCES	Professor	0,07	***2,87***	***1,73***
	Associate professor / senior lecturer	*0,94*	*-1,04*	-0,22
	Assistant professor & University/college lecturer	-0,01	-0,61	-0,31
	Research fellow	0,42	-0,08	0,29
6 AGRICULTURAL, FISHERY & VETERENARY SCIENCES	Professor	0,49	-0,06	0,14
	Associate professor / senior lecturer	0,67	0,47	0,56
	Assistant professor & University/college lecturer	-0,08	0,03	0,00
	Research fellow	0,39	0,24	0,32
Total		0,00	0,00	0,00

Source: Vabø and Ramberg 2009: 82 Note: Research fellow did not form part of the subsample used in this thesis

Appendix E: Australian population and sample comparisons

		Target population		Planned sample		Secured sample	
		n	%	n	%	n	%
Institution	University of Western Australia	1,201	5.8	321	5.8	60	4.8
	University of Southern Queensland	467	2.3	125	2.3	29	2.3
	Curtin University of Technology	1,239	6.0	331	6.0	68	5.4
	University of Canberra	355	1.7	95	1.7	29	2.3
	Charles Darwin University	271	1.3	72	1.3	21	1.7
	University of Western Sydney	905	4.4	242	4.4	52	4.2
	Charles Sturt University	639	3.1	171	3.1	63	5.0
	Victoria University	544	2.6	145	2.6	35	2.8
	University of Queensland	2,286	11.1	611	11.1	142	11.3
	University of South Australia	1,050	5.1	281	5.1	88	7.0
	Flinders University	722	3.5	193	3.5	56	4.5
	Deakin University	959	4.7	256	4.7	55	4.4
	RMIT University	1,108	5.4	296	5.4	61	4.9
	The University of Melbourne	3,105	15.1	830	15.1	172	13.7
	Southern Cross University	278	1.4	74	1.3	28	2.2
	University of New England	446	2.2	119	2.2	29	2.3
	University of Sydney	2,682	13.0	717	13.0	161	12.9
	Queensland University of Technology	1,146	5.6	307	5.6	52	4.2
	University of the Sunshine Coast	152	0.7	41	0.7	14	1.1
	University of Ballarat	241	1.2	64	1.2	20	1.6
	University of Wollongong	767	3.7	205	3.7	17	1.4
	Total	20,563	100.0	5,496	100.0	1,252	100.0
Sex	Female	8,700	42.3	2,327	42.8	622	50.5
	Male	11,622	56.5	3,105	57.2	610	49.5
	Total	20,563	100.0	5,432	100.0	1,232	100.0
Work contract	Full-time work contract	16,044	82.0	4,291	82.1	1,022	84.1
	Fractional full-time work contract	3,511	18.0	936	17.9	193	15.9
	Total	19,555	100.0	5,227	100.0	1,215	100.0
Current duties term	Limited term 1-60 months	8,122	40.0	3,260	50.0	761	50.0
	Limited term > 5 years	826	4.1	215	3.3	41	2.7
	Probationary tenurable term	1,963	9.7	521	8.0	145	9.5
	Confirmed tenurable term	9,377	46.1	2,518	38.6	574	37.7
	Other	34	0.2	6	0.1	1	0.1
	Total	20,322	100.0	6,520	100.0	1,522	100.0
Current duties classification type and level	Level E	2,287	11.3	614	11.3	122	9.9
	Level D	2,455	12.1	654	12.0	153	12.4
	Level C	4,660	22.9	1,249	23.0	294	23.9
	Level B	6,912	34.0	1,842	33.9	449	36.4
	Level A	4,008	19.7	1,073	19.8	214	17.4
	Total	20,322	100.0	5,432	100.0	1,232	100.0
Academic function	Teaching only function	582	2.9	153	2.8	32	2.6
	Research only function	3,773	18.6	1,005	18.5	219	17.8
	Teaching and research function	15,632	76.9	4,183	77.0	951	77.2
	Other function	335	1.6	91	1.7	30	2.4
	Total	20,322	100.0	5,432	100.0	1,232	100.0

Source: Coates et al. 2008: 192-3

Appendix F: Sub-sample data respondents by gender and discipline

Norway									
Discipline of current acad.unit	**Male**	**%**	**Valid %**	**Female**	**%**	**Valid %**	**Total**	%	Valid %
Teacher training and education science (1)	15	4 %	4 %	22	14 %	16 %	37	7 %	7 %
Humanities and arts (2)	60	15 %	17 %	32	20 %	23 %	92	17 %	19 %
Social and behavioural sciences (1)	58	15 %	16 %	28	18 %	20 %	86	16 %	17 %
Business and administration, economics (1)	16	4 %	5 %	0	0 %	0 %	16	3 %	3 %
Law (1)	6	2 %	2 %	3	2 %	2 %	9	2 %	2 %
Life sciences (3)	33	8 %	9 %	11	7 %	8 %	44	8 %	9 %
Physical sciences, mathematics, computer sciences (3)	68	17 %	19 %	5	3 %	4 %	73	13 %	15 %
Engineering, manufacturing and construction, architecture (4)	41	10 %	12 %	3	2 %	2 %	44	8 %	9 %
Aggriculture (3)	0	0 %	0 %	0	0 %	0 %	0	0 %	0 %
Medical sciences, health related sciences, social services (5)	57	15 %	16 %	35	22 %	25 %	92	17 %	19 %
Personal services, transport services, security services (1)	1	0 %	0 %	0	0 %	0 %	1	0 %	0 %
Other	20	5 %	N/A	7	4 %	N/A	27	5 %	N/A
Unknown	18	5 %	N/A	14	9 %	N/A	32	6 %	N/A
Total	**393**	**100 %**	**100 %**	**160**	**100 %**	**100 %**	**553**	**100 %**	**100 %**
Field of learning									
1) Social sciences	96	24,4 %	27,0 %	53	33,1 %	38,1 %	149	26,9 %	30,2 %
2) Humanities	60	15,3 %	16,9 %	32	20,0 %	23,0 %	92	16,6 %	18,6 %
3) Natural sciences	101	25,7 %	28,5 %	16	10,0 %	11,5 %	117	21,2 %	23,7 %
4) Technology	41	10,4 %	11,5 %	3	1,9 %	2,2 %	44	8,0 %	8,9 %
5) Medical sciences	57	14,5 %	16,1 %	35	21,9 %	25,2 %	92	16,6 %	18,6 %
Other/Unknown	38	9,7 %	N/A	21	13,1 %	N/A	59	10,7 %	N/A
Total	**393**	**100,0 %**	**100,0 %**	**160**	**100,0 %**	**100,0 %**	**553**	**100,0 %**	**100,0 %**

Note: the field of learning for each discipline is indicated by the numbered reference in parentheses

Australia									
Discipline of current acad.unit	Male	%	Valid %	Female	%	Valid %	Total	%	Valid %
Teacher training and education science (1)	32	7 %	9 %	27	6 %	7 %	59	6 %	8 %
Humanities and arts (2)	42	9 %	11 %	57	12 %	15 %	99	10 %	13 %
Social and behavioural sciences (1)	46	10 %	13 %	36	8 %	10 %	82	9 %	11 %
Business and administration, economics (1)	51	11 %	14 %	52	11 %	14 %	103	11 %	14 %
Law (1)	5	1 %	1 %	5	1 %	1 %	10	1 %	1 %
Life sciences (3)	40	8 %	11 %	30	6 %	8 %	70	7 %	9 %
Physical sciences, mathematics, computer sciences (3)	43	9 %	12 %	38	8 %	10 %	81	9 %	11 %
Engineering, manufacturing and construction, architecture (4)	20	4 %	5 %	27	6 %	7 %	47	5 %	6 %
Aggriculture (3)	4	1 %	1 %	10	2 %	3 %	14	1 %	2 %
Medical sciences, health related sciences, social services (5)	81	17 %	22 %	94	20 %	25 %	175	19 %	24 %
Personal services, transport services, security services (1)	3	1 %	1 %	0	0 %	0 %	3	0 %	0 %
Other	2	0 %	N/A	1	0 %	N/A	3	0 %	N/A
Unknown	107	22 %	N/A	90	19 %	N/A	197	21 %	N/A
Total	**476**	**100 %**	**100 %**	**467**	**100 %**	**100 %**	**943**	**100 %**	**100 %**
Field of learning									
1) Social sciences	137	28,8 %	37,3 %	120	25,7 %	31,9 %	257	27,3 %	34,6 %
2) Humanities	42	8,8 %	11,4 %	57	12,2 %	15,2 %	99	10,5 %	13,3 %
3) Natural sciences	87	18,3 %	23,7 %	78	16,7 %	20,7 %	165	17,5 %	22,2 %
4) Technology	20	4,2 %	5,4 %	27	5,8 %	7,2 %	47	5,0 %	6,3 %
5) Medical sciences	81	17,0 %	22,1 %	94	20,1 %	25,0 %	175	18,6 %	23,6 %
Other/Unknown	109	22,9 %	N/A	91	19,5 %	N/A	200	21,2 %	N/A
Total	**467**	**100,0 %**	**100,0 %**	**476**	**100,0 %**	**100,0 %**	**943**	**100,0 %**	**100,0 %**

Note: the field of learning for each discipline is indicated by the numbered reference in parentheses

Appendix G: Research output by gender, years of experience and field

Norway								
Experience	Soc. Sci	N	Hum	N	Nat. Sci. & Tech.	N	Med.	N
0-5	1,95	13	2,83	6	1,54	13	3,71	8
6-10	2,41	27	2,29	8	3,29	17	4,76	7
11-15	3,68	22	4,25	24	2,75	19	5,49	17
16-20	3,62	29	3,85	18	2,43	30	4,32	21
21-25	3,04	19	3,39	6	3,98	19	4,88	8
26-30	4,95	7	2,96	8	4,45	23	3,82	13
31-35	6,37	19	6,10	10	2,35	16	12,44	6
36+	5,33	7	3,48	7	3,43	18	6,63	8

Australia								
Experience	Soc. Sci	N	Hum	N	Nat. Sci. & Tech.	N	Med.	N
0-5	1,87	66	2,71	28	2,01	52	1,75	45
6-10	2,39	49	4,06	30	2,79	35	2,41	26
11-15	2,89	41	3,07	15	3,07	41	2,58	28
16-20	4,01	30	1,86	7	3,65	33	3,06	36
21-25	2,47	22	4,04	8	6,67	11	4,00	13
26-30	3,81	18	4,67	4	4,67	10	1,76	7
31-35	2,47	10	4,00	3	5,55	11	3,14	7
36+	7,00	5	0,00	0	2,00	2	11,67	1

Appendix H: Research preferences by gender and rank

Norway

	Assist. Prof.		Assoc. Prof.		Professor		All ranks	
Preferences	N	%	N	%	N	%	N	%
Female								
Primarily in teaching	2	8.3 %	1	1.3 %	0	0.0 %	3	1.9 %
Leaning towards teaching	11	45.8 %	15	19.7 %	3	5.0 %	29	18.1 %
Leaning towards research	9	37.5 %	46	60.5 %	39	65.0 %	94	58.8 %
Primarily in research	2	8.3 %	14	18.4 %	18	30.0 %	34	21.3 %
Total	24	100.0 %	76	100.0 %	60	100.0 %	160	100.0 %
Male								
Primarily in teaching	1	4.5 %	2	1.6 %	1	0.4 %	4	1.0 %
Leaning towards teaching	9	40.9 %	38	29.5 %	28	11.9 %	75	19.4 %
Leaning towards research	8	36.4 %	69	53.5 %	151	64.3 %	228	59.1 %
Primarily in research	4	18.2 %	20	15.5 %	55	23.4 %	79	20.5 %
Total	22	100.0 %	129	100.0 %	235	100.0 %	386	100.0 %

Australia

Preferences	Level A N	Level A %	Level B N	Level B %	Level C N	Level C %	Level D N	Level D %	Level E N	Level E %	All ranks N	All ranks %
Female												
Primarily in teaching	5	7.2%	7	3.7%	4	3.3%	1	2.3%	0	0.0%	17	4 %
Leaning towards teaching	11	15.9%	54	28.7%	38	30.9%	8	18.6%	2	5.6%	113	25 %
Leaning towards research	27	39.1%	76	40.4%	47	38.2%	22	51.2%	17	47.2%	189	41 %
Primarily in research	26	37.7%	51	27.1%	34	27.6%	12	27.9%	17	47.2%	140	30 %
Total	69	100.0%	188	100.0%	123	100.0%	43	100.0%	36	100.0%	460	100 %
Male												
Primarily in teaching	2	3.8%	10	6.8%	6	5.2%	1	1.3%	0	0.0%	19	4 %
Leaning towards teaching	9	17.3%	38	25.7%	30	26.1%	13	16.5%	7	9.5%	97	21 %
Leaning towards research	12	23.1%	56	37.8%	62	53.9%	49	62.0%	34	45.9%	213	45 %
Primarily in research	29	55.8%	44	29.7%	17	14.8%	16	20.3%	33	44.6%	139	30 %
Total	52	100.0%	148	100.0%	115	100.0%	79	100.0%	74	100.0%	471	100 %

Appendix I: Bi-variate correlation coefficients with research productivity (article equivalents)

		Norway Male	Norway Female	Australia Male	Australia Female
Individual background	Age	**0.18**	**0.19**	0.11	0.07
	Unmarried	-0.04	-0.12	-0.08	0.00
	Married to academic	0.02	**<u>0.26</u>**	**0.14**	**0.13**
	Married to non-academic	0.01	**-0.20**	-0.08	-0.09
	No children	0.09	0.09	-0.07	0.03
	One child	-0.03	0.03	0.04	-0.02
	Two children	-0.05	-0.06	0.03	-0.04
	Three children or more	-0.04	-0.09	0.03	0.03
	Career interruption for caring	-0.09	0.06	-0.01	-0.09
Individual achievement	Experience	0.13	**0.22**	**0.19**	**0.22**
	Academic rank	**<u>0.31</u>**	**<u>0.41</u>**	**<u>0.45</u>**	**<u>0.50</u>**
	Doctoral degree	0.14	**<u>0.26</u>**	**<u>0.27</u>**	**<u>0.34</u>**
	Time spent on research	**0.23**	**0.15**	**0.21**	**<u>0.29</u>**
	Preferences towards research	0.05	**<u>0.27</u>**	**0.19**	**<u>0.26</u>**
	Research collaboration	0.08	0.11	**0.16**	0.11
	International collaboration	**0.16**	**<u>0.20</u>**	0.14	**0.17**
	International conference	N/A	N/A	**0.29**	**0.32**
Institutional	Performance-based funding	-0.05	0.12	0.05	0.03
	Performance orientation	-0.03	-0.02	0.07	0.03
	Research funding satisfaction	0.02	-0.06	**0.20**	0.02
	Time spent on teaching	-0.07	-0.04	-0.13	**-0.16**
	ATN university	N/A	N/A	-0.04	-0.01
	Group of 8 university	N/A	N/A	**0.16**	0.13
	Other university	N/A	N/A	-0.13	-0.12
	Collegial support	N/A	N/A	0.09	0.05

Appendix J: The CAP questionnaire

A. Career and Professional Situation

A1 For each of your degrees, please indicate the year of completion and the country in which you obtained it.

Degree	Year	Earned in country of current employment	If no, please specify country
First degree - Bachelors (or equivalent)	☐☐☐☐	Yes ☐ No ☐	....
Second degree (if applicable) Masters (or equivalent)	☐☐☐☐	Yes ☐ No ☐	....
Doctoral degree (if applicable)	☐☐☐☐	Yes ☐ No ☐	....

A2 Please, identify the academic discipline or field of your…

Check only one in each column

Highest Degree	Current Acad. Unit or unit	Current Teaching Area area	
1 ☐	1 ☐	1 ☐	Teacher training and education science
2 ☐	2 ☐	2 ☐	Humanities and arts
3 ☐	3 ☐	3 ☐	Social and behavioural sciences
4 ☐	4 ☐	4 ☐	Business and administration, economics
5 ☐	5 ☐	5 ☐	Law
6 ☐	6 ☐	6 ☐	Life sciences
7 ☐	7 ☐	7 ☐	Physical sciences, mathematics, computer sciences
8 ☐	8 ☐	8 ☐	Engineering, manufacturing and construction
9 ☐	9 ☐	9 ☐	Agriculture
10 ☐	10 ☐	10 ☐	Medical sciences, health related sciences, social services
11 ☐	11 ☐	11 ☐	Personal services, transport services, security services
12 ☐	12 ☐	12 ☐	Other: (please specify) .... (please specify)

1

A3 How would you characterize the training you received in your doctoral degree? (If you do not hold a doctoral degree: Please go to question A4)

Check all that apply

1 ☐ You were required to take a prescribed set of courses
2 ☐ You were required to write a thesis or dissertation
3 ☐ You received intensive faculty guidance for your research
4 ☐ You chose your own research topic
5 ☐ You received a scholarship or fellowship
6 ☐ You received an employment contract during your studies (for teaching or research)
7 ☐ You received training in instructional skills or learned about teaching methods
8 ☐ You were involved in research projects with faculty or senior researchers
9 ☐ You served on an institutional or departmental (unit) committee

A4 Since your first degree, how long have you been employed in the following? [If "0," so indicate]

Full time	Part time	
☐☐	☐☐	Higher education institutions
☐☐	☐☐	Research institutes
☐☐	☐☐	(Other) Government or public sector institutions
☐☐	☐☐	(Other) Industry or private sector institutions
☐☐	☐☐	Self-employed

☐☐☐☐ If you reported some non-academic employment, what was the year of your latest re-entry to academic work?

A5 By how many institutions have you been employed since your

First degree	Highest degree	
☐☐	☐☐	Higher education institutions or research institutes
☐☐	☐☐	Other institutions (including self-employment)

A6 Please indicate the following

☐☐☐☐ Year of your first full-time appointment (beyond research and teaching assistant) in the higher education/research sector

☐☐☐☐ Year of your first appointment to your current institution (beyond research and teaching assistant)

☐☐☐☐ Year of your appointment/promotion to your current rank at your current institution

☐☐ For how many years have you interrupted your service at your current institution for family reasons, personal leave or full-time study? [If "0," so indicate]

A7 What is your employment situation in the current academic year at your higher education institution/research institute? [Check one only]

1 ☐ Full-time employed

2 ☐ Part-time employed, ☐☐ % of full-time

3 ☐ Part-time with payment according to work tasks

4 ☐ Other (please specify) ....

A8 Do you work for an additional employer or do additional remunerated work in the current academic year?

1 ☐ No

2 ☐ In addition to your current employer, you also work at another research institute or higher education institution

3 ☐ In addition to your current employer, you also work at a business organization outside of academe

4 ☐ In addition to your current employer, you also work at a non-profit organization or government entity outside of academe

5 ☐ In addition to your current employer, you are also self-employed.

6 ☐ Other: ....
(please specify)

A9 How would you describe your current institution?

Check one only

1 ☐ Group of Eight (Go8)

2 ☐ Australian Technical Network of Universities (ATN)

3 ☐ Innovative Research Universities Australia (IRUA)

☐ Other: ....

A10 What is your academic rank (If you work in a research institutions with ranks differing from those at higher education institutions, please choose the rank most closely corresponding to yours)?

1 ☐ Level A (Associate Lecturer)

2 ☐ Level B (Lecturer)

3 ☐ Level C (Senior Lecturer)

4 ☐ Level D (Associate Professor)

5 ☐ Level E (Professor)

6 ☐ Other: ....
(please specify)

A11 What is the duration of your current employment contract at your higher education institution or research institute? [Check only one]

Check only one

1 ☐ Permanently employed (tenured)

2 ☐ Continuously employed (no preset term, but no guarantee of permanence)

3 ☐ Fixed-term employment *with* permanent/continuous employment prospects (tenure-track)

4 ☐ Fixed-term employment *without* permanent/continuous employment prospects

5 ☐ Other:...

(please specify)

A12 What is your overall annual gross income (including supplements) from the following sources?

☐☐☐☐ Your current university

☐☐☐☐ All other concurrent employers

☐☐☐☐ Other income (e.g. self-employment)

A13 During the current academic year, have you done any of the following?

Check all that apply

1 ☐ Served as a member of national/international scientific committees/boards/bodies

2 ☐ Served a peer reviewer (e.g. for journals, research sponsors, institutional evaluations)

3 ☐ Served as an editor of journals/book series

4 ☐ Served as an elected officer or leader in professional/academic associations/organizations

5 ☐ Served as an elected officer or leader of unions

6 ☐ Been substantially involved in local, national or international politics

7 ☐ Been a member of a community organizations or participated in community-based projects

8 ☐ Worked with local, national or international social service agencies

9 ☐ Dean or head of department/school/faculty

10 ☐ Attended an overseas conference

11 ☐ Other: ....

(please specify)

A14 Within the last five years, have you considered a major change in your job? And did you take concrete actions to make such a change? [If yes, check all that apply in both columns A and B. If no, so indicate in column A and skip to B1]

Considered	Concrete action taken	
1 ☐	1 ☐	To a management position in your higher education/research institution
2 ☐	2 ☐	To an academic position in another higher education/research institute within the country
3 ☐	3 ☐	To an academic position in another country
4 ☐	4 ☐	To work outside higher education/research institutes
5 ☐		No, I have not considered making any major changes in my job

4

B. General Work Situation and Activities

B1 Considering all your professional work, how many hours do you spend in a typical week on each of the following activities? [If you are not teaching during the current academic year, please reply to the second column only.]

Hours per week when classes are in session	Hours per week when classes are not in session	
☐☐	☐☐	Teaching (preparation of instructional materials and lesson plans, classroom instruction, advising students, reading and evaluating student work)
☐☐	☐☐	Research (reading literature, writing, conducting experiments, fieldwork)
☐☐	☐☐	Service (services to clients and/or patients, unpaid consulting, public or voluntary services)
☐☐	☐☐	Administration (committees, department meetings, paperwork)
☐☐	☐☐	Other academic activities (professional activities not clearly attributable to any of the categories above)

B2 Regarding your own preferences, do your interests lie *primarily* in teaching or in research?

Check only one (MARTIN - THIS DOES NOT APPEAR ONLINE)

1 ☐ Primarily in teaching

2 ☐ In both, but leaning towards teaching

3 ☐ In both, but leaning towards research

4 ☐ Primarily in research

B3 At your institution, how would you evaluate each of the following facilities, resources, or personnel you need to support your work?

Excellent 1	2	3	4	Poor 5	
☐	☐	☐	☐	☐	Classrooms
☐	☐	☐	☐	☐	Technology for teaching
☐	☐	☐	☐	☐	Laboratories
☐	☐	☐	☐	☐	Research equipment and instruments
☐	☐	☐	☐	☐	Computer facilities
☐	☐	☐	☐	☐	Library facilities and services
☐	☐	☐	☐	☐	Your office space
☐	☐	☐	☐	☐	Secretarial support
☐	☐	☐	☐	☐	Telecommunications (Internet, networks, and telephones)
☐	☐	☐	☐	☐	Teaching support staff
☐	☐	☐	☐	☐	Research support staff
☐	☐	☐	☐	☐	Research funding

B4 Please indicate the degree to which each of the following affiliations is important to you.

Very important 1	2	3	4	Not at all important	
☐	☐	☐	☐	☐	My academic discipline/field
☐	☐	☐	☐	☐	My department (at this institution)
☐	☐	☐	☐	☐	My institution

B5 Please indicate your views on the following

Strongly Agree 1	2	3	4	Strongly Disagree 5	
☐	☐	☐	☐	☐	Scholarship is best defined as the preparation and presentation of findings on original research
☐	☐	☐	☐	☐	Scholarship includes the application of academic knowledge in real-life settings
☐	☐	☐	☐	☐	Scholarship includes the preparation of reports that synthesize the major trends and findings of my field
☐	☐	☐	☐	☐	This is a poor time for any young person to begin an academic career in my field
☐	☐	☐	☐	☐	If I had it to do over again, I would not become an academic
☐	☐	☐	☐	☐	My job is a source of considerable personal strain
☐	☐	☐	☐	☐	Teaching and research are hardly compatible with each other
☐	☐	☐	☐	☐	Faculty in my discipline have a professional obligation to apply their knowledge to problems in society
☐	☐	☐	☐	☐	I support university efforts to commercialise research findings

B6 How would you rate your overall satisfaction with your current job?

Very high 1	2	3	4	Very low 5
☐	☐	☐	☐	☐

B7 Since you started your career, have the overall working conditions in higher education and research institutes improved or declined?

Very much improved 1	2	3	4	Very much deteriorated 5	
☐	☐	☐	☐	☐	Working conditions in higher education
☐	☐	☐	☐	☐	Working conditions in research institutes

6

C. Teaching

(Refer to the current academic year or the previous academic year (if you do not teach in this academic year). If you do not/did not teach in this or the previous academic year go to section D)

C1 Please indicate the proportion of your teaching responsibilities during the current academic year that are devoted to instruction at each level below and the approximate number of students you instruct at each of these levels

Percent of instruction time	Approximate average number of students per course	
☐☐	☐☐☐	Undergraduate programs
☐☐	☐☐☐	Master programs
☐☐	☐☐☐	Doctoral programs
☐☐	☐☐☐	Non-credit programs
☐☐	☐☐☐	Others

C2 During the current (or previous) academic year, have you been involved in any of the following teaching activities?

Check all that apply

1 ☐ Classroom instruction/lecturing
2 ☐ Individualized instruction
3 ☐ Learning in projects/project groups
4 ☐ Practice instruction/ laboratory work
5 ☐ ICT-based learning/computer-assisted learning
6 ☐ Distance education
7 ☐ Development of course material
8 ☐ Curriculum/program development
9 ☐ Face-to-face interaction with students outside of class
10 ☐ Electronic communications (e-mail) with students
11 ☐ Teaching offshore

C3 Does your institution set quantitative load targets or regulatory expectations for individual faculty for the following:

Check all that apply

1 ☐ Number of hours in the classroom
2 ☐ Number of students in your classes
3 ☐ Number of graduate students for supervision
4 ☐ Percentage of students passing exams
5 ☐ Time for student consultation

C4 Please indicate your views on the following:

Strongly agree 1	2	3	4	Strongly disagree 5	
☐	☐	☐	☐	☐	You spend more time than you would like teaching basic skills due to student deficiencies
☐	☐	☐	☐	☐	You are encouraged to improve your instructional skills in response to teaching evaluations
☐	☐	☐	☐	☐	At your institution there are adequate training courses for enhancing teaching quality
☐	☐	☐	☐	☐	Practically oriented knowledge and skills are emphasized in your teaching
☐	☐	☐	☐	☐	In your courses you emphasize international perspectives or content
☐	☐	☐	☐	☐	You incorporate discussions of values and ethics into your course content
☐	☐	☐	☐	☐	You inform students of the implications of cheating or plagiarism in your courses
☐	☐	☐	☐	☐	Grades in your courses strictly reflect levels of student achievement
☐	☐	☐	☐	☐	Since you started teaching, the number of international students has increased
☐	☐	☐	☐	☐	Currently, most of your graduate students are international
☐	☐	☐	☐	☐	Your research activities reinforce your teaching
☐	☐	☐	☐	☐	Your service activities reinforce your teaching

C5 During the current (or previous) academic year, are you teaching any courses.

Check all that apply

1 ☐ Abroad

2 ☐ In a language different from the language of instruction at your current Institution

D. Research (Refer to the current academic year or the previous academic year (if you are not active in research in this academic year). If you are not/were not active in research in this or the previous academic year go to section E.)

D1 How would you characterize your research efforts undertaken during this (or the previous) academic year?

Yes	No	
1 ☐	1 ☐	Are you working independently on any of your research projects?
2 ☐	2 ☐	Do you have collaborators in any of your research projects?
3 ☐	3 ☐	Do you collaborate with persons at other institutions in your country?
4 ☐	4 ☐	Do you collaborate with international colleagues?

8

D2 How would you characterize the emphasis of your primary research this (or the previous) academic year?

Very much 1	2	3	4	Not at all 5	
☐	☐	☐	☐	☐	Basic/theoretical
☐	☐	☐	☐	☐	Applied/practically-oriented
☐	☐	☐	☐	☐	Commercially-oriented/intended for technology transfer
☐	☐	☐	☐	☐	Socially-oriented/intended for the betterment of society
☐	☐	☐	☐	☐	International in scope or orientation
☐	☐	☐	☐	☐	Based in one discipline
☐	☐	☐	☐	☐	Multi-/interdisciplinary

D3 Have you been involved in any of the following research activities during this 9or the previous) academic year?

Check all that apply

1 ☐ Preparing experiments, inquiries etc.

2 ☐ Conducting experiments, inquiries etc.

3 ☐ Supervising a research team or graduate research assistants

4 ☐ Writing academic papers that contain research results or findings

5 ☐ Involved in the process of technology transfer

6 ☐ Answering calls for proposals or writing research grants

7 ☐ Managing research contracts and budgets

8 ☐ Purchasing or selecting equipment and research supplies

8 ☐ Consultancies with external organisations

D4 How many of the following scholarly contributions have you completed in the past *three* years?

(Number completed in the past three years)

☐☐ Scholarly books you authored or co-authored

☐☐ Scholarly books you edited or co-edited

☐☐ Articles published in an academic book or journal

☐☐ Research report/monograph written for a funded project

☐☐ Paper presented at a scholarly conference

☐☐ Professional article written for a newspaper or magazine

☐☐ Patent secured on a process or invention

☐☐ Computer program written for public use

☐☐ Artistic work performed or exhibited

☐☐ Video or film produced

☐☐ Others (please specify):...

(please specify)

D5 Which percentage of your publications in the last three years were

☐☐☐ published in a language different from the language of instruction at your current institution

☐☐☐ co-authored with colleagues located in the country of your current employment

☐☐☐ co-authored with colleagues located in other (foreign)countries

☐☐☐ published in a foreign country

☐☐☐ On-line or electronically published

☐☐☐ Peer-reviewed

D6 Please indicate your views on the following

Strongly agree 1	2	3	4	Strongly disagree 5	
☐	☐	☐	☐	☐	Restrictions on the publication of results from my publicly-funded research have increased since my first appointment
☐	☐	☐	☐	☐	Restrictions on the publication of results from my privately-funded research have increased since my first appointment
☐	☐	☐	☐	☐	External sponsors or clients have no influence over my research activities
☐	☐	☐	☐	☐	The pressure to raise external research funds has increased since my first appointment
☐	☐	☐	☐	☐	Interdisciplinary research is emphasized at my institution
☐	☐	☐	☐	☐	Your institution emphasizes commercially-oriented or applied research
☐	☐	☐	☐	☐	Your research is conducted in full-compliance with ethical guidelines
☐	☐	☐	☐	☐	Research funding should be concentrated(targeted) on the most productive researchers
☐	☐	☐	☐	☐	High expectations to increase research productivity are a threat to the quality of research
☐	☐	☐	☐	☐	High expectations of useful results and application are a threat to the quality of research
☐	☐	☐	☐	☐	Research results should be freely available to other researchers and the community

D7 In the current (or previous) academic year, which percentage of the funding for your research came from

- ☐☐☐ Your own institution
- ☐☐☐ Public research funding agencies (eg. ARC, NHMRC)
- ☐☐☐ Government entities
- ☐☐☐ Business firms or industry
- ☐☐☐ Private not-for-profit foundations/agencies
- ☐☐☐ International entities (governments, not-for-profit foundations, or non-governmental agencies)
- ☐☐☐ Others: ....

(please specify)

D8 In the current (or previous) academic year, which percentage of the *external* funding for your research came from

☐☐☐	National organizations/entities
☐☐☐	International organizations/entities

E. Management

E1 At your institution, which actor has the primary influence on each of the following decisions (please check only one column on each decision)?

Government or external stakeholders	Institutional managers	Academic Unit managers	Faculty committees/ boards	Individual faculty	Students	
☐	☐	☐	☐	☐	☐	Selecting key administrators
☐	☐	☐	☐	☐	☐	Choosing new faculty
☐	☐	☐	☐	☐	☐	Making faculty promotion and tenure decisions
☐	☐	☐	☐	☐	☐	Determining budget priorities
☐	☐	☐	☐	☐	☐	Determining the overall teaching load of faculty
☐	☐	☐	☐	☐	☐	Setting admission standards for undergraduate students
☐	☐	☐	☐	☐	☐	Approving new academic programs
☐	☐	☐	☐	☐	☐	Evaluating teaching
☐	☐	☐	☐	☐	☐	Setting internal research priorities
☐	☐	☐	☐	☐	☐	Evaluating research
☐	☐	☐	☐	☐	☐	Establishing international linkages

E2 How influential are *you*, personally, in helping to shape key academic policies?

Very influential	Somewhat influential	A little influential	Not at all influential	Not applicable	
☐	☐	☐	☐	☐	At the level of the department or similar unit
☐	☐	☐	☐	☐	At the level of the faculty, school or similar unit
☐	☐	☐	☐	☐	At the institutional level

E3 By whom is your teaching, research, and service regularly evaluated?

Check all that apply

Your teaching	Your research	Your service	
1 ☐	1 ☐	1 ☐	Your peers in your department or unit
2 ☐	2 ☐	2 ☐	The head of your department or unit
3 ☐	3 ☐	3 ☐	Members of other departments or units at this institution
4 ☐	4 ☐	4 ☐	Senior administrative staff at this institution
5 ☐	5 ☐	5 ☐	Your students
6 ☐	6 ☐	6 ☐	External reviewers
7 ☐	7 ☐	7 ☐	Yourself (formal self-assessment)
8 ☐	8 ☐	8 ☐	No one at or outside my institution

E4 At my institution there is…

Strongly agree 1	2	3	4	Strongly disagree 5	
☐	☐	☐	☐	☐	… A strong emphasis on the institution's mission
☐	☐	☐	☐	☐	…. Good communication between management and academics
☐	☐	☐	☐	☐	… A top-down management style
☐	☐	☐	☐	☐	…. Collegiality in decision-making processes
☐	☐	☐	☐	☐	… A strong performance orientation
☐	☐	☐	☐	☐	… A cumbersome administrative process
☐	☐	☐	☐	☐	… A supportive attitude of administrative staff towards teaching activities
☐	☐	☐	☐	☐	… A supportive attitude of administrative staff towards research activities
☐	☐	☐	☐	☐	…professional development for administrative/management duties for individual faculty
☐	☐	☐	☐	☐	… a supportive governing body contributing to the strategic development of the institution
☐	☐	☐	☐	☐	…. collegial support for my research

E5 Please indicate your views on the following issues.

Strongly agree 1	2	3	4	Strongly disagree 5	
☐	☐	☐	☐	☐	Top-level administrators are providing competent leadership
☐	☐	☐	☐	☐	I am kept informed about what is going on at this institution
☐	☐	☐	☐	☐	Lack of faculty involvement is a real problem
☐	☐	☐	☐	☐	Students should have a stronger voice in determining policy that affects them
☐	☐	☐	☐	☐	The administration supports academic freedom
☐	☐	☐	☐	☐	My university should play an active role in the local community

E6 To what extent does your institution emphasize the following practices?

Very much 1	2	3	4	Not at all 5	
☐	☐	☐	☐	☐	Performance based allocation of resources to academic units
☐	☐	☐	☐	☐	Evaluation based allocation of resources to academic units
☐	☐	☐	☐	☐	Funding of departments substantially based on numbers of students
☐	☐	☐	☐	☐	Funding of departments substantially based on numbers of graduates
☐	☐	☐	☐	☐	Considering the research quality when making personnel decisions
☐	☐	☐	☐	☐	Considering the teaching quality when making personnel decisions
☐	☐	☐	☐	☐	Considering the practical relevance/applicability of the work of colleagues when making personnel decisions
☐	☐	☐	☐	☐	Recruiting faculty who have work experience outside of academia
☐	☐	☐	☐	☐	Encouraging academics to adopt service activities/entrepreneurial activities outside the institution
☐	☐	☐	☐	☐	Encouraging individuals, businesses, foundations etc. to contribute more to higher education

F. Personal Background

F1 What is your gender?

1 ☐ Male
2 ☐ Female

F2 Year of birth

☐☐☐☐ Year

F3 What is your familial status

1 ☐ Married/partner
2 ☐ Single
3 ☐ Other: ....
(please specify)

F4 If married/partner, is she/he employed?

1 ☐ Yes, full-time
2 ☐ Yes, part-time
3 ☐ No

F5 Is your spouse/partner also an academic?

1 ☐ Yes
2 ☐ No

F6 Do you have children living with you?

1 ☐ Yes, 1 child
2 ☐ Yes, 2 children
3 ☐ Yes, 3 or more children
4 ☐ No

F7 Did you ever interrupt your employment in order to provide child or elder care in the home?

1 ☐ Yes
2 ☐ No

☐☐ If yes, for how many years?

F8 What is your parents' highest, and if applicable, partner's highest education level?

Father	Mother	Partner	
1 ☐	1 ☐	1 ☐	Entered and/or completed tertiary education
2 ☐	2 ☐	2 ☐	Entered and/or completed secondary education
3 ☐	3 ☐	3 ☐	Entered and/or completed primary education
4 ☐	4 ☐	4 ☐	No formal education
5 ☐	5 ☐	5 ☐	Not applicable

F9 What was/is your nationality/citizenship and your country of residence

	Citizenship	Country of Residence
At birth	....	....
At the time of your first degree	....	....
Currently	....	....
	(please specify)	(please specify)

F10 What is first language/mother tongue

....

(please specify)

F11 Which language do you primarily employ in teaching

1 ☐ First language/mother tongue

2 ☐ Other: ....

(please specify)

F12 Which language do you primarily employ in research?

1 ☐ First language/mother tongue

2 ☐ Other: ....

(please specify)

F13 How many years since the award of your first degree have you spent…

☐☐ ...in the country of your first degree

☐☐ ...in the country in which you are currently employed, if different from the country of your first degree

☐☐ ...in other countries (outside the country of your first degree and current employment)