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TARGETING THE LEAKY PIPELINE: PROMOTION AND PRODUCTIVITY AT THE DEPARTMENTS OF ECONOMICS IN SWEDEN

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Abstract

In this paper, levels of productivity at Swedish academic departments of economics are measured in order to understand why there are so few women at the higher ranks. A probability model is constructed to study if there are any gender differences in promotion within the labour market of academic economists. A unique data set consisting of 245 academic economists—with a complete record of publications between the years of 1990 to 2015—is used. By weighting each publication according to journal quality indices, productivity for every researcher can be assessed and controlled for on an annual basis. The use of event history analysis allows for both the inclusion of censored individuals and time-varying variables. Our findings show that gender has no significant effect on the likelihood of promotion within the departments of economics in Sweden during the period 1990–2015, after controlling for productivity. The conclusion is that the leaky pipeline cannot be explained by gender differences in promotion given a certain level of productivity.

Keywords: gender gap, promotion, academic labour market, productivity, discrimination

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1. Introduction

The leaky pipeline conceptualises the under-representation of high-positioned women in the labour market. As the analogy goes, there is an uneven distribution of men and women that cannot be explained merely by a time lag in equality—i.e. that the discrepancies today are due to the fact that women have been in minority in the labour market traditionally—but rather that women drop off to a higher extent the further up the career ladder they go. The labour market outcome of the leaky pipeline phenomenon is the gender promotion gap, which will be defined as the dissonance between the numbers of women and men at high positions in a labour market. This paper focuses on promotions in the academic labour market where doctoral graduates in economics—defined as academic economists—constitute the labour input.

Researchers within the intersected field of labour economics and gender has applied the leaky pipeline metaphor to the academic world and highlighted the high female drop-off rates within the STEM[1] fields as well as in economics. The gender distribution of academic economists is highly relevant in terms of power and influence on society—e.g. through policy making—and the field of economics is far less gender-balanced than other social sciences. We therefore believe economics is particularly interesting from a gender perspective. The academic labour market is suitable for the study of the gender promotion gap for two reasons: first of all, the productivity of academic economists is—compared to other professions—relatively easily measured through the quality of their research output. Secondly, the titles in the academic career ladder have formal requirements that can be applied across departments at different universities and over time.

The main body of research on the gender promotion gap among academic economists is centred on the American universities (for reference see e.g. Ginther & Kahn 2004; Ginther 2006). In a Swedish context, Jonung and Ståhlberg (2003; 2008) have charted the share of female academic economists between 1969[2] and 2006. The findings showed that while 18% of the doctoral graduates in the period were female, the fraction of women among the full professors in economics were only 6% in 2006.

In light of the skewed gender distribution within Swedish departments of economics, we aim to investigate the low levels of high-positioned women by measuring the productivity levels of academic economists. Consequently, we have formulated the research question: *Is there a gender difference in promotion given a certain level of productivity for academic economists in Sweden?*

[1] Science, Technology, Engineering and Mathematics.
[2] The modern doctoral degree programme was introduced after a 1969 reform.

In order to answer the question, we use a unique set of data—including 245 academic economists—to study the relationship between publications and promotion as well possible gender differences. In this thesis we will focus on the promotion to associate professor (see section 5.3.1. and 5.4.1.). All individuals in the data set received their doctoral degree between 1990 and 2015 and were at some point during the period employed at a Swedish university.

The paper is organised as follows: the second section gives a background on the academic world in Sweden. A literature review is presented in section 3. Section 4 outlines the method, whereas the data and the model specifications are discussed in sections 5 and 6 respectively. The results are presented in the seventh section. The paper is wrapped up by a discussion in section 8 and conclusions in section 9.

2. Background

The purpose of this section is to provide an overview of the academic world as well as to set the stage for the analysis of this paper. Firstly, statistics on doctoral graduates and employment within academia are outlined, in order to describe the supply and the demand of the academic labour market. Secondly, the mechanisms that shape the Swedish academic labour market and the behaviour of the academic economists are presented. The factors that will be highlighted due to their importance are the distinct titles in the academic ladder and the incentive structures behind the research funding system. Thirdly, the trends in economics toward increased co-authorship and a stronger focus on publications in top journals are reviewed in light of the implications they have for the careers of the academic economists.

2.1. Statistics

2.1.1. Doctoral graduates

The gender distribution of doctoral graduates is important since they are the possible candidates for the academic labour market and will constitute the labour input.[3] In turn, as prospective employees, they are the supply side of the academic labour market. We have assembled statistics on the doctoral graduates in economics from all Swedish universities (see Table 2, Appendix I), based on the latest raw data from Statistics Sweden.[4] In total, there are 76% men and 24% women (633 men and 204 women) in the population of 837 doctoral graduates between 1990 and 2010. The respective distributions of male and female doctoral graduates show that the number of women has continuously increased but—unlike the academic world in general—the

[3] The academic career ladder is further described in sections 2.2.1. and 5.3.1.
[4] Statistics Sweden has data on the doctoral graduates by university, type of degree (the two-year licentiate degree or four-year doctoral degree), field of research, gender and age between years 1973 and 2010.

distribution is still not equal. In 2010, the distribution of doctoral graduates in economics was 38% females and 62% males.

2.1.2. Swedish academic labour market

The universities and university colleges—through the positions that are offered within the departments—represent the demand side of the academic labour market as employers. Although there are no statistics on a departmental level, the 2015 Status Report of the Swedish Higher Education Authority (Universitetskansler-ämbetetet [UKÄ] 2015) presented summary statistics on academia in Sweden. The overall number of employees at Swedish universities and university colleges has increased since the beginning of the 1990s with the exception of the period 2004–2008. The fraction of employees with teaching or researching positions—i.e. employees with a licentiate or doctoral degree—increased from four out of ten in 1985 to nearly six out of ten in 2002 and onwards (UKÄ 2015).

2.2. The Swedish university system

2.2.1. The academic ladder

There are three positions codified in Swedish law since 2012: *professor* and *lektor*—which are considered as teaching positions—as well as *anställning för meritering*—which is a fixed-term contract on a maximum of four years unless reasons specific calls for an extended period of six years in total (SFS 1993:100). The purpose of the latter position—which includes the titles *forskarassistent*, *biträdande lektor* and *postdoktor*—is to offer doctoral graduates the opportunity to qualify for an academic career and a higher position. A Swedish graduate with a doctoral degree—corresponding to four years of full-time studies—that wishes to stay within the academic world can apply for research and teaching positions and usually start with some kind of fixed-term contract. In 2014, the fraction of female researchers at a fixed-term contract across all academic fields was 33%, whereas the fraction of male researchers was 29% (UKÄ 2015).

During recent years, there have been reforms that have shaped the Swedish university system in direction toward the American. The most relevant change for this paper is that there are departments in Sweden today that have applied the American tenure-track system to a large extent through the use of the American titles—assistant professor, associate professor and professor—as well as a special fixed-term contract up to six years. As follows, an outline of the American tenure-track system is necessary in order to understand the academic ladder in a Swedish context.

A researcher with a doctoral degree in the United States can be hired as an assistant professor on a tenure-track, i.e. employment on an annual basis at an American university. At the end of the tenure-track—most commonly after six or seven years as assistant professor—the researcher

goes up for tenure. The tenure review is based on research, education and service during the tenure-track period (Sabatier 2010). If the review results in tenure, which signifies a position with strong employment protection and academic freedom[5], the person is generally appointed to associate professor at the same time. If the person is denied tenure, the likelihood of being offered another position at the same university is low, which have given rise to the phrase "publish or perish" (Beckman & Schneider 2013).

The respective labour market institutions of the United States and Sweden are naturally reflected in each of the academic labour markets.[6] Due to stronger employment protection, the Swedish university system has been inspired by—rather than fully adapted—the American tenure system. The researchers on a Swedish tenure-track are hired as assistant professors on a fixed term contract of three plus three years, at the end of which the researcher applies to become associate professor.

Although there are only three university positions codified by Swedish law, various titles are used across the academic world.[7] An important clarification that needs to be made for this paper is the distinction between the titles *docent* and associate professor, which are often used interchangeably in Sweden. The main difference is that the former is a position held at a department, while the latter in fact represents an academic grade—*docentkompetens*—which is similar to the academic qualification *habilitation* used in continental Europe. Another is that associate professor normally should be preceded by six years of full-time employment, whereas *docent* should correspond to four years of full-time research. In practice however, assistant professors (or equivalent positions) often need to combine research with teaching duties. The result is that few researchers are appointed to *docent* within four years.

2.2.2. The research funding system

The main part of the research in Sweden takes place at universities and university colleges rather than—as in many other countries—by private research institutes or government bodies separated from education. There are both public and private universities and university colleges in Sweden, however the public constitutes the main part of the higher education. The publicly owned universities are governed directly by the Swedish government, however with an increasingly large independence. An example of a reform that has made the universities more independent is the previously mentioned reduction in titles codified by Swedish law (UKÄ 2015).

More than half of the university expenditures are spent on research and researcher education. In 2014, 75% of the overall research grants to the Swedish universities were public, while 25%

[5] For reference see the 1940 Statement of Principles on Academic Freedom and Tenure.
[6] The varieties of capitalism approach by Hall and Soskice (2001) can be used as a reference for institutional differences in labour markets.
[7] For instance *adjunkt*, *lektor*, *postdoc* and *forskarassistent* are all titles that are used at the initial level of employment for doctoral graduates at the universities.

were privately funded donations (UKÄ 2015). A reform of the public funding system was initiated in 2009 with the intention of creating an incentive structure for universities to increase the quality of the research in order to make Swedish research competitive in an international perspective. The result of the reform was the introduction of competitive based research grants, which are allocated based on two quality indicators. The first indicator focuses on the size of the external funding of the universities, i.e. the larger external funds, the higher quality the research is expected to be and therefore, the better potential it seems to have. The second indicator is based on publication and citation metrics. The universities that have researchers that publish papers in the most prominent journals and have the highest number of citations are judged to have the research with highest quality (Utbildningsdepartementet 2008). At the point of introduction, the competitive based research granting was supposed to make up 10% of the direct governmental grants for research and the share was increased to 20% in 2014 (Utbildningsdepartementet 2012).

The incentivising structures are also applied within the universities—both between different faculties and at the respective departments. Most importantly, the distribution of resources among researchers is highly driven by quality indicators, making the phrase "publish or perish" applicable in a Swedish context as well. Individual researchers that succeed in obtaining external funds and publish in prominent journals might be rewarded, e.g. through promotion or a reduction or removal of teaching duties which in turn gives more time to produce research (Görnerup 2013). Consequently, the Swedish academic world can be perceived as both competitive as well as insecure for the researchers on fixed-term contracts.

2.3. Publication trends at Swedish economics departments

Following the works of Hamermesh (2013) and Card and Della Vigna (2013) about the development of the research in economics, Björklund (2014) highlighted the Swedish perspective in a discussion about what characterises the modern research in economics based on top journal publications. Between the years 2002 to 2013, there were 65 articles—written by at least one Swedish researcher—published in the top six economic journals.[8] The female fraction of the authors was 7.9%. We argue that two trends are important to outline in light of this study: the focus on publication in international top journals and the collaboration between researchers.

2.3.1. Focus on publications in international journals

Academic economists—as well as doctoral graduates across other academic fields—have three formal assignments: to research and produce papers, to teach students and to contribute to the societal debate (Björklund 2014). The first two obligations are often regulated in the

[8] These are in alphabetical order *American Economic Review*, *Econometrica*, *Journal of Economic Literature*, *Journal of Political Economy*, *Quarterly Journal of Economics* and *Review of Economic Studies*.

employment contracts, whereas the latter is not. Björklund (2014) seems to be of the opinion that the third obligation is neglected to an ever-higher extent within the field of economics.

A similarity found in the papers of Card and Della Vigna (2013) and Björklund (2014) is the importance of publications in top journals for career paths. Even though the procedures somewhat differ across departments, the overall trend is that—although all three researcher obligations need to be fulfilled—publications are becoming the single most important factor in the promotion process. Whereas Card and Della Vigna merely stated that publications affect the careers and salaries of researchers, Björklund (2014) argued that the focus on research in the specific form of publications in international journals has increased at the expense of the other two formal assignments.

Besides the risk of underplaying the importance of all research obligations, another is that other forms of research output—e.g. papers published in interdisciplinary fields and books—could be viewed less meriting. Additionally, the increased focus on research output might create a disadvantage for female academic economists since they often are involved in educational obligations and administrative work to a higher extent than male researchers (Stock 2006; Jonung & Ståhlberg 2008). As follows, there might be unintended drawbacks from the incentive structure of encouraging research output. This notwithstanding, the focus on publication merits has enabled formal requirements and transparency in promotion processes.

2.3.2. Collaboration between researchers

Both the papers of Card and Della Vigna (2013) and Björklund (2014) showed a trend toward increased co-authorship. In an international context, Card and Della Vigna showed that the average number of authors per paper increased from 1.3 in 1970 to 2.3 in 2012 based on a data set of 13,245 articles within the field of economics. The average number of authors in articles with at least one Swedish academic economist was 2.34 between 2002 and 2013, indicating that the Swedish pattern is consistent with the international (Björklund 2014). The results are specifically significant in light of Sarsons' (2015) study on the gender promotion gap within departments of economics in the United States, in which she found that men get credited to a higher extent for work done jointly with women at American top universities.

3. Literature review

The leaky pipeline describes the diminishing fraction of female academic economists at higher positions in the academic ladder, which is a gender difference in a labour market outcome. From an economic point of view, the phenomenon is interesting in two ways: first of all, what factors can explain the respective supply and demand of men and women? And secondly: can the gender

differences be an equilibrium outcome in the labour market? In order to understand how the interplay of demand and supply factors affect equilibrium outcomes, we will review the theories and previous empirical research explaining the gender promotion gap.

This section is divided into two parts: a theoretical and an empirical. In the first part, we begin by applying an economic perspective to the understanding of labour market outcomes. Next, we summarise the theories on gender differences in labour market outcomes and the main explanations for differences in promotion between men and women. The first section is finished by an outline of the literature on discrimination in the labour market, which is the focus of this study. The second part of the section presents studies on the leaky pipeline in academia in general, and within the fields of economics in particular. Finally, previous empirical research on the gender promotion gap in the academic labour market is reviewed.

3.1. Economic theory on labour market outcomes

The starting point of the economic analysis of labour market outcomes can be thought of as a traditional general equilibrium at the intersection of the demand and supply curves. These curves reflect the net value of benefits and costs for the agents, i.e. the employers and the employees.[9] The employers' demand stem from the benefit of more output produced by the workers, weighed against the costs in the form of wages, other non-monetary benefits for the workers as well as absence and turnover costs. The amount of labour the employees will supply is the net value of costs—e.g. input of time and effort as well as years of education—and the benefits of salary, power and prestige. Jonung and Ståhlberg (2009) noted that the benefits and costs are on the one hand affected by institutions—e.g. taxation, educational system, family policies, social security programmes and labour market regulation—and on the other by traditions and social norms. Applied to our labour market of interest, the academic economists constitute labour supply whereas the demand is reflected through the positions at the departments of economics.

3.1.1. Explaining the gender promotion gap

Altonji and Blank summarised the research on labour market outcomes based on race and gender in a chapter in the *Handbook of Labor Economics* of 1999. At the time, they claimed there were three underlying factors explaining the differences in outcomes: skill differences, preferences and discrimination. Whereas the first implicates that women do not have the same human capital as men, the second implicates that women do not want to stay within academia. The third factor was discrimination, defined as "a situation in which persons who provide labor market services and who are equally productive in a physical or material sense are treated

[9] We acknowledge that there are several agents that can affect the equilibrium outcome, but the focus will be on the employers and the employees.

unequally in a way that is related to an unobservable characteristic such as race, ethnicity, or gender" (Altonji & Blank 1999). We will further discuss the theory of labour market discrimination in sections 3.1.2. and 3.2.5.

In the fourth volume of the *Handbook of Labor Economics* , Bertrand (2010) provided an update on the research in labour economics of gender in the chapter "New Perspectives on Gender". Although the focus in the summary chapter of Altonji and Blank—differences in human capital accumulation and discrimination—still are considered important factors in describing skewed labour market outcomes, Bertrand maintained that the last decade's research has brought to light new factors of explanations. In particular, psychological attributes and gender identity (reflected in the respective preferences of men and women) are two factors that have gained popularity in the beginning of the 21th century.

The differences in preferences that have been linked to labour market outcomes are particularly interesting in light of the competition in the academic world as well as the insecurity of fixed-term contracts and research funding, discussed in section 2.2.2. For instance, experimental studies have shown that women—on average—are more risk-averse as well as less willing to compete than men. Bertrand (2010) stated that the underrepresentation of women in "high-profile" occupation can be explained by that "women may systematically under-perform relative to men in competitive environments and that many women, even among the most able, may simply prefer to stay away from such environments" (Bertrand 2010).

With the note that there are various factors on how the gender differences in labour market outcomes can be explained, the focus of this paper will be on the demand side of the academic labour market. Given the research question formulated for the aim of this study—i.e. conditional on productivity, is there a gender difference in promotion?—we will mainly focus on theories of discrimination, which arguably is a natural starting point.

3.1.2. Discrimination

The main idea behind discrimination in the labour market is that only sub-optimal equilibria will be reached when individuals are treated unequally based on factors such as race or gender. The consequence of such discrimination is that the affected group will have lower returns to invested human capital and thus lower incentives to proceed on the career path in question. As follows, the rational response to discriminative action in a certain field is to leave it for another non-discriminatory environment, where investments in human capital are more profitable (Altonji & Blank 1999). If it is the case that women are discriminated in the labour market for academic economists, it could be one explanation for the leaky pipeline. These negative incentives for women to pursue a career in the field of academic economics can therefore result in high societal costs, since the resources in form of labour supply are not efficiently allocated.

The *Economics of Discrimination* (Becker 1957, rev. 1971) is one of the most famous works on discrimination, in which the economist Gary Becker approached differences in labour market outcomes from an economic perspective. In order to identify the presence of discrimination, he constructed a model to capture the dissonance between the discriminated and the non-discriminated by the use of quantitative data. Since then, there have been various models of discrimination presented in the literature on labour market outcomes, often categorised into competitive and collective models (for a summary of discrimination models see e.g. Altonji & Blank 1999). The assumption for a competitive model is that an employer acts individually, whereas in collective models, groups are polarised to act against each other. In turn, competitive discrimination models can be divided into taste-based or statistical discrimination (Altonji & Blank 1999).

A taste-based model is based on the notion that an employer has a "taste for discrimination", or in other words, dislikes a certain minority group. The employer will therefore impute a non-monetary cost of hiring or promoting people from that group. A key assumption in a taste-based model is that the employer has information on the applicant's productivity but ignores it due to an irrational distaste. This is contrasted against statistical discrimination where the employer—in lack of information of the applicant's productivity—imputes a perceived group-average to that person (Altonji & Blank 1999).

The main theoretical difference between the taste-based and the statistical model of discriminations is that the latter are consistent with a long-run equilibrium, while the former is not. Becker (1971) argued that taste-based discrimination cannot persist in a competitive environment since it is an inefficient way of allocating resources. In terms of the supply and demand of the labour market, the taste-based discrimination would not be an equilibrium outcome since workers are not hired at the marginal product of labour. As a consequence, market competitors would have the opportunity to seize the arbitrage and hire the discriminated employees with a positive net value of benefits. The statistical discrimination models however acknowledge that when employers face imperfect information, discrimination can be a rational response since—given the limited amount of information—predictions based on stereotypes might be rational. As follows, there is no market mechanism that guarantees a transition into a more efficient equilibrium outcome (Altonji & Blank 1999).

3.2. Empirical research

3.2.1. The leaky pipeline

The leaky pipeline has been used as a metaphor in several papers and articles on gender distribution within academia. In "Where are the Women?", Romero (2013) referred to a 2012

report from CSWEP[10] that showed that at the departments of economics in the United States 28% of the assistant professors, 22% of the associate professor and less than 12% of the full professors were women. According to Romero, the ratio of female doctoral graduates was 34% in 2011—a lower fraction than in 1997—which could indicate there might be even fewer females at departments of economics in the future.

Ginther has published various reports on women within academia (e.g. Ginther 2001, Ginther & Kahn 2004, Ginther 2006, Ginther & Hayes 2006 and Ginther & Kahn 2014). The 2004 paper—"Women in Economics: Moving Up or Falling Off the Academic Ladder?"—investigated whether the increase in female doctoral graduates between 1974 and 2000 had resulted in a corresponding increase in female faculty members at departments of economics. It had not. Based on a sample of 188 assistant professors that had received their doctoral degree during the 1980s in North America, Ginther and Kahn found that women that stay within academia are less likely to get tenure than men. Their results were significant after controlling for prestige of Ph.D. department, employer and the number of citations and publications. Within the field of economics a gender promotion gap at 21%[11] could be shown ten years after the academics received their doctoral degree, which is far larger than the other disciplines surveyed.[12]

Amilon, Persson and Rooth (2008) noted that the research on gender differences within the academic labour market is centred on the United States and the United Kingdom. The low—yet increasing—representation of Swedish female academic economists up until the early 2000s have been outlined by Persson (2002) as well as by Jonung and Ståhlberg (2003). In 2002, women held 20% of the assistant professor positions, 19% of the associate professor positions and 4% of the full professors positions (Jonung & Ståhlberg 2003). Using new data, Jonung and Ståhlberg (2008) showed that estimations of the ratio of females for 2011—made in the 2003 paper—had already been surpassed, indicating that the field of economics is developing, yet slowly.

The same 2008 paper studied the composition of economics faculties in Sweden, the United States, the United Kingdom, Canada and Australia and found that the distribution of women was similar across the five countries (Jonung & Ståhlberg 2008). Close to a third of the PhD students in economics as well as the assistant professor were female, with the exception of Sweden where the fraction of women among the assistant professors was at 19% (based on 2006 data). The share of female associate professors varied from 11 to 22%, whereas women held between 5 to 9% of the full professor positions.

[10] CSWEP stands for Committee on the Status of Women in the Economics Profession, which is part of the American Economic Association.
[11] A gender promotion gap of 21% means that if there were 79 promoted female academic economists, there were 100 male.
[12] The other disciplines were political science (-4.4%), statistics (0.3%), physical science (2.8%), life science (-2.2%), engineering (-3.9%) and social science (8.1%). A negative number indicates that the gender promotion gap is in favour of women.

Studies on Swedish academia have shown that women are particularly underrepresented in mathematics and economics (Jonung & Ståhlberg 2008). On the bright side, there are signs of progress. Amilon, Persson and Rooth (2008) and Amilon and Persson (2010) claimed that—unlike the findings of international research on the academia in the United States and the United Kingdom—male and female doctoral graduates stay within academia to the same extent in Sweden. With the note that the studies were on academia in general—rather than on the field of economics—this could be a sign that the gender promotion gap is decreasing in Sweden. Björklund (2014) seems to share the view in his paper on publication trends within the field of economics.

3.2.2. Publications

A pattern that appears across the research on gender promotion is that women seem to produce less research output than men. Based on a sample of assistant professors, Ginther and Kahn (2004) could explain 30% of the gender promotion gap by the fact that the female researcher published fewer papers than their male counterparts. Similarly, Ginther and Hayes (2006) claimed that the gender promotion gap is partly due to differences in scientific merits.

Kahn (1995) explained that there was no consensus regarding whether the gender promotion gap could be entirely explained by differences in publications, i.e. different studies showed distinct results. On the one hand, McDowell and Smith (1992) and Kahn (1995) found that there was a gender promotion gap even conditional on publications, whereas the results of Willis and Pieper (1993) indicated that there was not. However, these studies were on samples from the late 1970s. More recently, Jonung and Ståhlberg (2008) presented results from studies by Lindqvist (2003), Boschini and Sjögren (2007a) and an investigation by Canadian Economic Association (2001) that indicated that the publication gap is smaller, if existing at all, among young researchers today. The main view in the literature seems to be that men traditionally have produced more research output than women and that this partly explains the gender promotion gap. We will discuss the potential explanations for these differences in publications in section 8.

3.2.3. Family factors

A number of studies on the gender difference in promotions have controlled for family factors, such as marital status and children. Ginther and Kahn (2004) presented the results that female academic economists with children are less likely to receive tenure than male. Ginther and Hayes (2006) explained that since women typically have the main responsibility of caretaking, it is reasonable that children could be a factor that lowers productivity and therefore also the chances of promotion for women. They provided further evidence that this was the case according to data on faculties of humanities in the United States from 1977 to 1995.

Ginther and Kahn (2014) later found that children negatively affects promotion within academia, by showing that having young children decreases the probability that a woman will have a tenure-track job and that there is a gender difference in the chances of getting a promotion if you are married and have children. They made the remark, however, that their results do not indicate that there is a difference in promotion between women with or without children. The implication of the study is that even though there is a correlation, causality is difficult to prove. On the one hand, having children might impede the academic career for women. On the other hand, the women that are most devoted to their careers might choose not to have children, but would pursue a career to the same extent even if they did. The selection bias is very difficult to control for and consequently it is impossible to know whether children *per se* affect the careers for women, or alternatively, that women more devoted to their career are less likely to have children (Ginther & Kahn 2014).

Research on the Swedish academic labour force—doctoral graduates within the faculties of humanities, social sciences, natural sciences and medicine—indicated that children only had a negative effect on the individuals that had left rather than stayed within academia. Marriage had a positive effect on wages for both genders, regardless if the doctoral graduates had remained at universities or not (Amilon & Persson 2010). Similar to the study of Ginther and Kahn (2014), there is an issue of establishing causality. However, even when controlling for family factors—such as marital status and children—there still seems to be a gender difference in the likelihood of promotion that have yet not been explained, i.e. the unexplained gender promotion gap.

3.2.4. The unexplained promotion gap

Publications and family factors have in most cases failed to explain all gender differences in promotion, which has resulted in further studies on the search for factors that can account for the unexplained gap. Boschini and Sjögren (2007a) took on a preference-based perspective in a study on co-authorship and found patterns that could reject the hypothesis on gender neutrality in team formation in economics. In other words, the results showed a gender preference, i.e. that men prefer to work with other men, whereas women prefer to work with other women. The findings were used in a follow-up paper on the low number of female professors in economics, in which they found that factors such as gender differences in age, department and subfield of economics did not seem to affect the team formation. Their conclusion was that academic economists seem to prefer to research with same-sex co-authors and that the higher fraction of female there are within a research field, the more gender segregated the team formation is (Boschini & Sjögren 2007b).

Jonung and Ståhlberg (2008) summarised the four main explanations for the gender promotion gap that are brought up in the literature and then applied them to the Swedish case. The first one—preferences and family obligations—have already been discussed above. Secondly, they

brought up societal institutions, which include features of distinct labour markets as well as policies—such as family policies, social policies and tax policies—with the common attribute that they all affect the incentive structures for women to pursue top-careers within academic economics. For instance, the authors argued—in a Swedish context—that the generous regulations for parental leaves might contribute to that women tend to have longer absence from work, which is particularly difficult when pursuing a career in a competitive environment, such as academia.[13] Additionally, the combination of high income tax base and relatively high wages at the lower end of the wage distribution may also contribute to lower incentives for women to pursue top-level careers, since the monetary rewards are less extensive than in many other countries. They described the Swedish societal institutions as being a "double-edged sword": On the one hand, the family policies facilitate the combination of work and family. On the other hand, the policies do not provide incentives for women to commit to their careers (for reference see also Albrecht, Björklund & Vroman 2003).

As a third potential explanatory factor for the gender promotion gap, Jonung and Ståhlberg (2008) discussed the internal structures within the departments of economics. As shown by Stock (2006) women tend to engage more in teaching and administrative work than men do, which leads to fewer publications and therefore also less scientific merits. The absence of female role models and mentoring in combination with difficulties in obtaining professional networks are also parts of the internal structures that constrain women in pursuing top-careers within academic economics.[14] Finally, Jonung and Ståhlberg (2008) also suggested that gender discrimination could be in play at the departments of economics.

3.2.5. Discrimination

Ginther and Kahn (2004) summarised the grey area between the unexplained factors behind the gender promotion gap and discrimination of women accordingly:

> "All studies of gender differences come down to the interpretation that one places on an unexplained coefficient on a gender variable or differences in coefficients when estimates are allowed to vary by gender. Such studies always leave a reader grasping for possible alternative variables, whether potentially observable or not, which might fill the gap and offer an explanation not based in discrimination. Any satisfactory explanation for the gender gap in economics based on women's behaviour or choices must account for why it does not apply equally in many other scientific disciplines."

[13] For reference see also Ruhm (1998), who showed that even though extensive parental leave entitlements in Europe increase the likelihood of women entering the labour market, it also reduces their relative wages.
[14] For discussion of the importance of mentoring and networks see section 8.

The exceptionality of economics is pointed out by Jonung and Ståhlberg (2009) as well. They question the notion that the underrepresentation of women would be a result of different preferences in top careers; if preferences are the underlying factor, why are other academic disciplines more gender-balanced?

Kahn (1995) found that there were gender differences in promotion—between individuals from equally ranked universities at the same point in time—that could be explained by neither family factors nor the number of publications. Even though she believed that some evidence pointed toward the explanation being a mix of choice and discrimination, she reasoned: "As other explanations fail, it becomes more likely that gender differences are the result of discrimination, either direct or subtle, against female colleagues" (Kahn 1995). However, in order to conclude that the gender promotion gap is the result of discrimination, Ginther and Hayes (2006) noted that all variables that are related to promotion needs to be controlled for, which would be very difficult. At the same time, the authors maintained that they could not rule out discrimination as a cause for the promotion differences either.

There are also studies that have failed to find signs of discrimination. Beckman and Schneider (2013) studied the relationship between promotion and publications in Germany and failed to reject the hypothesis "There is no gender bias against women in the university recruitment process", i.e. they could not find a female discrimination effect. In a Swedish context, however, Wennerås and Wold (1997) showed that the peer-reviews of the Swedish Medical Research Center (MRC) systematically underestimated the performance of women while overestimating the performance of men. Although this study surveyed the field of bioscience rather than economics, as well as considered applications for postdoctoral fellowships rather than promotion, it showed that discrimination did take place in a country like Sweden, which is perceived to offer equal opportunities regardless of gender. In this paper, we want to see if there are any signs of discrimination within the field of economics in Sweden today.

4. Method

In the following section, our chosen method for approaching the research question is presented. We first outline a discrimination model defined by Cain (1986) that is combined with a Linear Probability Model (LPM). The LPM is used due to our binary dependent variable, promotion, an event that either occurs or not. In a second step, the empirical approach of analysing event histories by Allison (1982; 1984) is applied to the model that will constitute our framework.

4.1. Model

In this paper, we will build a competitive, taste-based model based on the model of Cain (1986). The model, denoted as "Model I", was presented in the first volume of the *Handbook of Labor Economics* and outlined in the following relationship:

$$Y = \beta X + AZ + \varepsilon \tag{1}$$

Cain defined the dependent variable Y as wage, the independent variable X as a vector for productivity and the independent variable Z as representation for a membership in the studied majority group. A general description of Model I would be that it is designed to capture differences (Z) in labour market outcomes (Y) for equally productive workers (X). If the coefficient for Z is positive ($A > 0$), discrimination is at hand, whereas Cain consider the opposite case to be $A = 0$, rather than $A < 0$ (i.e. there is no "reverse discrimination").

The Cain model of discrimination is applied to the gender promotion gap accordingly:[15]

$$Promotion = \beta X + AFemale + \varepsilon \tag{2}$$

The dummy dependent variable signifies that—in a multiple linear regression—the model is constructed as a Linear Probability Model (LPM), i.e. the dependent variable expresses the probability of an academic economist to be promoted. Any change in a covariate therefore changes the probability that promotion will occur, holding all other factors fixed. Given the linear characteristic, the model predicts that the parameters linearly affect the probability of promotion, which means that the partial effect of each covariate on the dependent variable is constant (Wooldridge 2013). In accordance, by combing Cain's model of discrimination and the LPM the following relationship can be derived, where E is the expected value and P is the probability:

$$E(Y) = \beta X + AZ + \varepsilon \tag{3}$$

$$E(Y) = 1 \times P(Y = 1) + 0 \times P(Y = 0) = P(Y = 1) \tag{4}$$

$$E(Y) = \beta X + AZ + \varepsilon = P(Y = 1) \tag{5}$$

As follows, our model shows the effect of gender (Z) on the probability of promotion (Y). In order to answer our research question—*Is there a gender difference in promotion given a certain level of productivity for academic economists in Sweden?*—we are interested in if $A \neq 0$. A negative

[15] The dependent variable *Promotion* = 1 if promotion occurs and = 0 if it not. The variable *Female* = 1 if the individual is identified as a woman, and = 0 if the individual is identified as a man. We acknowledge that there are individuals that do not identify themselves as neither of the genders, alternatively both, but the binary distinction is necessary for the model.

coefficient ($A < 0$) would signify that the characteristic *female* reduces the likelihood of promotion, whereas a positive coefficient ($A > 0$) would implicate the opposite.

4.2. Empirical strategy

We will use an empirical strategy outlined by Allison (1982) in the article *Discrete Time Methods for the Analysis of Event Histories*. Event History Analysis (EHA) is used for analysing the probability of an event to occur. In the EHA, each time period *t* for an individual *i* is treated as a single observation, leading to a panel data set where each individual contributes with a set of observations. When the event has occurred in time period *t*, the individual will not be included in the data set in the following time period $t + 1$ since the individual is no longer *at risk* for an event to occur (Allison 1984).

Conceptually, the method of EHA signifies that a regression for every time period is run and then all the regressions are pooled into a single one—but in practice, it is done instantaneously with a single regression. This method is appropriate to use in the study of causal effects due to the inclusion of a time frame, which gives the possibility of holding some factors fixed while simultaneously allowing for others to change. As a consequence, it is possible to isolate which changes in the time-varying covariates that affect the occurrence of an event and how these effects depend on the time-fixed variables. By pooling all the time periods together one can also gain more power and preciseness in the estimates.

Most importantly, the EHA provides solutions to the issue of "censored" individuals. A censored individual can be categorised as either left or right censored, which means that there is a lack of information on the individual either before (left) or after (right) the observation period (Allison 1984). In this study, all individuals are observed from the year they received their doctoral degree, which provides a level playing field. Consequently, we argue that left censorship—the more problematic kind—needs not be considered.[16] Right censorship, on the other hand, is an issue since there are researchers that are not appointed to associate professor during the course of our observation period. We cannot know when or if they will be promoted. In order to deal with right censorship—a matter that will be more closely discussed in section 5.2.—the model constructed needs to observe each individual in every time period.

As follows, we need to use EHA rather than a traditional multivariable linear regression model. In the use of the latter method, it would be necessary to exclude all individuals that are not promoted, which would involve two severe drawbacks. The first is that it would reduce the number of observations considerably. Secondly, and more importantly, the approach could lead

[16] With the note that the starting point of doctoral degree is not perfect since network effects, journal publications before the doctoral degree is finished and other factors may distinguish the individuals from each other even at this level.

to an attrition bias since the exclusion of these individuals might distort the effect of the independent variables (e.g. gender) on the dependent variable (promotion) (Allison 1984). If one gender systematically is not promoted despite the same level of productivity as the other, the model will fail to capture the gender difference since many individuals with explanatory value are excluded. We therefore argue that EHA should be used in order to avoid the issue of censored individuals.

4.3. Critical discussion

4.3.1. Model of discrimination

The strength of the model of discrimination, reported by Cain (1986), is that it provides straightforward inference of direct discrimination. There are however a number of drawbacks, due to its simple construction. Firstly, the model incorporates productivity as an exogenous variable. The implication is that potential discrimination, that affects the respective productivity of women and men, is not considered. Given that our purpose is to study gender differences in promotion *conditional on* productivity, we argue that factors affecting the productivity fall outside the scope of this paper.

Secondly, findings of discrimination in the model neither prove nor disprove the existence of discrimination at an individual level, but rather on average in an aggregate labour market. The outcome can therefore be interpreted as an indirect measure of a potential general prejudice held by the market. Thirdly, if the findings indicate that there is no discrimination, there is a possibility that the result is due to two opposite effects. For instance, if discriminating actions toward one group in the past has been compensated for in later time periods through affirmative actions, the two effects would balance each other out. As follows, the model would not show any signs of discrimination (Cain 1986). In conclusion, we argue that the model of discrimination, despite its disadvantages, is a first important step in the process of studying the Swedish gender promotion gap within the departments of economics in combination with levels of productivity.

4.3.2. Linear probability model

In this section, we will discuss three potential issues of the LPM. The first two are related to the Bernoulli structure of the error terms, which signifies that conditional on $E(Y) = P(Y = 1)$, the variance of the error term is defined as: $Var(e) = P(1 - P)$. As follows, two of the Gauss-Markov assumptions are violated. Firstly, the error terms cannot follow a normal distribution in the LPM (see Figure 2, Appendix I). Consequently, inference in the form of t-tests and F-tests is not possible in its standard form (Wooldridge 2013). The second issue is that the distribution of the error terms will be heteroskedastic by definition and therefore not efficient, since the Gauss-Markov assumption of homoskedasticity is violated. We will correct for these violations of the Gauss-Markov theorem by using robust standard errors (Wooldridge 2013).

There is also a third issue that cannot be as easily corrected for; namely that the predicted values need to be in the range $[0, 1]$ in order for interpreting them as probabilities (Wooldridge 2013). As a consequence, the values of our regression models need to be predicted before analysing the implications of our findings.

Another option is to use an alternative method for handling the dependent dummy variable. The probit and the logit models are two non-linear models that often are brought up in the literature (see e.g. Wooldridge 2013; Greene 2012; Holm, Ejrnæs & Karlson 2014). Both of the methods are considered more sophisticated than the LPM due to the fact that they do not assume linearity between the dependent and the independent variables. This notwithstanding, the LPM is widely used in economics today, particularly in the comparison of group differences in coefficients (Green 2012; Holm, Ejrnæs & Karlson 2014). Between 2007 and 2011, 9% of the articles published in the *Quarterly Journal of Economics* used the LPM and more than half of these used it in order to estimate group differences by comparing coefficients (Holm, Ejrnæs & Karlson 2014). Despite its drawbacks, the LPM is in conclusion still appreciated due to its straightforward structure and interpretations and often mentioned as an appropriate way of estimating covariate effects (Angrist & Pischke 2009).

Our purpose is to study potential gender differences in promotion and therefore we argue that the LPM will suffice in order to answer our research question. Due to its simplicity in terms of construction and interpretations it will constitute our main model. Additionally, we will use the probit and logit models as complementarities.

4.3.3. Event history analysis

Even though the use of EHA solves some of the problems brought up in section 4.2. there are also drawbacks of the empirical approach that need to be considered. The use of EHA signifies that differences in time cannot be analysed due to the construction of pooling all observations. For instance, we can neither observe if the variable for gender is more or less important at earlier or latter stages of an academic career, nor if certain levels of productivity are more or less important at different time periods. However, since a single time period includes relatively few appointments, we believe that such time-separated coefficients are not valuable on their own due to impreciseness in their estimates. By pooling all the time periods we can instead gain more power and preciseness in order to generate coefficients that can be applied generally and over time (Allison 1984).

5. Data

In this section, the details on the data used in the study will be outlined. Firstly, we describe the method for data collection and present the model data set as well as the two additional data sets used for analytical purposes. Next, the construction of the model data set is provided together with the details on dealing with right censorship. In the third subsection, the variables of the main model are presented. Finally, the potential issues regarding the data are discussed.

5.1. Data collection

Our data set was collected in three steps:

Firstly, we assembled a list of the departments of economics at Swedish universities and sent emails to prefects and administrators, asking for a list of the individuals with a doctoral degree in economics that had held a position at their department from 1990 or later (alternatively as far back in time as their personnel records go).

Next, we wanted to find out when the researchers had received their doctoral degree and when they had been promoted by assembling CVs. In the cases the CV was not available on the university's or a personal webpage, we sent an email to the person in question and asked if they could send us their CV or reply in an email.

The third step was to collect information on the publications, mainly via the CVs, but also through web-based Scopus, Web of Science and Google Scholar as supplements. We were interested in what year each publication was published in as well as in which journal and the number of co-authors. Finally, the publications were weighted according to the respective procedures derived from the ABS Guide and Tinbergen Journal List, further described in the section 5.3.2. and in Appendix IV.

The data was collected between February-April 2016. We have excluded all publications and promotions occurring after 31th of December 2015. All data was anonymised early in the process of setting up the data set.

5.2. Data description

5.2.1. Model data set

Our main data contains a unique set of 245 academic economists that received their doctoral degree between 1990 and 2015. The following table shows the distribution of the sample divided by gender and academic rank:

TABLE 1: SUMMARY STATISTICS

	Assistant Professors	Associate Professors	Total	Percentage
Female	46	22	68	27.76
Male	91	86	177	72.24
Total	137	108	245	100.00
Percentage	55.92	44.08	100.00	

The gender distribution for the sample researchers across universities is shown in Table 7 (Appendix I). The average time for being promoted is 5.5 years for men and 7 years for women (see Figure 4, Appendix I). Figure 5 (Appendix I) shows the sample distribution of the years the academic economists received their doctoral degree. The number of men is larger than the number of women all years except for in 2015. There are no females between the years 1990 and 1997. Figure 6 (Appendix I) shows the distributions of appointment to associate professor. Similarly to Figure 5, the distribution of female academic economists is skewed to the later part of the time span we look at.

The first step in processing our data was to handle right censorship by creating an observation for each individual in every time period they belong in the data set. We have documented the researchers in every time period *t*, where the year the individuals received their doctoral degree represents time period 0. The following time periods are *t* years after the doctoral degree was received. An individual can be removed from the data set in one of the following three ways: by promotion, by leaving academia, or—if that the last year for observation is 2015 and the person has neither been promoted nor left—by becoming censored. Consequently, a researcher that is in the data set for three time periods (i.e. for time periods $t = 0;\ 1;\ 2$) will contribute with three observations. As follows, the researcher is removed either due to promotion in time period 2, leaving academia in time period 2, or by being censored. In the latter case, it follows that the researcher received its doctoral degree in 2013, so the last year for observation (in time period 2) is at the end of our observation period (2015).

For each time period *t,* we have collected the individuals' accumulated research output and where they have been employed each year up until they are promoted, leave academia or are censored. As follows, the data set is an unbalanced panel data set (shown in Figure 3 in Appendix 1). As outlined in section 4.2, all time periods will be run in a single regression, leading to that our sample size is magnified to 1,488 observations, which is the total number of time periods all researchers are included in the sample. The distribution of promotions and researchers at risk for promotion in every time period is shown in Table 10 (Appendix I).

5.2.2. Additional data sets

One of the two additional data sets includes complete information on the publications of the 245 researchers in our sample. The information on publications that we have collected is in which year and what peer-reviewed journal it was published in as well as the number of co-authors in every paper.

We have collected a total of 2,563 papers, with the note that a paper that is published by several co-authors included in our sample will appear multiple times. 450 (17.6%) of the publications have a female author and 2,113 (82.4%) have a male author. Table 12 (Appendix II) shows the number of co-authors each publication has, where the publications with five or more co-authors have been grouped together. Table 13 (Appendix II) shows how the average number of co-authors varies between women and men, as well as how the number of co-authors has varied over time. Table 14 (Appendix II) shows a regression of the number of co-authors on gender and year for publication.

The other additional data set is used in order to measure the productivity level—through accumulated research output—for the academic economists five years after they received their doctoral degree. There are 177 academic economists in our sample that have been in academia for five years or more. Table 8 (Appendix I) shows that the women in our sample have a lower average publication scores than the men after five years.

5.3. Variable description

5.3.1. Dependent variable: Promotion

The dependent variable of our model is a dummy variable that is coded 1 if person *i* has been promoted in time period *t* and coded 0 in all other periods. We will centre this paper on the promotion from assistant to associate professor.

There are various titles used within Swedish departments of economics, as mentioned in section 2, which we have chosen to group into three categories: assistant professor, associate professor and full professor. The category of assistant professor includes—besides the American system's title assistant professor—post-doctoral researchers, lecturers and equivalent titles. We consider an assistant professor to be promoted if the person is either appointed to associate professor or to *docent*. We will use the title associate professor for the remaining part of the paper.

We argue that associate professor is the most suitable step since the requirements for the promotion is standardised both within and also across departments of economics, as opposed to the earlier stage of employment within academia, where there are several positions that are not clearly hierarchical and differ across time as well as departments.

Visiting titles have not been considered as promotions since these are temporary and not permanent. The academic economists that have held a position as associate professor or higher as their first position at a Swedish university—i.e. have been promoted outside of Sweden—have been excluded from the sample. We are looking at the relationship between promotion and publications within Swedish academia. Consequently, we argue these observations are not of interest. Researchers that have held assistant professor as their first position at a Swedish department, but received their doctoral degree in another country, have been included in the sample.

A note to make is that through the choice of dependent variable, we do not separate people that actively choose to leave academia from those that are unobserved in time period t + 1 (i.e. year 2016). The main issue regarding individuals that leave academia is that we cannot capture the reason why they leave by studying their CVs. Since there are only 18 individuals that have left academia in our sample (where 15 are men and 3 are women), we do not believe that this will distort any of our results.

5.3.2. Independent variable: Productivity

We will proxy an individual's level of productivity through research output. Research output is measured through the quantity of publications alongside proxies of their quality. The quality proxies we have used derive from rankings used in promotion processes by the universities in the sample (for reference see Appendix IV). We argue that research output in the form of publications is a suitable proxy since it is the kind of labour output—unlike e.g. books or teaching hours—that matters in practice when evaluating promotion decisions to an all higher extent, as discussed in section 2.3.1.

By covering different ways of measuring the quality of the research output, we expect to avoid potential measurement bias to a large extent. We have used a total of 10 productivity indicators to measure the quality of each publication in order to fully capture the researcher's productivity. The indicators are derived from two lists of journal ranking: the Tinbergen List and the Academic Journal Guide. Stockholm School of Economics uses the Academic Journal Guide, while the University of Gothenburg, Lund University and Uppsala University use the Tinbergen List. The other universities have been contacted but either claimed to not have formal qualifications or chosen not to respond us. Since our purpose is to examine if there are any gender differences in promotion, the measurements we have chosen to use are based on the same journal rankings as the universities use.

We have two variables based on the metrics from the ABS Guide—which will be called ABS-variables—and eight variables based on an extended version of the Tinbergen List—called the

AIS-variables[17]. The major difference between the two journal rankings is that the ranking in the ABS Guide is—in addition to citation metrics—based on peer reviews as well as on editorial and expert judgments, whereas the Tinbergen List is purely based on citation metrics. Consequently, the latter has been extended to include journals outside the actual list, which is impossible in a list based on expert judgments. The respective journal ranking lists are further outlined in Appendix IV.

TABLE 2: DESCRIPTION OF VARIABLES OF PRODUCTIVITY

Variable	Description
ABS	A publication in a journal ranked 4* is coded 2 and a publication in a journal ranked 3 or 4 is coded 1
ABS/n	Variable ABS—linearly adjusted for number of authors
AIS	Raw AIS
AIS/n	Raw AIS—linearly adjusted for number of authors
AIS_good	Raw AIS where all publications with a below-average score ($AIS < 1$) are coded 0
AIS_good/n	Variable AIS_good— linearly adjusted for number of authors
AIS_good_top	Publications with an AIS between 1 and 2 are coded 1, and publications with an AIS equal to or above 2 are coded 2
AIS_top	Raw AIS where all publications with an AIS below 2 are coded 0
AIS_top/n	Variable AIS_top—linearly adjusted for number of authors
AIS_top_dum	Dummy variable where a top publications ($AIS \geq 2$) are coded 1 and all other publications are coded 0

The ABS variables are in line with the journal ranking used by Stockholm School of Economics, rather than the full ABS ranking from 1-4*. The reason is that journals ranked within the categories 1 and 2 are not considered in the promotion process and therefore it would be wrong to equal e.g. three papers in category 1 with one paper in category 3.

The Tinbergen List values a publication using the raw Article Influence Score of the journal it is published in. The sample universities have different routines in valuing papers published in journals that are not included in the Tinbergen List, namely that some choose to extend the list and others do not. We have chosen to include all publications in journals that are listed in Thomson Reuters' Journals Citations Report (JCR)—and therefore to extend the Tinbergen List—since we believe that it is important to capture potential gender differences in journal publications. If one gender is more prone to publish in journals that fall outside the ABS Guide and the Tinbergen List, this difference is important to capture when assessing productivity. In order for comparison across the ABS Guide and the Tinbergen List, we have constructed AIS variables that only contain "good" and "top" publications, coded in the same way as the ABS variables. Additionally, there are variables adjusted linearly to the number of co-authors.

[17] AIS stands for Article Influence Score, which is the citation metric that the journals are ranked after in the Tinbergen list. See Appendix IV for further information.

5.3.3. Time variables

Our empirical analysis is based on a data set of academic economists in Sweden that received their doctoral degree between years 1990 and 2015. The time frame was chosen on two grounds. On the one hand, we want to have relevant data to look at. On the other hand, we need to go sufficiently far back in time to have a large enough sample as well as allow for the promotion process to take more than a few years. We believe that the chosen time-span is reasonable in order to counter-balance the benefits and costs from including respectively excluding more years.

We do not think that top publications have been as an important factor behind promotion decisions as they are today, which is why we have excluded years before 1990. The number of female researchers that received their doctoral degree before this time period is very low, which is why the inclusion of earlier years would not help in order to capture gender differences in promotion. We acknowledge that the time-span of 26 years still is a long period in which the procedures and requirements for promotion have changed, i.e. the time variable might affect the probability of promotion. We have therefore included two variables in order to capture the effects of time: year for doctoral degree and number of years since doctoral degree (counted in time periods t).

We will also control for the year the academic economists received their doctoral degree in order to compare researchers within the same cohort, since we believe the requirements for promotion might differ across the years we study. At the same time we need to avoid losing too much explanatory value by an excessive amount of dummy variables. The years the researchers received their doctoral degree have been binned into five indicator variables: 1990-1994, 1995-1999, 2000-2004, 2005-2009 and 2010-2015.

The time period t is constructed as a series of indicator variables with one variable for each year since the individual received its doctoral degree (the year for doctoral degree is time period 0). We control for time period in order to compare the probability of promotion for researchers in the same time period after their doctoral degree since we can observe from the data, that promotions are more likely to occur in given years after doctoral degree (for reference see Figure 4, Appendix I).

5.3.4. Departments

The data set is restricted to individuals with a doctoral degree in economics that have been employed at one of the following six universities in Sweden at some point in time between years 1990 to 2015: University of Gothenburg (GU), Lund University (LU), Stockholm School of Economics (SSE), Stockholm University (SU), Umeå University (UMU) and Uppsala University (UU). We have chosen the universities on the basis that they combined accounted for 92% of all

doctoral graduates in economics between years 1990 and 2010 (Table 1, Appendix I). In addition these have also been the six most prominent universities in terms of publishing research in economics journals (Lindqvist 2003).

We will include indicator variables at a departmental level—including one variable for departments that are not in the sample—which results in a total of 10 indicator variables.[18] The sample from Stockholm School of Economics is divided into two departments: Department of Finance and Department of Economics. Stockholm University is divided into three departments: Department of Economics, the Institute for Economic Studies (IIES) and the Swedish Institute for Social Research (SOFI).[19] We argue that we need to control for departments in order to adjust for factors such as differences in requirements for promotion.

We motivate the selection of the six universities based on their numbers of doctoral graduates as well as number of employed academic economists, which suggests a focus on research. As Lindqvist (2003) stated, the official main objective for IIES at Stockholm University is to publish in international economic journals. It is reasonable to assume that the employees at smaller universities and university colleges in first hand have other responsibilities and possibly more focus on teaching than on research. We argue that the different priorities affect promotion processes as well as the significance of publications in that process. The implication is that it will be more complicated to isolate the effect of gender on promotion if we include all universities and university colleges, since promotion processes will differ to a large extent.[20]

We are only interested in promotions within academia, which is why we have excluded research centres from the sample. However, in the distinction whether a person have left academia or not, we have decided that a person that leaves for a research centre but then comes back to a university has not left academia. The reason is that an individual that leaves academia for a research centre will continue to publish papers. If she or he returns to academia, the person can be promoted based on research output produced at the research centre. However if that researcher does not return to a university during the course of our observation period (1990–2015), that individual is coded as having left academia since we do not know if or when she or he may return.

[18] These are GU, LU, SSE-DE, SSE-FI, SU-DE, SU-IIES, SU-SOFI, UMU, UU and Others

[19] Only researchers with a doctoral degree in *economics* have been included, i.e. researchers in sociology at SOFI have been excluded

[20] Note that the selection of the six most prominent universities in economic research might lead to a stronger relation between publications and promotions than what would have been the case if we had studied the entire population of Swedish universities. Since these universities however constitute the main labour market for academic economists, we believe that they will still be representative for the labour market as a whole.

5.4. Potential Issues

Our ideal data set would contain full information—including perfect measures of productivity and promotion—on every academic economist in Sweden between years 1990 and 2015. We have been forced to proxy these variables, since we have neither complete information nor perfect measures. In this section, we will elaborate on the most relevant issues related to our dependent variable *promotion* and the main control variable of interest—*productivity*. We will also discuss the potential problems regarding attrition and biasedness in our samples.

5.4.1. Docent as a proxy for promotion

We stated in section 5.4.1 that the different academic grades have been categorised into three levels—assistant professor, associate professor and professor—and that the focus of this paper is on the promotion step from assistant professor to associate professor. The category associate professor contains the researchers that either hold the title associate professor, or that have received the Swedish *docentkompetens*. The latter of the two is only a proxy for promotion. A listing of either the title associate professor or the academic grade *docentkompetens* in the CV is therefore regarded as a promotion to associate professor in that given year.

We see a potential problem in the fact that the universities in our sample have different categorisations. While the majority of the departments translate the Swedish title *docent* to associate professor, the universities that have a tenure-track system use the title associate professor, which they equal to *docent*. As discussed in section 2.2.1., the requirements somewhat differ between *docent* and associate professor, which makes comparisons across universities that use distinct titles problematic. The same goes with comparing promotions across years since requirements and processes have changed at many departments. We do however control for both department and year so we expect that the differences will not create any biasedness. Additionally, the control for department signifies that adjust for the fact that the departments in Sweden have distinct requirements that need to be met before being appointed to *docent*.

Another issue regarding the variable *Promotion* is that in order to receive the title *docent*, the researcher needs to apply for the appointment. The implications of voluntarism indicate that in order for associate professor to be an unbiased estimate of promotion, women and men must be equally likely to apply for the appointment at a given level of productivity. Behavioural studies on gender differences show that men in general are more willing to take risks (Croson & Gneezy 2009) and are more competitive (Bertrand 2010; Bosquet, Combes & García-Peñalosa 2014; Niederle & Vesterlund 2007) than women. Our sample contains men and women that have chosen to remain within academia despite the fact that the field is competitive as well as risky, due to the lack of guarantee of a permanent position in the future. We therefore argue that it is reasonable to assume that gender differences in competitiveness and risk-taking are small within the departments of economics, in which case there would not be an issue to proxy promotion

through *docentkompetens*. We acknowledge that the issues brought up in this section are due to our choice of proxy for promotion; this notwithstanding we argue that we have chosen the most suitable proxy for promotion at the departments of economics.

An alternative approach would be to study the probability of employment within the academic world after receiving the doctoral degree. As mentioned, the tenure system is not applied at all of the Swedish universities, and there is a range of different titles that are used. We would end up having to either sum up all the titles for the first employment or choose which one of the many titles that should be considered the first position within academia. For reference, the Swedish title *lektor* is translated to lecturer, associate senior lecturer or assistant professor at different departments in our sample—showing that a ranking of the titles would be arbitrary. Associate professor and *docent* are however fairly standardised both over time and across departments.

Another issue with the first level of employment is the risk of self-selection bias, i.e. the probability of employment is dependent on the individual's preferences in staying or leaving the academic world. If there were a gender difference in the preferences, there would be a bias. The effect could possibly be captured but we would need information on the doctoral recipients that applied for a position within academia, assuming that the individuals that did not apply for a position were not interested. We argue that by focusing on the promotion step from assistant professor to associate professor, the problem of self-selection bias disappears to a large extent, since we can assume that the researchers that have chosen to stay within academia are interested in a promotion to associate professor.

Finally, the only research output that a newly graduated doctoral recipient has produced is—at least in most cases—the doctoral thesis. Consequently, there is no way of measuring productivity—which we believe is of great importance in order to compare observationally equivalent researchers—and we maintain that the appointment to associate professor is the most suitable proxy for promotion.

Another alternative approach would also be to study the appointment to full professor. The main issue is empirical: the number of female professors in economics in Sweden is too low. The approach would most likely signify an extension of the scope to a cross-country study, in which we would lose some of the "ceteris paribus" of the researchers' characteristics—e.g. the human capital and the quality of the education. From another point of view, it has been shown that the leakage of women is larger at the step from assistant to associate professor, rather from the associate to full professor. The former step is often also accompanied with the first permanent employment and therefore a crucial step for every researcher that wants to remain within academia (McDowell, Singell & Ziliak 1999).

5.4.2. Measuring the level of productivity

A taste-based discrimination model requires information on the individuals' skills, which in turn requires an indicator that can capture the true level of productivity. The most difficult part of measuring gender gaps in the labour market is reasonably how to correctly capture the level of productivity. There are however few—if any—places where productivity is as documented and scrutinised as in the academia, namely through research output.

There is an extensive field of research centred on bibliometrics, i.e. the statistical analysis of publications (for reference see Bergstrom, West & Wiseman 2008; Chang & McAleer 2014; Ellison 2010). Henreksson and Waldenström (2011) showed the importance of comparing results from different metrics when measuring research output. By comparing weighted research output according to the procedures of different metrics they received productivity estimates that varied extensively depending on the metric. In order to reduce the potential bias from this issue—acknowledging that research output can never be measured in a completely objective fashion—we have composed several different versions of our productivity measurements for comparison. We will particularly focus on how the estimated productivity changes when including journals not within the field of business administration or economics, when categorising journals in distinct ranking schemes and when adjusting for the number of co-authors.

We argued in section 5.3.2 that research output should be used as a proxy for the researchers' level of productivity. We also argued that this output should be assessed according to the measurements that the universities in our sample use. The drawback from this approach is that we will not capture potential gender discrimination in how productivity is measured. A possible scenario could be that the publication metrics favour—respectively disfavour—certain fields that a higher fraction of one gender is researching on, which would cause biasedness. Although the possible presence of gender discrimination in the measurements of productivity is an issue, the aim of this paper is to study gender differences in promotion. We argue that the most suitable way to assess publications is to use the same procedure as the universities use. In order to reduce potential bias—as well as for the sake of comparison—we have computed extensions of the metrics used.

We have computed ten variables for productivity, out of which four are adjusted for co-authors and the remaining are not. The literature of bibliometrics on the treatment of co-authors primarily uses two approaches: the full credit approach and the per capita approach. In the first approach, the number of co-authors in each article is completely neglected, whereas the second divides the publication score with the total number of authors (1/n) (for reference see Hilmer, Hilmer & Ransom 2012). Ellison (2010) suggested a division of the publication score by an

adjusted value ($1/n^c$ where $0 < c < 1$)—rather than by the actual number of authors—in order to better capture how co-authorship de facto is valued in the promotion process.

We have chosen to create variables based on the full credit approach as well as variables adjusted for co-authorship by the per capita approach (1/n) but not adjusted according to Ellison's (2010) approach. The motivation is that our purpose is not to investigate the actual credits that an author receives—or should receive—from a publication, but rather if the credits differ across gender. We believe that the advantage of using the full credit and per capita approaches is that they represent the "extreme" cases, which should capture possible gender differences in co-authorship to the largest extent. Since the universities do not adjust publication scores for the number of co-authors, the unadjusted measurements are our main variables of interest.

5.4.3. Attrition

Given the scope of this paper, our main source of concern regarding attrition and biasedness lies in the fact that the CVs of the researchers that are currently employed at one of the universities have been easier to collect than the CVs of the researchers that have left. Additionally, the further back in time, the harder it has been to find updated contact information.

We have not been able to collect any CVs for females between the years 1990 and 1997, resulting in a distribution of women that is highly skewed to the latter half of the time frame. If the lack of female academic economists in the early 1990s is the result of discrimination in the promotion process, we have an attrition bias. The data on doctoral graduates from Statistics Sweden, however, show that only 22 women received their doctoral degree in economics within that time span. Given the low number of females and that some of them were never employed within academia, we expect that the potential attrition is limited.

5.4.4. Excluded variables

In the literature review, we showed that marital status and children are two factors that frequently appear in the research on gender differences in labour market outcomes. We have chosen to exclude family-related variables because we expect severe measurement errors due to lack of information in the CVs. Not all researchers include family-related information in their CVs, which could lead to potential bias, e.g. if one gender reports parental leave to a higher extent in their CVs. We argue that the severity of including a family-related variable that suffers from measurement errors outweighs the potential omitted variable bias. Additionally, we expect to capture some of the family-related effects through our measure of productivity. A researcher on parental leave will not write on any papers—or at least, not to the same extent as usual—and the slowdown in productivity will be incorporated in our main model.

Another possible omitted variable bias may arise by not controlling for field of research in our model. We know that there is an occupational segregation on a societal level as well as in the academic labour market, which opens up for the possibility that segregation is present even within the fields of economics (for reference see Boschini & Sjögren 2007a; 2007b). There are many sub-fields within the discipline of economics is extensive and the importance of publications as well as practices for citations varies a lot across the different fields.

We have chosen to not include the field variable for three reasons. First of all, if we control for field in order to capture different citation practices, we might also remove differences that exist across fields due to the fact that certain fields might actually be more or less *relevant* for the current research. The AIS metrics that we use do also incorporate and normalise the effect of different citation practices across fields and should therefore already capture the field effect to some extent. Secondly, the categorisation of researchers into different fields would be arbitrary. We could make the distinction between theoretical or empirical researchers, as well as researchers focusing on macro economy or micro economy for example. Regardless, there will always be several researchers—and fields of economics—that are in the grey area between categories. Thirdly, if there is a gender difference in the probability of promotion depending on field, the effect is not captured by the formal requirements for promotion used by the universities in our sample. We therefore exclude the variable since we aim to use the same criteria as the universities.

6. Model specification

In this section, the specifications of the model used to study our research question—*Is there a gender difference in promotion given a certain level of productivity?*—will be outlined. The model is constructed as combination of the Cain model of discrimination, the linear probability model and the Allison method of analysing event histories, previously presented in section 4. The model is specified accordingly:

$$Promotion_{ityd} = \alpha + \delta Female_i + \beta Productivity_{it} + \theta_t + \theta_y + \theta_d + \varepsilon_{ityd}$$

The dependent variable *Promotion* is coded 1 if individual i is promoted in time period t, and 0 if not. When the coefficient for *Female* is separated from zero ($\delta \neq 0$), there are gender differences in the likelihood of promotion—conditional on *Productivity*. The variable *Productivity* is coded as the accumulated publication score for individual i in time period t.[21]

[21] If the individual has published papers before receiving the doctoral degree, its previous research output is accumulated at time period 0.

The time period t is created as a series of indicator variables (θ_t) with one variable for each year since the individual received its doctoral degree (where the year for doctoral degree is $t = 0$). Every researcher is therefore compared with other researchers in the same time period t after their doctoral degree, in accordance with Allison's method. To control for the actual year for doctoral degree we have also included a series of indicator variables (θ_y) that compares researchers within the same cohort (1990–1994, 1995–1999, 2000–2004, 2005–2009 or 2010–2015). Since promotion practices and requirements might differ across departments we include an indicator variable (θ_d) for each department.

TABLE 3: DESCRIPTION OF VARIABLES

Variable	Description
Promotion	Dummy variable that is coded 1 if promoted and 0 if not
Female	Dummy variable that is coded 1 if female and 0 if not
Productivity	Accumulated research output
(θ_t) *Time period*	Factor variable for time period
(θ_y) *Year*	Factor variable for year for doctoral degree
(θ_d) *Department*	Factor variable for department

7. Results

TABLE 4: PROMOTION ON GENDER AND PRODUCTIVITY (ABS)

	(1) Promotion	(2) Promotion	(3) Promotion	(4) Promotion	(5) Promotion	(6) Promotion
Female	-0.0247**	-0.0305**	-0.00675	-0.00984	0.0102	0.00946
	(0.0108)	(0.0133)	(0.0134)	(0.0130)	(0.0108)	(0.0116)
ABS					0.0389***	
					(0.00455)	
ABS/n						0.0569***
						(0.00935)
Time period	No	Yes	Yes	Yes	Yes	Yes
Year for PhD	No	No	Yes	Yes	Yes	Yes
Department	No	No	No	Yes	Yes	Yes
Constant	0.0793***	0	0	-0.0224	-0.0649*	-0.0657*
	(0.00641)			(0.0249)	(0.0351)	(0.0383)
Observations	1,488	1,488	1,488	1,488	1,488	1,488
R-squared	0.002	0.088	0.119	0.128	0.197	0.184

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

In the first regression of our model outlined in section 6, without controlling for anything other than gender (1), we can see that the female researchers are less likely to be promoted than their male counterparts. The results are significant at a 5% level, however the goodness-of-fit (R-squared) is at the low level of 0.002, indicating that there is a severe omitted variable bias. By controlling for the time period (2) the coefficient for gender is still negative and significant at a 5% level while the goodness-of-fit appreciates to 0.088. After the addition of control variables for

which year the researcher received its doctoral degree (3) and at which department they are employed at (4), the coefficient for gender ceases to be significant at any level.

By using the ABS based variables as controls for productivity—both without (5) and with (6) adjustments for co-authors—the coefficient for gender shifts to a positive value and remain insignificant at all levels. This indicates that a large fraction of the lower promotion rate for the women in our sample (1) can be explained partly by the age-distribution (3), partly by lower research output according to the ABS measurement (5; 6).

TABLE 5: PROMOTION ON GENDER AND PRODUCTIVITY (AIS)

	(7) Promotion	(8) Promotion	(9) Promotion	(10) Promotion	(11) Promotion	(12) Promotion	(13) Promotion	(14) Promotion
Female	-0.00739	-0.00673	-0.00936	-0.00876	-0.00432	-0.0108	-0.0107	-0.00970
	(0.0124)	(0.0121)	(0.0125)	(0.0124)	(0.0121)	(0.0127)	(0.0128)	(0.0127)
AIS	0.00664***							
	(0.00136)							
AIS/n		0.0118***						
		(0.00323)						
AIS_good			0.00578***					
			(0.00124)					
AIS_good/n				0.00964***				
				(0.00280)				
AIS_good_top					0.0248***			
					(0.00356)			
AIS_top						0.00479***		
						(0.00109)		
AIS_top/n							0.00683***	
							(0.00237)	
AIS_top_dum								0.0523***
								(0.00963)
Time period	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year for PhD	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Department	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-0.0763**	-0.0831**	-0.0675**	-0.0722**	-0.0745**	-0.0626**	-0.0600**	-0.0904***
	(0.0323)	(0.0323)	(0.0307)	(0.0308)	(0.0329)	(0.0301)	(0.0303)	(0.0339)
Observations	1,488	1,488	1,488	1,488	1,488	1,488	1,488	1,488
R-squared	0.154	0.150	0.147	0.142	0.177	0.139	0.134	0.159

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

In the regressions of our model on the eight productivity variables based on AIS (7–14) the coefficients for gender change from the positive to negative values, but remain insignificant at all levels. According to the AIS measurement female researchers in our sample are therefore—in contrast to the ABS measurements—less likely to be promoted even conditional on productivity. The gender differences are however diminishing and insignificant in all our models that are conditioned on productivity, which cause for caution in the interpretations. The average publication scores for female respectively male researchers at the time for promotion are shown in Table 9 (Appendix I).

As discussed in section 4.3.2., we need to investigate whether there are predicted values outside the range (0, 1) or not. By looking at the predicted values of our dependent variable from our model, we see that we have several observations with a predicted probability of promotion that is negative, which clearly is not possible (Figure 7, Appendix I). Consequently, we cannot

interpret the coefficients for the covariates in our model as changing the probability of promotion by a specific percentage, which is one of the main advantages with the LPM (Wooldridge 2013). Since our objective however is not to obtain predicted probabilities, but rather to see if the variable for gender has any effect—i.e. being significantly separated from zero—this does not impair our use of the model. An important note here however is that the value of the coefficient for gender should only be interpreted by sign and not by nominal value. Additionally, the output from the logit and the probit models show the same result as the LPM, namely that we cannot reject the null hypothesis of gender being insignificant (Tables 15–18, Appendix III).

8. Discussion

In this section, we will discuss the implications of our findings presented in section 7. We begin by interpreting the results of our main model as well as the implications of using different productivity measures. The discussion is wrapped up by suggesting improvements of our framework for future studies.

8.1. Findings

8.1.1. Interpreting the results of the main model

The results of the regressions on our main model—including all control variables—are not significant at any level, which can indicate two things. Firstly, the sample size might be too small to draw any conclusions from our model. Secondly, there might be no gender differences in the probability of promotion conditional on productivity.

The low number of female associate professors in our sample might call for the question if any inference can be made. By the design of the main model, the total number of observations that the model is regressed upon is 1,488 rather than 245 and the number of female observations is 403 rather than 68. An argument against using the method outlined by Allison (1984)—discussed in section 4.4.3.—is that the sample size is artificially magnified, which also should yield higher t-statistics. However, since we cluster every observation on an individual level—and use robust standard errors—this should not cause for any concern.[22] To summarise, even though the number of female associate professors in our data is relatively low we argue that inference can be drawn from the results of the regressions.

[22] Allison even argues that clustering is not necessary in the model since the estimates should still be consistent, asymptotically efficient and asymptotically normally distributed (1984).

The regressions in section 7 show that although the variable for gender is positive for the ABS variables and negative for the AIS variables—a matter that will be further discussed in section 8.1.2.—the coefficients are relatively close to zero in both categories of regressions. For instance, the regression on promotion including ABS as productivity measure gives the gender coefficient a 95% confidence interval of [–0.0006, 0.021], whereas the same confidence interval by instead including AIS is [–0.01979, 0.00501]. The results are similar across all regressions.

In section 4.3.2., the potential issue of values outside the boundary of 0 to 1 was discussed, which is relevant due to the presence of negative values in our predicted regression models. As follows, the coefficients of the gender variable cannot be considered as linear additions or subtractions to the probability of promotion. They can however give guidance to the interpretation of the result through the relative values of the coefficients. If we assume that there are no negative values, the 95% confidence of ABS would indicate that the effect of gender on promotion—conditional on productivity—was somewhere between "women have a 1% lower probability of promotion than men" to "women have a 3% higher probability of promotion than men". In conclusion, the conditional probabilities seem to be low.

In order to be able to reject the null hypothesis of each regression, we have investigated the sample size needed through power and sample analyses (see Table 11, Appendix I), which indicate that we would need a sample of 21,216 observations for a power of 80%. The average time period before the promotion to associate professor is nearly six years in our sample, which implies that the estimated number of academic economists needed would be in the range of 3,000–4,000. In light of the statistics in section 2.1.1.—the total number of Swedish doctoral graduates in economics between 1990 and 2010 was 837—the sample size is unreasonable. In order to be able to reject the null hypothesis, a necessary condition would be that we had the complete population of academic economists in Sweden. Based on the results of our regression model—as well as the power and sample size analyses—we argue that the results of our models show that there are no gender differences in the probability of promotion after controlling for level of productivity.

In an economic context, the implication of our results is that there are no signs of discrimination in play at this stage since female academic economists—as a group and given a certain level of productivity—are not treated unequally due to their gender (for our definition of discrimination see section 3.1.1.). There is no sign of any "reverse discrimination" either.[23] Consequently, our findings suggest that the explanations for the leaky pipeline within the Swedish departments of economics cannot be found in discrimination at the promotion step to associate professor.

[23] Note that the results indicate an average effect. As discussed in section 4.3.1., we cannot tell if there are two counterbalancing effects—discrimination and reverse discrimination in distinct time periods—present.

8.1.2. Interpreting the productivity measurements

Tables 4 and 5 (section 7) show that, in the regressions with ABS variables as the productivity measurement, the values of R-squared are consistently higher than in the regressions with the AIS variables. This could indicate that productivity measured by ABS corresponds better with promotions. Another finding is that the use of measurements based on either ABS or AIS affect the variable *Female* differently: the two ABS-based variables yield a positive coefficient whereas the case is reversed for all the eight AIS-variables. The null hypotheses of the gender coefficient in the regressions on the final model cannot however be rejected at any significant level, i.e. the changing signs of the coefficients could be coincidental. This notwithstanding we believe that the pattern is interesting to analyse due to the implication that the level of productivity for women is estimated relatively lower by the ABS metric, which also seems to correspond better with promotions.

As brought up in section 5.4.2, the main distinction between the two types of variables is the exclusion respectively inclusion of journals that are not categorised into the field of business administration and economics. *AIS_good_top* contains the highly valued journals in Thomson Reuters´ Journal Citation Report. The variable has been designed partly according to the structure of the variable ABS, partly according to one of the sample universities' guidelines in appointment to *docent*: a "good" publication is considered to have an AIS over 1 and a "top" publication have an AIS over 2. Publications with an AIS between 1 and 2 are coded 1, and publications with an AIS equal to or above 2 are coded 2. *AIS_good_top* and *ABS* has a correlation of 0.7905 (see Table 19, Appendix IV)—yet the variables correlate differently with gender. Since the constructions of the measurements are very similar, the main difference must lie in the inclusion respectively exclusion of journals not strictly within business administration and economics. Another point to make is that the ABS measurement correlates to a higher extent with promotion than the AIS measurement. A plausible interpretation is that the departments value publications within business administration and economics higher than journals within other fields of research.

A possible explanation for the positive respectively negative impact of the AIS and ABS variables on *promotion* could then be that female researchers in our sample publish in interdisciplinary highly-rated journals—rather than strictly within the field of business administration and economics—to a higher extent than men. This could in turn have implications for the female probability of promotion at the universities that only place value in research output that can be measured through the ABS Guide or the Tinbergen List (i.e. within business administration and economics). A related interpretation is that the result could be a sign of occupational segregation within the field of economics, in which case we encourage researchers in the future to find a suitable way to categorise the researchers in order to be able to control for possible gender differences in fields of research.

Finally, the distinct effects of the chosen proxies to level of productivity—in line with the results of Henreksson and Waldenström (2011)—show the importance of evaluating different measurements as well as being aware of possible gender biases in the choice of measuring research output for promotion processes.

8.2. Improving the Framework

In this paper, we have focused on the demand side of the academic labour market through investigating if there are any signs of discrimination in the appointment to associate professor at Swedish departments of economics. We argue that future studies should incorporate other economic explanations—discussed in section 3.1.—for the gender promotion gap in order to include the perspective of the supply side as well as to shed further light on the demand side of the academic labour market.

The difference in the average number of years it takes to be promoted to associate professor is 1.5 years longer for the female academic economists in the sample than for the male (Figure 4, Appendix I). The female researchers in our sample do also on average have less research output than their male counterparts in five years after receiving their doctoral degree (Table 8, Appendix I). A plausible—and at least partial—explanation could be that Swedish women in general are on parental leave for a longer time period than men. We argued in section 5.5.4 that the inclusion of family-related variables could lead to measurement errors and biasedness. This notwithstanding, the matter should be investigated in future research.[24]

In our model, productivity—measured through the quality of research output—is an exogenous variable. As discussed in the literature review, a number of studies have aimed to find factors to call for the gender differences—e.g. team formation (Boschini & Sjögren 2007a) and network effects (Ginther & Kahn 2004)—which should be studied in the context of the female research output. The professional networks discussed by Ginther and Kahn (2004) are particularly interesting in light of the 2010 study of Blau, Currie, Croson and Ginther. Blau et. al studied the role of mentorship through a randomised trial by a mentorship programme called CeMENT (CSWEP Mentoring Program). The programme was established by the Committee on the Status of Women in the Economics Profession (CSWEP) with the purpose of helping junior female faculty for the tenure hurdle. In the paper, the authors showed that the mentoring programme had "increased top-tier publications, the total number of publications, and the total number of successful federal grants in treated women relative to controls". However, they also stated that they could not tell at the time whether the programme would have an effect on neither the probabilities of women staying within academia nor receiving tenure. A suggestion for future research is to treat the variable for productivity as endogenous—by incorporating factors such as

[24] One way of handling the issue of measurement error could be to use survey data where the respondents are asked on variables such as marital status, children and parental leaves.

network effects and mentoring—in order to better understand the persistence of the leaky pipeline within the departments of economics.

Contrary to the results of Boschini and Sjögren (2007a)—based on articles published in economic top journals—our results show that Swedish female researchers on average have a higher number of co-authors than male (Appendix II). On average, a publication coded with a male author has 1.21 co-authors whereas publications with a female author have 1.35 co-authors (+0.14).[25] This can be interesting in light of the indication that women seem to research in interdisciplinary fields to a higher extent than men, which in general should demand more co-authors. As stated previously, we believe that gender differences in fields of research could be relevant to investigate further. Additionally, we believe that the identification and mapping of co-authors can be interesting in a gender perspective in light of network effects: do male academic researchers co-author with senior academic economists to higher extent than females? Another interesting approach would be a framework similar to that of Sarsons (2015): who gets the credit for papers published in gender-mixed teams at the Swedish departments of economics?

9. Conclusion

The aim of this paper has been to study if there is a gender difference in promotion, conditional on productivity, within the departments of economics in Sweden. We have argued that the investigation of any discrimination is an important part in targeting the leaky pipeline. Based on our sample of 245 academic economists, we find that women—on average—have a lower productivity score than men five years after receiving the doctoral degree. Promotions to associate professor occur later for women than for men (on average 1.5 years). Both of these findings are consistent with previous research on family factors and publication scores. Given a certain level of productivity, however, we find no evidence of discrimination. In light of these results, we argue that the under-representation of women within the field of economics in Sweden should be further studied. Our suggestion is that the variable *Productivity* should be treated as endogenous, which would enable the incorporation of supply side factors, e.g. preferences, as well as shed further light on the demand side, i.e. the employers in the academic labour market.

[25] Note that one publication can appear several times in the data set, i.e. if more than one of the authors is part of our sample. Note also that we have restricted the maximum number of co-authors to 5, which means that if the publication has more than five co-authors it is still reported as 5.

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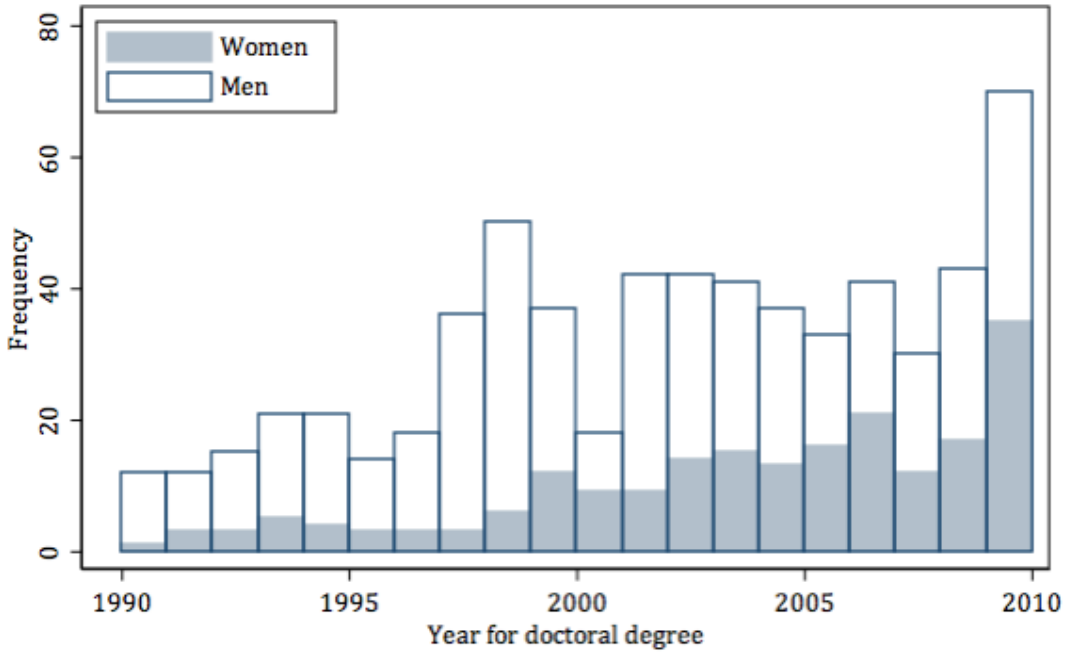
Appendix I: Descriptive statistics

TABLE 6: DOCTORAL GRADUATES IN ECONOMICS (1990–2010)

University	Female	Male	Total	Female %
Jönköping University	5	16	21	24%
Royal Institute of Technology	0	3	3	0%
Linköping University	2	5	7	29%
Linnaeus University	4	6	10	40%
Luleå University of Technology	3	10	13	23%
Lund University	21	97	118	18%
Örebro University	4	9	13	31%
Stockholm School of Economics	42	135	177	24%
Stockholm University	41	91	132	31%
Umeå University	18	46	64	28%
University of Gothenburg	34	123	157	22%
Uppsala University	30	92	122	25%
Total	204	633	837	24%

Source: Raw data collected from Statistics Sweden. *Note*: 92% of the population received their doctoral degree in economics from one of the six universities in our sample. Stockholm University has the most even gender distribution (31% are female) whereas Lund University has the most uneven gender distribution (18% are female). Additional information is that the number of doctoral graduates has risen from the beginning of the 1990s to the 2000s: from approximately 20 each year to somewhere between 40 and 60 onwards.

Figure 1: Distribution of doctoral graduates in economics (1990–2010)



Source: Raw data collected from Statistics Sweden.

Figure 2: Bernoulli structure of the error terms

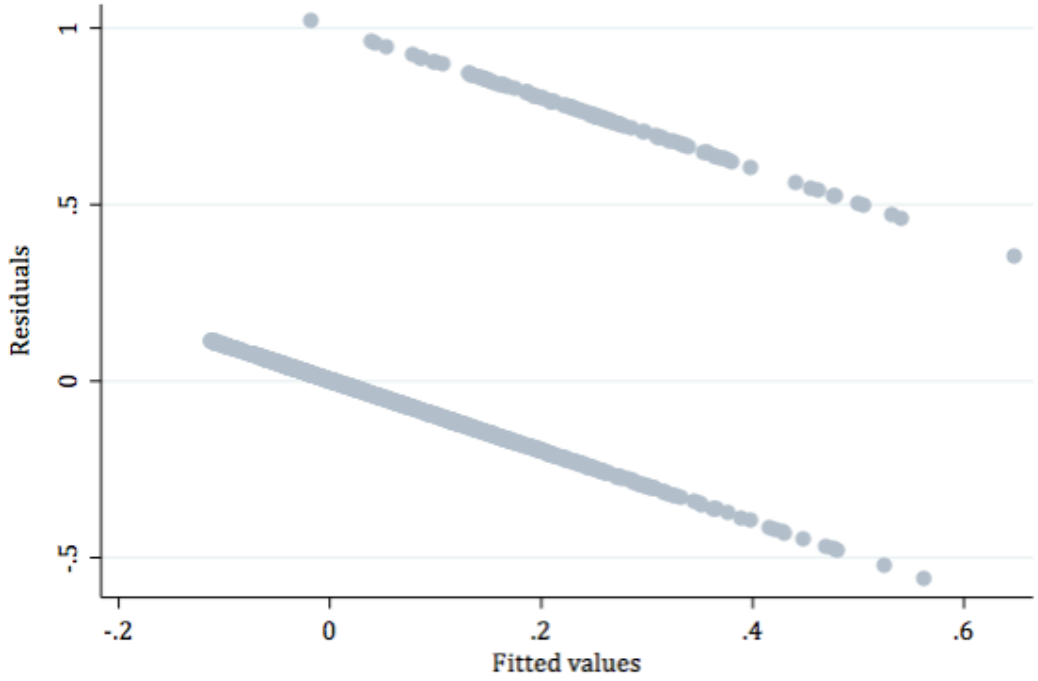


Figure 3: Distribution of observations across time periods

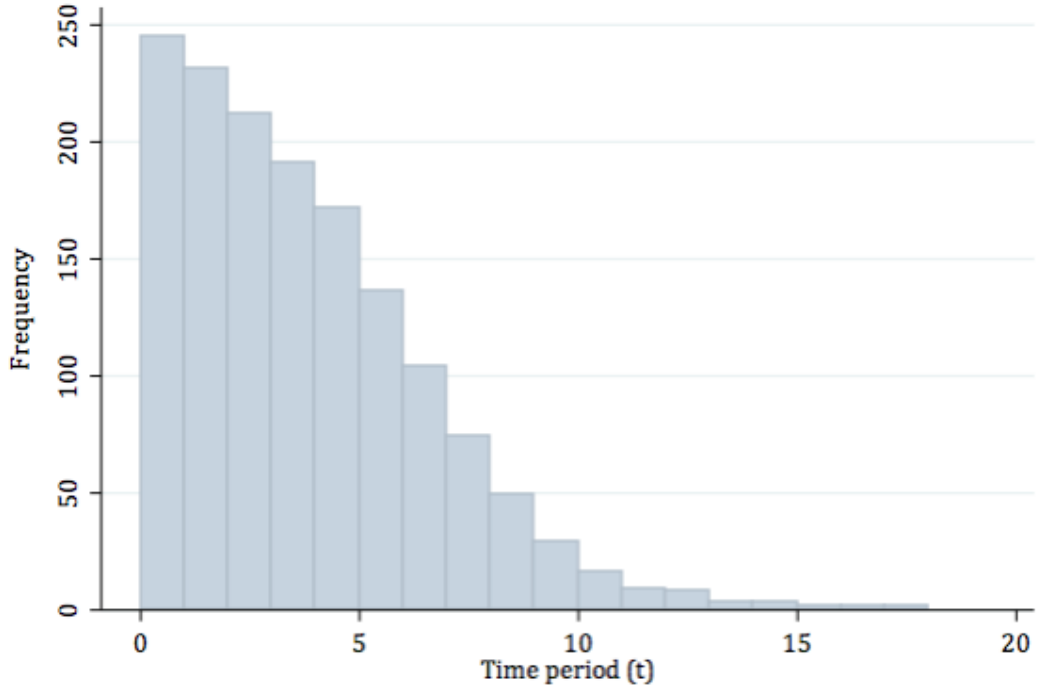


TABLE 7: GENDER DISTRIBUTION ACROSS UNIVERSITIES (SAMPLE)

University	Female	Male	Total	Female %
University of Gothenburg	12	23	35	34%
Lund University	11	36	47	23%
Stockholm School of Economics	7	24	31	23%
Stockholm University	16	26	42	38%
Umeå University	5	18	23	22%
Uppsala University	9	25	34	27%
Others	8	25	33	24%
Total	68	177	245	28%

The table includes our full sample of 245 researchers. The division into universities have been made according to where the individual received its first employment after doctoral degree.

Figure 4: Distribution of years to appointment to associate professor (sample)

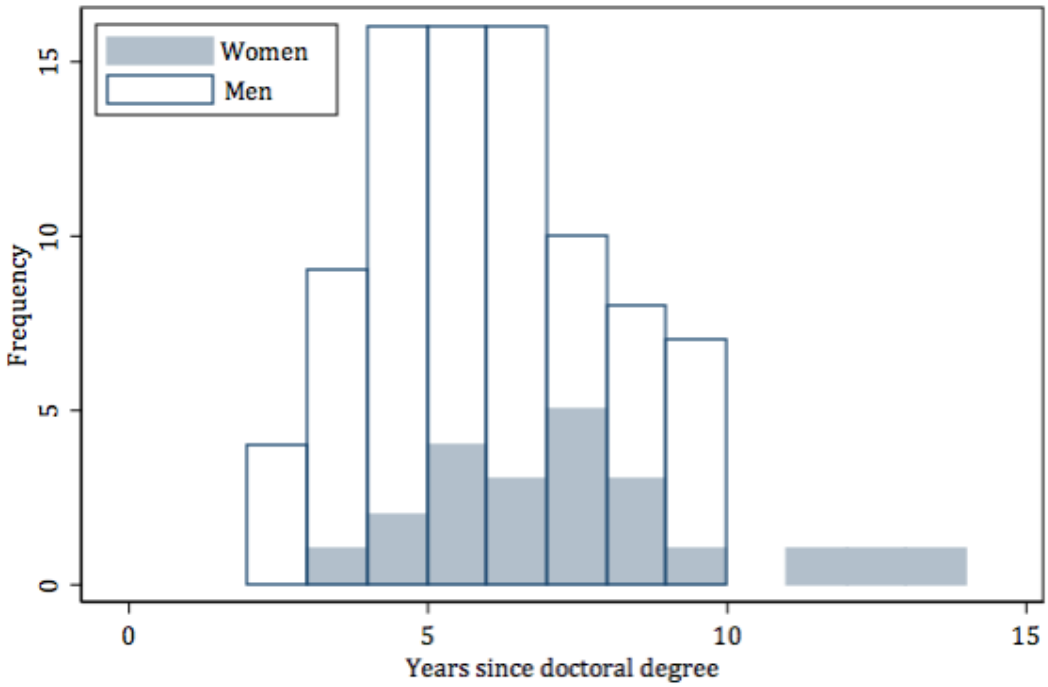


Figure 5: Distribution of doctoral graduates in economics 1990–2015 (sample)

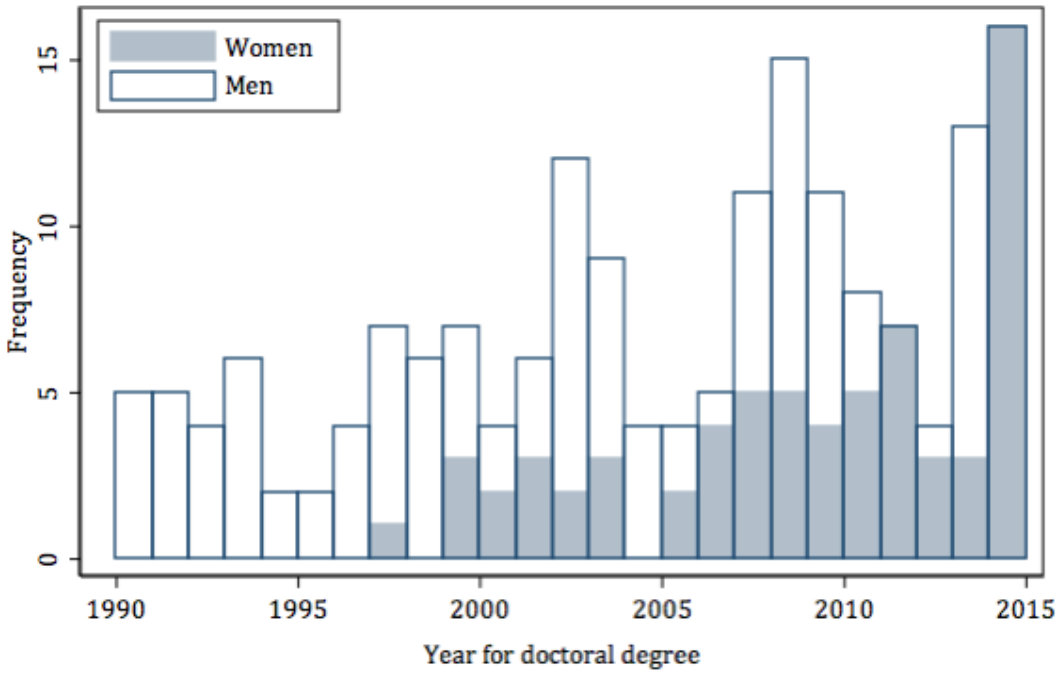


Figure 6: Distribution of appointments to associate professor 1990–2015 (sample)

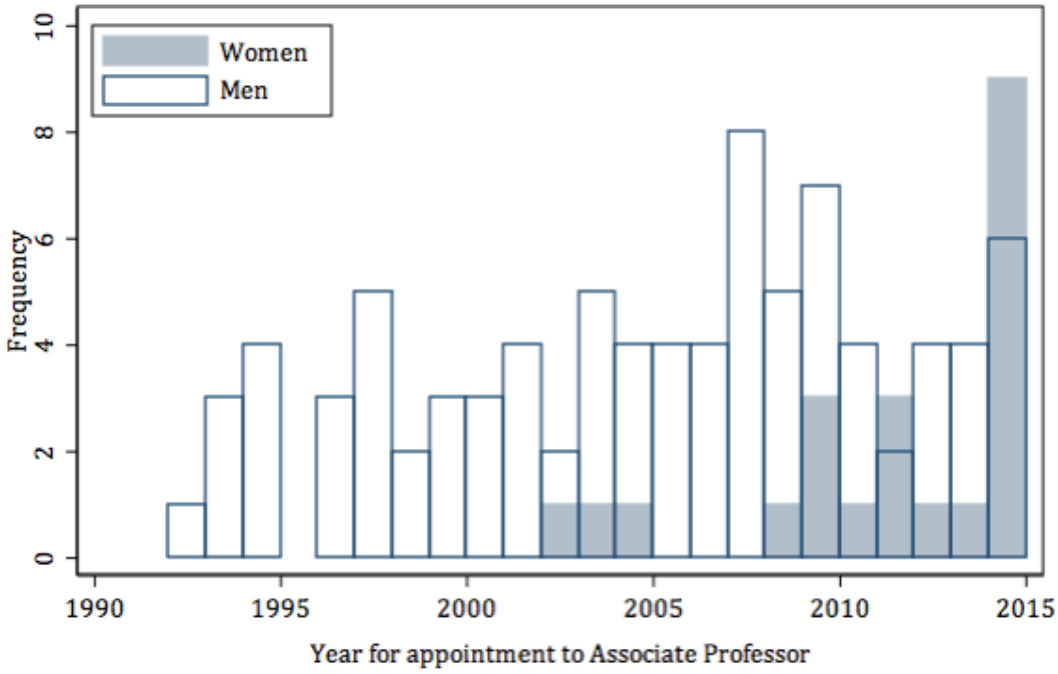
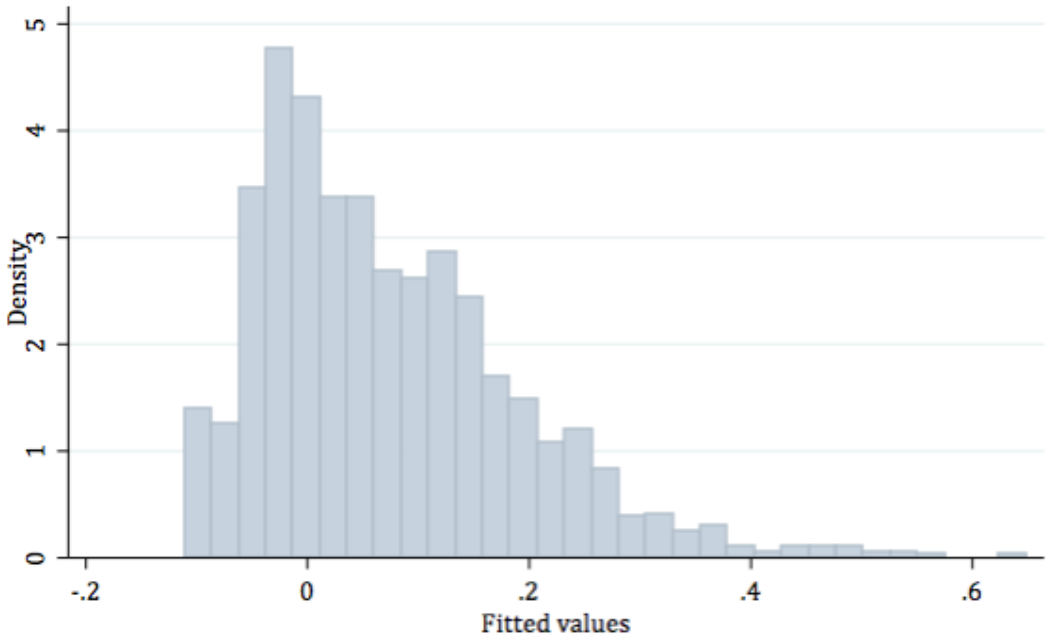


Figure 7: Distribution of predicted values



Note: Predicted values using the ABS variable are shown. The distribution is similar regardless of productivity variable.

TABLE 8: SUMMARY STATISTICS: PUBLICATION RECORD 5 YEARS AFTER DOCTORAL DEGREE

	Female		Male		Total		
	Obs	Mean	Obs	Mean	Obs	Mean	Female Mean / Male Mean
ABS	39	2.205128	138	3.094203	177	2.898305	0.712664
ABS/n	39	1.165232	138	1.951054	177	1.777907	0.597232
AIS	39	7.058974	138	7.637478	177	7.510011	0.924254
AIS/n	39	3.586053	138	4.43825	177	4.250478	0.807988

The table shows the average publication score for female respectively male researchers five years after they received their doctoral degree. The time frame was chosen on two grounds: firstly, it is sufficiently long for the researchers to have time to produce a representative amount of research. Secondly, few researchers have been promoted during the period, which otherwise could be an unfair comparison given that promotions might enable more focus on research as well as other network effects.

TABLE 9: SUMMARY STATISTICS: PUBLICATION RECORD AT TIME FOR APPOINTMENT TO ASSOCIATE PROFESSOR

	Female		Male		Total		
	Obs	Mean	Obs	Mean	Obs	Mean	Female Mean / Male Mean
ABS	22	3.5	86	4.395349	108	4.212963	0.796296
ABS/n	22	1.710335	86	2.681221	108	2.483448	0.637894
AIS	22	11.14091	86	10.48613	108	10.61951	1.062442
AIS/n	22	5.284291	86	5.92505	108	5.794525	0.891855
AIS_good	22	9.327273	86	8.617442	108	8.762037	1.082371
AIS_good/n	22	4.194708	86	4.775365	108	4.657083	0.878405
AIS_good_top	22	5.136364	86	4.837209	108	4.898148	1.061844
AIS_top	22	6.127273	86	6.061628	108	6.075	1.010829
AIS_top/n	22	2.73947	86	3.102345	108	3.028426	0.883032
AIS_top_good	22	1.272727	86	1.430233	108	1.398148	0.889873

The table shows the average publication score for female respectively male researchers at the time that they were appointed to associate professor. As seen from the table, the female researchers were more productive according to four of the measurements, while the male researchers were more productive according to the remaining six measurements.

TABLE 10: DISTRIBUTION OF PROMOTIONS AND RESEARCHERS AT RISK

Time period	Numbers promoted	Numbers censored	Numbers at risk	Estimated hazard	Women at risk	Men at risk
0	0	14	245	0.000	68	177
1	0	19	231	0.000	61	170
2	4	17	212	0.019	52	160
3	10	9	191	0.052	49	142
4	18	18	172	0.105	44	128
5	20	12	136	0.147	35	101
6	19	11	104	0.183	27	77
7	15	10	74	0.203	23	51
8	11	9	49	0.224	16	33
9	5	8	29	0.172	11	18
10	3	4	16	0.188	6	10
11	1	0	9	0.111	5	4
12	1	4	8	0.125	4	4
13	0	0	3	0.000	1	2
14	1	0	3	0.333	1	2
15	0	0	2	0.000	0	2
16	0	1	2	0.000	0	2
17	0	0	1	0.000	0	1
18	0	1	1	0.000	0	1
Total	108	137	1488	0.073	403	1085

The probability that an event will occur for individual i at time period t, conditional on that the individual is *at risk*, is also called the estimated *hazard rate*. The interpretation of this is that the hazard rate is the probability of promotion for a researcher in a given year, conditional on that he or she has not been promoted in any of the previous years (Allison 1984). If T is time period t where a promotion occur, the hazard rate $h(t)$ can be defined accordingly (Mills 2011): $h(t) = P(T = t \mid T \geq t)$

TABLE 11: POWER ANALYSIS

Nominal power	Sample size
0.5	10,296
0.6	13,104
0.7	16,536
0.8	21,216
0.9	28,080

The power analysis was made by the *powerreg* command in Stata, using the R^2 from the full model including *Female* (0,1967) and the R^2 from the restricted model excluding *Female* (0,1964). We have used ABS variable as productivity measurement for these analyses.

Appendix II: Co-authors

TABLE 12: NUMBER OF CO-AUTHORS

	Co-authors	0	1	2	3	4	5+	Total
Female	Publications	110	176	107	31	5	21	450
	Percentage	24.44	39.11	23.78	6.89	1.11	4.67	100.00
Male	Publications	584	856	450	131	51	41	2,113
	Percentage	27.64	40.51	21.30	6.20	2.41	1.94	100.00
Total	Publications	694	1,032	557	162	56	62	2,563
	Percentage	27.08	40.27	21.73	6.32	2.18	2.42	100.00

The data for the publications are based on the complete set of journal publications for the 245 researchers in our sample during the period 1990–2015. Publications occur multiple times if more than one author is represented in our sample.

TABLE 13: NUMBER OF CO-AUTHORS

	Observations	Mean	Standard deviation	Min	Max
Female	450	1.351111	1.218386	0	5
Male	2113	1.210601	1.105102	0	5
–2000	488	1.122951	1.261191	0	5
2001–2005	435	1.02069	.9893602	0	5
2006–2010	713	1.151473	1.009534	0	5
2011–	927	1.459547	1.161957	0	5
Total	2563	1.235271	1.126837	0	5

Note: If the number of co-authors is more than 5, the number is counted as 5. The data for the publications are based on the complete set of journal publications for the 245 researchers in our sample during the period 1990–2015. Publications occur multiple times if more than one author is represented in our sample.

TABLE 14: CO-AUTHORS ON GENDER AND YEAR FOR DOCTORAL DEGREE

	(1) Co-authors	(2) Co-authors	(3) Co-authors
Female	0.141**		0.0397
	(0.0622)		(0.0623)
Year		0.0231***	0.0225***
		(0.00351)	(0.00356)
Constant	1.211***	-45.13***	-43.94***
	(0.0240)	(7.054)	(7.153)
Observations	2,563	2,563	2,563
R-squared	0.002	0.018	0.018

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Note: If the number of co-authors is more than 5, the number is counted as 5. The data for the publications are based on the complete set of journal publications for the 245 researchers in our sample during the period 1990–2015. Publications occur multiple times if more than one author is represented in our sample. The table shows that when controlling for publication year (3), the variable *Female* only correlates weakly with the number of co-authors.

Appendix III: Results from probit and logit models

Note that differences in the magnitude of the coefficients in these models compared to the LPM are due to the different constructions of the models and should not be directly interpreted as differences in the effect of the gender variable on promotion (Wooldridge 2013).

TABLE 15: PROBIT MODEL: PROMOTION ON GENDER AND PRODUCTIVITY (ABS)

	(1) Promotion	(2) Promotion	(3) Promotion	(4) Promotion	(5) Promotion	(6) Promotion
Female	-0.192**	-0.298**	-0.0563	-0.0927	0.150	0.117
	(0.0896)	(0.126)	(0.143)	(0.152)	(0.149)	(0.152)
ABS					0.226***	
					(0.0293)	
ABS/n						0.308***
						(0.0600)
Time period	No	Yes	Yes	Yes	Yes	Yes
Year for PhD	No	No	Yes	Yes	Yes	Yes
Department	No	No	No	Yes	Yes	Yes
Constant	-1.410***	-0.311	0.433	0.456	0.357	0.366
	(0.0434)	(0.813)	(0.824)	(0.916)	(0.839)	(0.857)
Observations	1,488	1,003	1,003	1,003	1,003	1,003

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

TABLE 16: PROBIT MODEL: PROMOTION ON GENDER AND PRODUCTIVITY (AIS)

	(7) Promotion	(8) Promotion	(9) Promotion	(10) Promotion	(11) Promotion	(12) Promotion	(13) Promotion	(14) Promotion
Female	-0.0677	-0.0540	-0.0895	-0.0793	-0.0540	-0.0938	-0.0970	-0.0778
	(0.151)	(0.143)	(0.151)	(0.146)	(0.152)	(0.150)	(0.149)	(0.151)
AIS	0.0402***							
	(0.00819)							
AIS/n		0.0710***						
		(0.0187)						
AIS_good			0.0357***					
			(0.00730)					
AIS_good/n				0.0594***				
				(0.0165)				
AIS_good_top					0.144***			
					(0.0232)			
AIS_top						0.0311***		
						(0.00617)		
AIS_top/n							0.0455***	
							(0.0146)	
AIS_top_dum								0.305***
								(0.0541)
Time period	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year for PhD	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Department	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	0.413	0.375	0.494	0.450	0.411	0.524	0.493	0.542
	(0.894)	(0.884)	(0.913)	(0.904)	(0.891)	(0.919)	(0.911)	(0.910)
Observations	1,003	1,003	1,003	1,003	1,003	1,003	1,003	1,003

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

TABLE 17: LOGIT MODEL: PROMOTION ON GENDER AND PRODUCTIVITY (ABS)

	(1) Promotion	(2) Promotion	(3) Promotion	(4) Promotion	(5) Promotion	(6) Promotion
Female	-0.399**	-0.529**	-0.124	-0.196	0.255	0.207
	(0.190)	(0.239)	(0.269)	(0.284)	(0.276)	(0.288)
ABS					0.409***	
					(0.0577)	
ABS/n						0.595***
						(0.131)
Time period	No	Yes	Yes	Yes	Yes	Yes
Year for PhD	No	No	Yes	Yes	Yes	Yes
Department	No	No	No	Yes	Yes	Yes
Constant	-1.410***	-0.311	0.433	0.456	0.357	0.366
	(0.0434)	(0.813)	(0.824)	(0.916)	(0.839)	(0.857)
Observations	1,488	1,003	1,003	1,003	1,003	1,003

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

TABLE 18: LOGIT MODEL: PROMOTION ON GENDER AND PRODUCTIVITY (AIS)

	(7) Promotion	(8) Promotion	(9) Promotion	(10) Promotion	(11) Promotion	(12) Promotion	(13) Promotion	(14) Promotion
Female	-0.135	-0.0923	-0.183	-0.152	-0.0872	-0.189	-0.191	-0.136
	(0.288)	(0.266)	(0.285)	(0.272)	(0.296)	(0.281)	(0.279)	(0.286)
AIS	0.0698***							
	(0.0156)							
AIS/n		0.131***						
		(0.0389)						
AIS_good			0.0612***					
			(0.0132)					
AIS_good/n				0.105***				
				(0.0330)				
AIS_good_top					0.259***			
					(0.0461)			
AIS_top						0.0543***		
						(0.0111)		
AIS_top/n							0.0806***	
							(0.0291)	
AIS_top_dum								0.554***
								(0.102)
Time period	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year for PhD	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Department	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	0.810	0.732	0.928	0.846	0.786	0.988	0.935	1.025
	(1.551)	(1.516)	(1.608)	(1.579)	(1.545)	(1.619)	(1.597)	(1.583)
Observations	1,003	1,003	1,003	1,003	1,003	1,003	1,003	1,003

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Appendix IV: Derivation of productivity measures

The Tinbergen list is used by the University of Gothenburg, Lund University and Uppsala University. The list ranks journals according to the citation metric Article Influence Score (AIS). This metric is based on the Eigenfactor metric that was developed by Bergstrom, West & Wiseman (2008) as a more sophisticated version of the well-known impact factor provided by Thomson Reuters' Web of Science. The difference between the Eigenfactor and the impact factor is that the former uses an algorithm that does not only count for the absolute number of citations a journal receives, but also grades them depending on their journal source, i.e. citations in more cited journals are receiving greater weight. On top of this the Eigenfactor adjusts for citation practices across disciplines and it excludes self-citations. Its score is based on the weighted citations from the publications of the five preceding years. The AIS is the Eigenfactor divided by number of articles in the journal, i.e. the mean impact of the article, and is normalised with a mean score equal to 1 (Chang & McAleer 2014).

Stockholm School of Economics uses a version of Association of Business Schools' Academic Journal Guide (ABS). ABS ranks journals in a scale from 1 to 4, including 4* for outstanding journals. The ranking is—in addition to citation metrics—based on peer reviews as well as on editorial and expert judgments. ABS has been critiqued for the sparse endowments of the rating of 4 and the generous allotment of the 3 rating. Another downside with ABS is that the range of different journals is strictly limited to journals within the field of business and its closest related fields. A variety of journals popular among some fields of economics are not included, e.g. health economics and environmental economics. Due to the combination of citation metrics and expertise judgements, there is no possibility of extending ABS in the case of such publications. Regardless, SSE allots two points for a publication in a journal ranked 4* and one point for a publication in a journal ranked 3 or 4.

For every time period *t*, we have used the accumulated points of each individual *i*'s publications according to the two grading systems respectively. Additionally, we have adjusted each accumulated variable linearly by number of co-authors. In order to control for the difference between publishing a large number of articles with a low ranking and a low number of articles with a high ranking, we have also computed AIS scores based on university Uppsala University's definitions of good and top journals. A good publication has an AIS over 1, whereas a top publication has an AIS over 2.

The following are two extractions from the formal requirements for appointment to associate professor, regarding the ABS and AIS measurements respectively. The first states the *basic requirements* for research output according the ABS Guide and the second states the requirements for *sufficient* publication record according to the Tinbergen List:

Formal requirements from the ABS Guide as used by Stockholm School of Economics:
"The total research output should correspond to at least six journal articles published in journals belonging to the categories 3 or 4 in the Academic Journal Quality Guide published by the Association of Business Schools, UK (with 4* ABS journals and FT journals counted double). If the candidate does not fulfill this criterion, he/she might be fulfilling the criterion in other ways, such as having written a high quality PhD thesis, published books at international publishing houses, or published other peer reviewed articles."

Formal requirements from the Tinbergen List as used by Uppsala University:
"**A:** In order for the Assistant Professor's publication record to demonstrate **sufficient quality**, he or she should be the coauthor of at least: two publications in journals with an international recognition of *top field* journals, 2nd tier general interest economics journals, or top journals within other social sciences, or one publication in a *top-5* economics journal.
B: In order for the Assistant Professor's publication record to demonstrate **sufficient independence**, he or she should have published significant research *without more senior coauthors*: 2 publications in *good* international journals or 1 publication in a journal with a scientific recognition of *top field* journals, 2nd tier general interest economics journals, or top journals within other social sciences.
C: In order for the Assistant Professor's publication record to demonstrate **sufficient quantity**, he or she should: be the coauthor of at least five publications in *good* international journals or better or be the coauthor of at least four publications in *good* international journals or better, whereof at least one single-authored or be the coauthor of at least three publications in *good* international journals or better, whereof at least two single-authored or otherwise have proven the ability to *repeatedly* produce research of exceptional quality and independence."

TABLE 19: CROSS-CORRELATION OF PROMOTION, GENDER AND PRODUCTIVITY MEASURES

	Promotion	Female	ABS	ABS/n	AIS	AIS/n	AIS_ good	AIS_ good/n	AIS_ good_top	AIS_top	AIS_ top/n	AIS_ top_dum
Promotion	1.0000											
Female	-0.0423	1.0000										
ABS	0.3598	-0.1071	1.0000									
ABS/n	0.3452	-0.1412	0.9028	1.0000								
AIS	0.2369	-0.0225	0.7168	0.6125	1.0000							
AIS/n	0.2424	-0.0540	0.6980	0.7335	0.8891	1.0000						
AIS_good	0.2000	-0.0080	0.6608	0.5704	0.9867	0.8750	1.0000					
AIS_good/n	0.1984	-0.0393	0.6399	0.6822	0.8727	0.9823	0.8874	1.0000				
AIS_good_top	0.3088	-0.0308	0.7905	0.7026	0.8706	0.8144	0.8504	0.7956	1.0000			
AIS_top	0.1488	0.0065	0.5394	0.4637	0.9353	0.8342	0.9678	0.8666	0.7366	1.0000		
AIS_top/n	0.1329	-0.0090	0.5125	0.5339	0.8238	0.9193	0.8549	0.9549	0.6762	0.9023	1.0000	
AIS_top_dum	0.2370	-0.0111	0.6058	0.5492	0.8166	0.7950	0.8328	0.8146	0.8682	0.8419	0.8250	1.0000