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Why Tenure? An Optimal Contract Perspective

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Zhengzheng Qian

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To: Dean John F. Stack, Jr.
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This dissertation, written by Zhengzheng Qian, and entitled Why Tenure? An Optimal Contract Perspective, having been approved in respect to style and intellectual content, is referred to you for judgment.

I have read this dissertation and recommend that it be approved.

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ABSTRACT OF THE DISSERTATION

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Professor Jesse Bull, Major Professor

In academia, after a reasonable probationary period of service and upon the achievement of tenure, the recipients of tenure are entitled to a continuing appointment at an institution without mandatory retirement and with only limited grounds for revocation. Advocates of tenure argued that it protected academic freedom through economic security. Opponents of tenure argued that it fostered inefficient and unproductive behavior. This dissertation developed a framework for examining academic tenure in U.S. economics departments. I constructed a dataset of tenured U.S. economics professors who were Ph.D. recipients between 1990 and 2006 and tracked their publications. In the first chapter, based on difference-in-difference analysis I found that tenure has a direct effect on the choice of research direction/focus. In general, tenured groups had a higher degree of specialization than non-tenured groups after they received tenure. For some tenured groups, even if their extent of specialization decreased after tenure, when I controlled for unobserved heterogeneity, tenure still had a positive effect on extent of specialization. This result suggested that the job security provided by tenure made tenured faculty more narrowly

focused on their research. Using path analysis in the second chapter, my finding suggested that the extent of specialization was one of the key factors which might influence a scholar's productivity. In addition, the extent of specialization helped explain gender differences in academic productivity. The results revealed that the effect of gender on productivity through the degree of specialization was more notable among older generations, and in most fields, gender differences in extent of research specialization mediated gender difference in research performance; although there were some fields in which gender difference in the research process could not explain gender difference in research performance. The third chapter expanded our understanding of advancement in academics by exploring a new dimension of inquiry: whether the extent of specialization in scholars' research programs improved promotion prospects. Using discrete event analysis, my research showed that the extent of research specialization contributed to career acceleration, although gender difference on the prospects of advancement in academics was not significant.

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ABBREVIATIONS AND ACRONYMS

EG index	Ellison-Glaeser concentration index
QJE publications	Quarterly Journal of Economics equivalent publication
JEL codes	Journal of Economics Literature classification system codes
EHT	Economic History and Thought
EM	Econometrics
MICRO	Microeconomic Theory
LCE	Labor and Consumer Economics
IO/BE	Industry Organization/ Business Economics
PE	Public Economics
MACRO	Macroeconomics
TD	Trade and Development
FE	Financial Economics
RAE	Resource and Agricultural Economics

1 PREFACE

There are many explanations for why universities have a tenure system. From an economic viewpoint the possibility that a tenure system helps to solve a contracting problem between a faculty member and a university is a compelling reason for tenure contracts to be used.

The feature of a potential contracting problem I focus on deals with specialization in research. One might imagine that specialization in a relatively narrow research area might increase a faculty member's chances of big discoveries or publication in top journals. It's possible that with an employment-at-will contract, the faculty member's incentives to specialize may not be aligned with those of the university. One reason may be that the faculty member may wish to be more diversified in his/her areas of expertise to facilitate a job search should it become necessary.

By providing security of employment once a tenured position is attained, a tenure system may provide the faculty member the incentive to specialize, both pre and post tenure. The pre-tenure argument would be that specialization increases a faculty member's chances of successful research and increases her chances of earning tenure. Post-tenure, the security of employment may reduce the incentive for a faculty member to diversify research directions. Further, if there is a learning aspect associated with the pre-tenure activity, specialization pre-tenure may encourage specialization post-tenure.

This dissertation explores whether there is empirical evidence to support this type of explanation in the discipline of economics. Additionally, it provides an empirical investigation of the academic labor market for economists. In particular, my work here

seeks to better understand the relationship between tenure, promotion, specialization, and research productivity in economics.

In Chapter 2, I present sample and related variables.

In Chapter 3, I study the effects of tenure on specialization. With job security, it might be possible for faculty to devote more time to fundamental research that might lead to "big discoveries", and I believe most universities value research that results in "big discoveries," which shape a research area, and publications in top journals much more than they do a larger quantity of uninfluential publications in low-ranked journals.

In Chapter 4, I study the relationship between specialization and research productivity. As economics research is becoming more complex, the productivity gains realized from specializing seem intuitive. Gender difference in terms of research specialization contributes to gender difference in research productivity.

In Chapter 5, I explore the role of specialization in promotion. This also includes studying the effects of specialization on post-tenure promotion/promotion to full professor. A scholar's career benefits from repeatedly engaging in research on the same substantive topic.

2 DATA

This section provides a detailed description of the process through which the data used in the econometric analysis were assembled. In order, I describe (i) how I collected the whole sample; (ii) how to measure the extent of specialization; and (iii) how to measure productivity.

2.1 Sample

The economists included in the main dataset are the faculty from one of the top 86 Economics departments in the United States who received their doctorates between 1990 and 2006. This list of the top 86 U.S. Economics departments is according to RePEC (Research Papers in Economics) Economics department ranking[1]. This dataset contains 699 economists. Among them, 137 are female economists and 562 are male.

I used individual CVs to obtain information about where and when an individual received his/her doctoral degree, his/her employment history, and his/her primary and secondary fields and used first names and Internet searches, if necessary, to determine each individual's gender. I also used this information to obtain when and where an individual had been guaranteed tenure. I used department websites to find the current departmental position, such as associate or full professor.

Then, for each economist, I tracked his/her journal publications and constructed a complete record of their publications for the years from 1990 to 2014. The data were collected from the American Economic Association's electronic bibliography: EconLit.

[1] List of Economics departments used in sample are found in Appendix A. Further details may be found at: https://ideas.repec.org/top/top.usecondept.html

EconLit annually indexes the articles published in over 1000 journals across all disciplines within economics. There are nearly 1.3 million records to date. Coverage of articles reaches as far back as 1886. Although this database includes several different types of documents (peer-reviewed journal articles, working papers from leading universities, replies, obituaries, letters to the editor, reviews, etc.), only peer-reviewed journal articles were considered here, since these articles are generally regarded as original research (Moed 1996) and represent rigorous quality. By entering economists' names, I accessed all of their refereed journal articles. For each article, I collected the journal title, co-author names, and published date.

Most importantly for this study, I collected the JEL (Journal of Economics Literature classification system) codes. The JEL classification system is specifically subdivided into 20 fields and 841 subfields. Each subfield is denoted by a letter and a two-digit number[2]. I used the JEL codes in most detailed division, corresponding to two-digit JEL codes from the article, so as to categorize each article. Most articles use two or three JEL codes. The number is up to seven per article in my dataset. For articles having any missing information, I referred to the individual's CV and Internet searches for additional information. For example, if an article has more than three authors, EconLit might only report the first author's name. Pooling all years, the dataset contains 11230 peer-review articles.

[2] Further detail may be accessed at: http://www.aeaweb.org/journal/jel_class_system.html

2.2 Measure of Specialization

I used the Ellison-Glaeser (EG) concentration index to measure the extent of specialization. The Ellison-Glaeser index was introduced by Ellison (2000) to find the possible account for slowdowns in the economics publishing process. The Ellison-Glaeser index was originally adopted from Ellison and Glaeser's (1994) paper, which first proposed to measure geographic concentration. Ellison (2000) used the index to measure the degree to which economists are specialized across the main fields of economics.

The Ellison-Glaeser index of the extent of specialization for economist i can be described using:

$$\gamma_i = -\frac{1}{N_i - 1} + \frac{N_i}{N_i - 1}\sum_f \left(s_{if} - x_f\right)^2 / (1 - \sum_f x_f^2)$$

Suppose that a set of economics papers can be classified as belonging to one of F fields indexed by $f = 1, 2, \ldots, F$. N_i is the number of papers written by economist i. S_{if} is the share of economist i's papers in field f, and x_f is the fraction of all publications that are in field f.

As pointed out by Ellison (2000), under certain assumptions, the expected value of this index is unaffected by the number of papers by an author observed and by the number and size of the fields used in the breakdown. These two characteristics of the Ellison-Glaeser index make it a better candidate in the present research, since, for each group, the number of faculty in that group is small and so will be their corresponding publications.

I first classified articles based the most detailed JEL codes for 20 subcategories. For articles that contain JEL codes that seem to belong to different fields, I used rules based on the title keywords, both article and journal. And, in some cases, I assigned fields based on paper-by-paper judgements. In the minor subcategories, there might be a very small (and sometimes nonexistent) sample of economists and corresponding publications. Hence, I aggregated articles to one of ten fields: *Economic History and Thought (EHT), Econometrics (EM), Microeconomic Theory (MICRO), Labor and Consumer Economics (LCE), Industry Organization/ Business Economics (IO/BE), Public Economics (PE), Macroeconomics (MACRO), Trade and Development (TD), Financial Economics (FE)* and *Resource and Agricultural Economics (RAE)*. The method used to aggregate subcategories is taken from econphd.net[3] and the precise definitions of fields in terms of associated JEL codes is given in Appendix 2.

2.3 Measure of Productivity

I used journal articles as a measure of productivity. Although peer-reviewed publications is not equivalent to research productivity, it is a reliable indicator and is used most often in the literature (Fox 1989; Xie & Shauman 1998). For example, books might be an addition to an economist's reputation, but lack of an objective evaluation method makes it nearly impossible to evaluate the heterogeneity of book quality (Neary *et al.* 2003). In addition, policymakers and universities increasingly emphasize peer-reviewed publications and the performance indicators based on it (de Jong *et al.* 2011).

[3] Detailed information may be found at: http://econphd.econwiki.com/journals.htm, at the bottom of each page.

One way to measure journal article productivity is to use raw counts of publications, which has been used in many studies (Fox 1983; Fox & Faver 1984; Xie & Shauman 1998; Zainab 1999; Nakhaie 2002; Leahey 2006; Hunter & Leahey 2010; Mairesse & Pezzoni 2015). However, raw counts of publications do not take into account the variation in the quality of those publications or the number of pages or authors, so I took into account both the quality and pages of the publications. I used the journal rankings and journal factor from the RePEc/IDEAS[4] to control for the quality of a person's publications. It contains about 1559 current journals and up to 1777 titles if one includes the journals that are no longer referenced or renamed. I chose to take all journals and follow the method used by Conley, Crucini, Driskill and ONder (2013) to convert journal factors into Quarterly Journal of Economics (QJE) equivalence, which means I express the quality of each journal as a fraction of QJE quality and use these weights in calculating numbers of QJE equivalent publications and QJE equivalent pages in the analysis. I then adjusted the weight of all journals accordingly. However, I assigned any journal ranks beyond 1531 a score of 0.0001, as the journal rank 1531 already has a very small value of 0.0001 and the journals ranking beyond 1531 have an even lower score. The reason I included all journals is that I think even papers not published in top-ranked journals still undergo a widely accepted process of peer review, which is the essence of quality control. This results in the highest quality journal, QJE, receiving a score of 1, and the lowest 0.0001. I mainly used QJE equivalent publications for the following analysis. QJE equivalent pages and raw counts will be applied in a robustness check.

[4] More details may be accessed at: https://ideas.repec.org/top/top.journals.all.html

By assigning each publication the score of journal quality, I calculated the number of QJE equivalent publications for article i in journal j:

$$\text{QJE publications}_{ij} = \frac{(journal\ score)_j}{(authors)_i}$$

The number of QJE equivalent pages for article i in journal j is:

$$\text{QJE pages}_{ij} = \frac{(raw\ pages)_i (journal\ score)_j}{(authors)_i}$$

2.4 Other Related Variables

Department prestige of PhD-granting institutions is measured using RePEC US Economics department ranking in 2014. A few studies have evaluated Economics departments using their own constructed journal ranking to measure the quality of publication for sampled faculty. This might result in inconsistencies in data and methods used in analyses. In this study, since I used the journal rankings and journal factor from the RePEc to measure the quality of a person's publications, RePEC US Economics department ranking will be the ideal choice to score Economics departments. A lower value indicates more prestigious institutions.

I also observed the department prestige of current employing institutions. Scores were measured by the same RePEC US Economics department ranking as for department prestige of PhD-granting institution. Long *et al*. (1993) showed that the more prestigious the program, the more competitive the promotion process. Additionally, Ginther and Kahn (2004) found that, as the prestige of the institution increases, so does a male's advantage

over a female in earning tenure. Hence, the prestige of current employing institutions should be considered when I analyzed advancement in the academy.

Number of previous academic appointments indicates the number of departments in which scholars have held academic positions before the current employment position. Changing departments often results in at least a partial resetting of the tenure clock (Leahey, 2008). Studies show that changing institutions before promotion decreases the odds of obtaining tenure in a given year (Rosenfeld & Jones 1986; Hurlbert & Rosenfeld 1992). Thus, it is important to account for previous moves among departments.

3 TENURE'S EFFECT ON SPECIALIZATION

3.1 Introduction

There has been much discussion of tenure. Should it be retained as it is? Should it be reformed? Or should it be eliminated completely? Proponents of tenure argue that it guarantees the freedom of scholars to produce research and teach against prevailing orthodoxies, political landscapes, and fashionable issues (Stergiou & Machias 2015). In addition, tenure is necessary for the academic labor market to function. With the security provided by tenure, existing faculty will have the necessary incentive to hire high-quality scholars (Dnes & Garoupa 2005), and, without that, existing faculty might hire only candidates weaker than themselves (Carmichael 1988; Siow 1998). In contrast, opponents of tenure argue that tenure fosters mediocrity by making scholars inefficient and unproductive (Lewis 1980). An example of tenure's deleterious effects on its recipients is that some professors will stop writing altogether once they receive tenure. A negative correlation between scholars' productivity and career age has been found across different disciplines (Levin & Stephan 1991; Oster & Hamermesh 1998).

In this study, I regard tenure as a mechanism of employment and discuss its possible merits. Previous studies have shown that tenure provides the necessary incentive for scholars to engage in highly specialized academic work (McPherson & Winston 1983). My interest is in exploring whether tenure will promote more specialized work for tenured scholars compared to non-tenured scholars. Specifically, I try to find out how tenure affects the extent of research specialization whereby faculty research productivity might be influenced. Do tenured faculty differ in the extent of specialization from their pre-tenured counterparts? If so, along which dimensions do these differences occur and to what extent?

According to Leahey (2006), research institutions recognize the link between specialization and research performance and hope to recruit scholars "who have narrowly worked for 6-8 years to get tenure". In the context of my study, specializing allows scholars to master related literature and become familiar with important developments in that specific field. This makes successive papers on that topic easier to write, thereby increasing the likelihood of publishing. However, in academia, the lengthy probation period, normally six to seven years, sometimes eight years, is a costly opportunity for the scholar who has been denied tenure and ends up with a job outside academe. It is quite likely that a young scholar might choose a strategy to work relative broadly to land another position at another institution in academia. Hence, it will be important to study whether prospects/granting of tenure will have an influence on one's research choice.

I utilize empirical methods to find the actual consequence of tenure on individuals, especially on an individual's extent of research specialization. I accept the current institutional framework of tenure as a given and examine to what extent faculty specialize both before and after tenure. I constructed a unique dataset of scholars in economics who are PhD recipients between 1996 and 2006. I documented their research production, mainly peer-reviewed journal publications, three years before tenure and three/four years after tenure. For each publication, I recorded its JEL codes. Later, these JEL codes will be used to evaluate to what degree scholars specialize. I then observed the extent of specialization before and after receiving tenure. I constructed the extent of specialization as an indicator of an individual's degree of specialization and academic marketability. A higher value of the extent of specialization indicated scholars restricting their research to limited topics,

and their research lacks higher marketability. I predict that the security provided by tenure decreases the need for marketability and helps scholars become more focused.

One significant hurdle must be overcome in order to estimate the impact of tenure: constructing the counterfactual outcome that represents what would have happened in its absence. I need to identify a group of faculty who are appropriate controls for the faculty who have been tenured. One choice for the control group is faculty from the non-tenure track. However, given the high level of publishing exhibited by tenured faculty at the time of their appointment, a sample of non-tenure track faculty (e.g., clinical, research, adjunct faculty) with a similar career age would not be appropriate, since, in most cases, the principal duty for non-tenure-track faculty is not research. This will bring about the so-called 'Ashenfelter dip'(Ashenfelter 1978; Chay *et al.* 2005). Individuals are self-selected into different groups. Scholars choose a non-tenure track position because, at the beginning of their career, they are already low in their research productivity. The second choice is to compare faculty from institutions that provided tenure previously and later abolished it. Some universities or colleges have abolished their tenure system (McKenzie 1996). However, in most cases, these institutions are not research institutions, and the number of faculty affected is limited. If the goal is to analyze the effect of tenure on a scholar's research productivity, small institutions that are not research oriented might not be appropriate. Due to the lack of a plausible source of faculty who work under a contract severed as a variation for tenure mechanism that also research oriented and the need to avoid 'Ashenfelter dip', I have to carefully construct a control group. I will describe how I constructed the control group in the following section. The results provide support for the hypothesis that tenure improves the extent of specialization in most groups, and, in the

cases that it does not, it will prevent the extent of specialization of the tenured group from decreasing too much.

The rest of the article proceeds as follows. In the next section 3.2, I describe the construction of the treatment/tenured and control/non-tenured groups for analysis. Section 3.3 lays out the econometric methodology. Section 3.4 discusses the results of the analysis. Section 3.5 concludes.

3.2 Definition of treatment/tenured and control/non-tenured groups

This section provides a detailed description of the process through which I construct the sets of treatment and control faculty.

The treatment sample contains faculty who obtained tenure between 1996 and 2009. Starting from 1996, I divided tenured faculty in the sample into sixteen groups based on the year they were guaranteed tenure: 1996, 1997, 1998, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009. For each tenured group, I collected their publication data for three years before they received tenure and three or four years after they received tenure. Then I calculated the index of extent of specialization utilizing JEL codes of each article. For example, for the 1996 group, I recorded pre-tenure productivity as articles published in the years 1993, 1994, and 1995. If a scholar received tenure in 1996, articles published in 1996 were considered post-tenure production. The extent of specialization of the post-tenure period were based on three- or four-year intervals. Using the 1996 group as an example again, the three-year extent of specialization after tenure was calculated based on articles published in 1996, 1997, and 1998 or in 1997, 1998, and 1999. Publications from 1996, 1997, 1998, and 1999 were used to obtain a four-year extent of specialization.

In the absence of comparable faculty who work with other contracts, we must create viable control groups. The main challenge is that tenured faculty have a well record of publication which are necessary to calculate the extent of specialization. Controls should not only be well matched with tenured faculty in terms of career age, gender, rankings of graduation granting institution and current department, current position and employment histories, but their extent of specialization should also be comparable at beginning of observation. Faculty who are in our control groups are those who have started their academic career before the observation of tenured groups begin and who have not yet received tenure at the end of observation. For example, in order to construct the control group for the 1996 group with four-year post tenure observations, we select faculty who are on tenure-track and have graduated and started his/her research before 1993 and have not obtained tenure until 1999. All other control groups are constructed accordingly.

3.3 Method—difference-in-difference (DID) analysis

As mentioned previously, a major concern is that faculty who are on a tenure track could be different from faculty who do not, and these differences may be correlated with extent of specialization. I find that unobservable characteristics may confound the correlation between tenure and the extent of specialization, such as those that vary across faculty but are fixed over time. For example, male scholars might limit their research to fewer fields and have a higher probability to get promotion compared to female economists. Moreover, scholars who graduate from departments with higher ranking are more likely to find research positions, leading them to become more focused in one field rather than doing multiple topics for better job market results. Also, with more rigorous training from highly ranked departments, scholars have a higher probability to survive the probation period

compared to others. Thus, when choosing a possible method to do the analysis, I determined that the question is how to control possible differences between the scholars who are tenured and who are not. When there exists possible time-invariant unobserved heterogeneity, a common method is to use panel data and apply difference-in-difference models.

Difference-in-difference models compare the differences in the change of the extent of specialization between the treatment group and control group, which, in this study, are the tenured group and non-tenured group, before and after the treatment. By comparing changes of the outcomes, I am able to control for observed and unobserved time-invariant group characteristics that might be related to both tenure decision and extent of specialization. The change in extent of specialization in the non-tenured group is what would happen to the tenured group if they had not received tenure. The changes in extent of specialization in the tenured group controls for fixed characteristics, and the changes in the non-tenured group controls for time-varying factors that are common to both tenured and non-tenured groups.

The null hypothesis of this study is that tenure has no effect on an individual's research specialization. Put another way, no matter what incentives and abilities a scholar has, tenure does not affect it. If the null hypothesis holds, this does not mean that the extent of specialization will be the same before and after tenure. Scholars may become more or less specialized after tenure, but it is attributed to other factors. If I could reject the null hypothesis, then I could say that tenure has an effect on the extent of specialization. The difference-in-difference (DID) estimator is given by:

$$DID = E[Y_{11}] - E[Y_{10}] - (E[Y_{01}] - E[Y_{00}]) \quad (1)$$

An appropriate way to obtain (1) is to estimate the following two-way fixed-effect linear regression model:

$$Y_{it} = \alpha + \beta T_i + \gamma t_t + \delta(T_i * t_t) + \epsilon X_{it} + \varepsilon_{it} \quad (2)$$

Where Y_{it} is the extent of specialization for scholar i at time t and X_{it} is the vector of control variables for scholar i at time t. Tenure status is indicated by $T_i = 0,1$ where 0 indicates scholars who do not receive treatment, i.e. the non-tenured group, and 1 indicates scholars who do receive tenure treatment, i.e. the tenured group. Two time periods are indicated by $t_t = 0,1$ where 0 indicates the three-year period before the tenured groups receive tenure, and 1 indicates the three-/four-year period after the tenured groups receive tenure. α is the constant term. β accounts for the average difference between tenured groups and non-tenured groups. γ is the time trend common to tenured and non-tenured groups. δ is the true effect of tenure.

3.4 Data summary and model results

3.4.1 Data summary

Table 3.1 and Table 3.2 summarize the means for key variables in the dataset, averaged over each subset for each variable three-years before tenure. They show that the gender ratios are generally similar across different groups, with few exceptions. Male economists dominate most groups. The tenured group in 1998 has no female economists. However, in contrast, the non-tenured groups in 1997 and 1998 have the largest gender ratio, which is 0.29. The ratio among other groups varies from 0.10 to 0.26. Differences

are significant for group 1998. Tenured groups do not consistently have more or less female economists than non-tenured groups.

While the extent of specializations is generally similar between tenured and non-tenured faculty across different groups before tenure, three groups show significant difference between non-tenured groups and tenured groups. They are groups in year 1997, 1998 and 2000. This suggests that scholars from these tenured groups might have already limited their research to fewer topics than non-tenured groups before they receive their tenure. Hence, these groups are excluded from difference-in-difference analysis. Among the remaining groups, group 1996 has the highest degree of specialization, which is 0.76, and group 2009 is least specialized at 0.63.

Economists from the tenured groups have more publications than non-tenured groups in all groups. However, when I converted publication numbers into QJE equivalent quality, both tenured and non-tenured groups have very similar averages in different years. The only exception is group 2001, wherein the tenured group has significantly higher quality than the non-tenured group. The tenured group in 1996 has the highest publication quality, which is 0.34. For both department rankings, all groups have consistent values, although I found that economists in the dataset all hold positions at lower-ranked departments compared to the rankings of their graduate departments.

Overall, tenured and non-tenured groups show similar means for key variables before the tenured groups received tenure. Most tenured and non-tenured groups have statistically indistinguishable characteristics.

3.4.2 Difference-in difference analysis

In the following, the difference-in-difference analysis will focus on groups 1996, 1999, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, and 2009. As noted in Table 3.1 and Table 3.2, the specialization levels for all these groups are slightly different at the beginning of observation, but none of them is statistically significant. Table 3.3, Table 3.4, Table 3.6, Table 3.7, Table 3.9, and Table 3.10 summarize the levels and changes in extent of specialization per scholars for the above groups. The values of the extent of specialization before tenure are based on publication data from three years before tenure, not including tenure year. The main difference between the tables is the publication data used to calculate the extent of specialization after tenure. I present three different ways to check changes. Table 3.3 and Table 3.4 show the changes of the extent of specialization between three years before tenure and the first three years after tenure, which is Method 1. Table 3.6, Table 3.7, Table 3.9 and Table 3.10 present Method 2 and Method 3. Method 2 calculates the changes between three years before tenure and the second, third and fourth year after tenure. Meanwhile, the changes in Table 3.9 and Table 3.10 are from a comparison between three years before tenure and the first four years after tenure. This is Method 3.

Table 3.3 and Table 3.4 summarize the levels and changes in the extent of specialization per scholars with Method 1. As noted in the tables, the specialization levels for all these groups are slightly different at the beginning of observation, but none of them is statistically significant. For groups 1996, 1999, 2001, 2004, 2005, 2006, and 2007, the specialization levels are larger for tenured groups before scholars in tenured groups received tenure. It is smaller for tenured groups in groups 2002, 2003, and 2009.

Three years after the tenured groups received tenure, most non-tenured groups have lower or unchanged level of specialization than the beginning observation period except group 2005. For groups 1996, 1999, 2002, 2003, and 2004, economists from tenured groups have an increased specialization level after they are granted tenue, while, for groups 2001, 2005, 2006, 2007, and 2009, the extent of specialization decrease after tenure. With the above changes, I find that, three years after tenure, although the extent of specialization remains slightly different between tenured and non-tenured groups, the tenured group in 1999 has a significantly higher level of specialization than the non-tenured group. The relative rise (the difference-in-difference of the "tenure treatment") is positive across all groups except for group 2005. In addition, the difference-in-difference estimates for group 2003 is significantly different from zero.

Multiple regression results in Table 3.5 suggest that tenure effects on the extent of specialization are reasonably robust to specification. The entries in Table 3.5 are regression coefficients for δ from equation (2), with or without control variables or with different control variables. First, I estimate equation (2) without any control variables. The estimates in column (i) in Table 3.5 are comparable to the simple difference-in-difference of the extent of specialization changes in column (iii), row 4, 7 and so on of Table 3.3 and Table 3.4. Similar to previous calculations, the effects of tenure on the extent of specialization are positive, except groups 2001 and 2005. Tenure has significantly positive effects on economists' choice of research field. Model 2 in column (ii) introduces a set of three control variables: gender, ranking of graduate department and current employing department during the observation. The effects remain the same for most groups. Model 3 in column (iii), in addition to the three control variables used in the second model, includes previous

working experience, more specifically, how many different departments the economist has worked in before he/she obtained a position at the current department. The effects still remain the same as model 2.

Table 3.6, Table 3.7, and Table 3.8 present the levels and changes in extent of specialization and model regression results for Method 2. Results are mostly similar to Method 1 with a few difference. Unlike result from Method 1, level of specialization for non-tenured group 2005 remains unchanged. Tenured group 1996 has a decreased level of specialization. In addition to tenured group 1999, tenured group 2002 also has a significantly higher level of specialization than the non-tenured group in Method 2. Moreover, the difference-in-difference estimates in group 2002, not group 2003, are significantly different from zero. Regression results from three models are mostly similar to Method 1 except for groups 1996, 2002 and 2003. For group 1996, tenure's effect on economists' choice of fields to work changes from positive in Method 1 to negative in Method 2. Economists from group 2002 have a significantly more limited number of fields to conduct research after they obtain tenure. Tenure still has a positive effect on the choice of topics for economists in group 2003, although the effect is not as significant as in Method 1.

Table 3.9, Table 3.10, and Table 3.11 present the levels and changes in extent of specialization and model regression results for Method 3. Four years after tenured groups receive tenure, the non-tenured group with increased rather than decreased level of specialization is group 1996, not group 2005 as in Method 1. In addition, only tenured groups from groups 2001 and 2005 have lower levels of specialization after tenure. All

other groups have higher or unchanged levels after tenure in Method 3. Besides tenured group from group 1999, the tenured group from group 2003 has a significantly higher level of specialization than non-tenured group. All others remain the same as Method 1. Regression results are similar to Method 1.

3.5 Conclusion

In this article, I examine the impact of incentives embodied in tenure mechanisms on the extent of specialization. I find that being tenured, which awards job security, leads to more narrowed research compared to non-tenured faculty who are still under the pressure of job security. With the security provided by tenure, people might pay less attention to their marketability and focus more on limited topics. This effect is also consistent across groups in different time periods.

My findings are important, as they demonstrate the impact of tenure as positive on the extent of specialization. This has important implications for the organization of both public and private research universities, since previous studies have shown that research productivity is positively related to extent of specialization. Providing tenure to research faculty will make them limit their research to a few topics, producing a higher productivity rate.

There are a few limitations to this research. First, I limited the measure of specialization based on publications from peer-reviewed journals. I provided reasons for this objective approach earlier in the article, but omitting working papers and books might yield biased results. Working papers are a portion of a scholar's productivity. Some

working papers never get published, but they contribute to a scholar's research focus.[5] So are books. Adding a book to one's productivity, even if after converting it into comparable pages with journal publications, could influence their productivity.

Second, it is vital to recognize that the results are not based on a controlled randomized trial. Although I carefully constructed control/non-tenured groups, before finalizing the results, comparison should be repeated with different groups under different constructions.

[5] There are a few well-known examples of influential working papers that were eventually published many years after they were first circulated as working papers, such as Maskin (1977), which was eventually published in 2008.

Table 3.1: Means of Gender, Extent of Specialization and Publication Quantity

Year	N[1]		Gender			Extent of Specialization			Publication Quantity		
	T[2]	NT[3]	T	NT	p	T	NT	p	T	NT	p
1996	19	25	0.18 (0.39)	0.22 (0.44)	0.79	0.76 (0.12)	0.74 (0.12)	0.69	2.70 (1.45)	1.89 (1.05)	0.15
1997	18	41	0.17 (0.38)	0.27 (0.46)	0.50	0.78 (0.09)	0.63 (0.16)	0.00***	3.06 (1.92)	1.47 (0.83)	0.00***
1998	24	45	0.00 (0.38)	0.33 (0.49)	0.00***	0.81 (0.10)	0.67 (0.14)	0.00***	3.52 (2.14)	1.47 (0.64)	0.00***
1999	17	47	0.18 (0.39)	0.25 (0.44)	0.59	0.75 (0.12)	0.71 (0.13)	0.29	3.41 (2.50)	1.87 (1.03)	0.00**
2000	21	53	0.14 (0.36)	0.21 (0.41)	0.58	0.76 (0.08)	0.68 (0.16)	0.04**	3.90 (1.79)	1.92 (1.18)	0.00***
2001	25	60	0.24 (0.44)	0.21 (0.41)	0.80	0.71 (0.15)	0.70 (0.15)	0.83	3.04 (1.72)	1.79 (0.88)	0.00***
2002	18	61	0.25 (0.44)	0.23 (0.43)	0.89	0.67 (0.17)	0.70 (0.10)	0.58	3.19 (2.00)	1.65 (0.98)	0.00***
2003	28	55	0.19 (0.40)	0.15 (0.37)	0.77	0.66 (0.17)	0.70 (0.11)	0.22	3.15 (1.56)	1.92 (1.20)	0.00***
2004	31	70	0.26 (0.44)	0.14 (0.36)	0.25	0.68 (0.15)	0.67 (0.16)	0.80	3.13 (2.05)	1.83 (1.20)	0.00***
2005	31	72	0.19 (0.40)	0.09 (0.29)	0.31	0.67 (0.14)	0.63 (0.14)	0.32	2.97 (1.74)	1.77 (1.07)	0.01***
2006	25	54	0.13 (0.34)	0.10 (0.31)	0.80	0.69 (0.10)	0.67 (0.12)	0.56	3.25 (1.45)	1.85 (1.18)	0.00***
2007	36	50	0.22 (0.42)	0.14 (0.35)	0.43	0.66 (0.15)	0.65 (0.17)	0.82	3.47 (1.76)	1.91 (1.34)	0.00***
2008	44	55	0.14 (0.35)	0.16 (0.37)	0.82	0.69 (0.15)	0.60 (0.21)	0.15	3.21 (1.98)	2.32 (1.46)	0.08*
2009	27	40	0.23 (0.43)	0.38 (0.51)	0.33	0.63 (0.16)	0.65 (0.16)	0.69	2.81 (1.47)	2.61 (1.56)	0.71

This table summarizes the means for gender, EG index and publication quantity in the dataset, averaged over each subset for each variable three years before tenure. Values are presented separately for tenured and non-tenure groups, along with the p value for the null hypothesis that the means are equal in the two groups.

1. N: sample number;
2. T: tenured group;
3. TN: non-tenured group;
4. Gender: male=0, female=1;
5. Extent of specialization: EG Index;
6. Standard errors are shown in parentheses. ***: difference significant at 0.01 level; **: difference significant at 0.05 level; *: difference significant at 0.1 level.

Table 3.2: Means of Publication Quality, Graduate and Current Department Rank

Year	Publication Quality			Graduate Department Rank			Current Department Rank		
	T[1]	NT[2]	p	T	NT	p	T	NT	p
1996	0.34 (0.24)	0.20 (0.18)	0.14	1.88 (1.62)	2.00 (1.58)	0.46 (0.86)	2.47 (1.46)	3.67 (1.73)	0.07*
1997	0.20 (0.18)	0.21 (0.24)	0.83	2.94 (1.95)	1.87 (1.06)	0.06*	3.61 (1.75)	3.67 (1.45)	0.92
1998	0.25 (0.16)	0.18 (0.15)	0.32	2.38 (1.72)	2.20 (1.26)	0.73	3.00 (1.80)	3.80 (1.57)	0.15
1999	0.14 (0.12)	0.15 (0.10)	0.82	2.23 (1.39)	2.21 (1.41)	0.95	3.76 (1.64)	3.41 (1.50)	0.49
2000	0.20 (0.12)	0.17 (0.20)	0.58	2.76 (2.02)	2.67 (1.74)	0.86	3.52 (1.54)	3.88 (1.42)	0.43
2001	0.20 (0.15)	0.13 (0.08)	0.10*	1.60 (0.71)	2.83 (1.97)	0.01***	3.32 (1.73)	3.96 (1.40)	0.16
2002	0.19 (0.14)	0.14 (0.11)	0.17	2.06 (1.29)	2.73 (1.80)	0.20	3.06 (1.95)	3.73 (1.82)	0.27
2003	0.17 (0.11)	0.18 (0.14)	0.86	1.78 (1.09)	3.00 (1.77)	0.00***	3.33 (1.82)	3.69 (1.83)	0.48
2004	0.15 (0.10)	0.15 (0.10)	0.83	2.29 (1.40)	2.85 (1.77)	0.16	4.16 (1.68)	3.71 (1.72)	0.29
2005	0.18 (0.15)	0.17 (0.17)	0.79	2.16 (1.51)	3.41 (1.87)	0.01***	3.29 (1.74)	4.14 (1.61)	0.08*
2006	0.17 (0.11)	0.12 (0.13)	0.18	2.33 (1.55)	3.50 (1.76)	0.02**	3.00 (1.59)	4.35 (1.50)	0.00***
2007	0.18 (0.10)	0.15 (0.17)	0.35	2.53 (1.78)	2.73 (1.80)	0.68	3.32 (1.90)	3.41 (1.40)	0.86
2008	0.18 (0.11)	0.17 (0.14)	0.82	2.28 (1.45)	2.16 (1.46)	0.76	2.91 (1.57)	3.16 (1.30)	0.54
2009	0.22 (0.12)	0.29 (0.28)	0.23	2.23 (1.68)	2.69 (1.80)	0.43	2.96 (1.66)	3.15 (1.63)	0.73

This table summarizes the means for several key variables in dataset, averaged over each subset for each variable three years before tenure. Values are presented separately for tenured and non-tenure groups, along with the p value for the null hypothesis that the means are equal in the two groups.

1. T: tenured group;
2. TN: non-tenured group;
3. Publication quality: as QJE publication
4. Standard errors are shown in parentheses. ***: difference significant at 0.01 level; **: difference significant at 0.05 level; *: difference significant at 0.1 level.

Table 3.3: Average Extent of Specialization before and after Tenure for Groups 1996, 1999, 2001, 2002, and 2003. After Tenure Publications: The First, Second and Third Year

Group	Extent of Specialization	Non-tenured Group (i)	Tenured Group (ii)	Difference, Tenured Group - Non-tenured Group (iii)
1996	EG Index before tenure	0.74 (0.12)	0.76 (0.12)	0.02 (0.17)
	EG Index after tenure	0.72 (0.14)	0.77 (0.13)	0.05 (0.19)
	Change in mean EG Index	-0.02 (0.18)	0.01 (0.18)	0.03 (0.25)
1999	EG Index before tenure	0.71 (0.13)	0.75 (0.12)	0.04 (0.18)
	EG Index after tenure	0.71 (0.12)	0.78 (0.09)	0.07** (0.15)
	Change in mean EG Index	0.00 (0.18)	0.03 (0.15)	0.03 (0.23)
2001	EG Index before tenure	0.70 (0.15)	0.71 (0.17)	0.01 (0.23)
	EG Index after tenure	0.70 (0.13)	0.65 (0.14)	-0.05 (0.19)
	Change in mean EG Index	0.00 (0.20)	-0.06 (0.22)	-0.06 (0.30)
2002	EG Index before tenure	0.70 (0.10)	0.67 (0.17)	-0.03 (0.20)
	EG Index after tenure	0.63 (0.15)	0.68 (0.18)	0.05 (0.23)
	Change in mean EG Index	-0.07 (0.18)	0.01 (0.25)	0.08 (0.31)
2003	EG Index before tenure	0.71 (0.11)	0.66 (0.17)	-0.05 (0.20)
	EG Index after tenure	0.65 (0.15)	0.70 (0.12)	0.05 (0.19)
	Change in mean EG Index	-0.06 (0.19)	0.04 (0.21)	0.10** (0.28)

This table summarizes the levels and changes in average extent of specialization per scholar for each subset three years before tenure and the first, second and third year after tenure in groups 1996, 1999, 2001, 2002, and 2003. Columns (i) and (ii) are the average extent of specialization data for the tenured and non-tenured groups. The differences in average extent of specialization between tenured and non-tenured group are presented in column (iii). Rows 4, 7 and so on present the changes in average extent of specialization between pre-tenure and post-tenure period for each group. These entries are the differences between the average extent of specialization for the two periods.

Standard errors are shown in parentheses. ***: difference significant at 0.01 level; **: difference significant at 0.05 level; *: difference significant at 0.1 level.

Table 3.4: Average Extent of Specialization before and after Tenure for Groups 2004, 2005, 2006, 2007, and 2009. After Tenure Publications: The First, Second and Third Year.

Group	Extent of Specialization	Non-tenured Group (i)	Tenured Group (ii)	Difference, Tenured Group - Non-tenured Group (iii)
2004	EG Index before tenure	0.67 (0.16)	0.68 (0.15)	0.01 (0.22)
	EG Index after tenure	0.64 (0.18)	0.72 (0.11)	0.08 (0.21)
	Change in mean EG Index	-0.03 (0.24)	0.04 (0.19)	0.07 (0.31)
2005	EG Index before tenure	0.63 (0.14)	0.67 (0.14)	0.04 (0.20)
	EG Index after tenure	0.65 (0.15)	0.65 (0.12)	0.00 (0.19)
	Change in mean EG Index	0.02 (0.21)	-0.02 (0.18)	-0.04 (0.26)
2006	EG Index before tenure	0.67 (0.12)	0.69 (0.10)	0.02 (0.16)
	EG Index after tenure	0.65 (0.16)	0.67 (0.12)	0.02 (0.20)
	Change in mean EG Index	-0.06 (0.20)	-0.03 (0.16)	0.00 (0.26)
2007	EG Index before tenure	0.65 (0.17)	0.66 (0.15)	0.01 (0.23)
	EG Index after tenure	0.60 (0.16)	0.65 (0.16)	0.05 (0.23)
	Change in mean EG Index	-0.05 (0.23)	-0.01 (0.22)	0.04 (0.32)
2009	EG Index before tenure	0.65 (0.16)	0.63 (0.17)	-0.02 (0.23)
	EG Index after tenure	0.58 (0.14)	0.62 (0.12)	0.04 (0.18)
	Change in mean EG Index	-0.07 (0.21)	-0.01 (0.21)	0.06 (0.30)

This table summarizes the levels and changes in average extent of specialization per scholar for each subset three years before tenure and the first, second and third year after tenure in groups 2004, 2005, 2006, 2007, and 2009. Columns (i) and (ii) are the average extent of specialization data for the tenured and non-tenured groups. The differences in average extent of specialization between tenured and non-tenured group are presented in column (iii). Rows 4, 7 and so on present the changes in average extent of specialization between pre-tenure and post-tenure period for each group. These entries are the differences between the average extent of specialization for the two periods.

Standard errors are shown in parentheses. ***: difference significant at 0.01 level; **: difference significant at 0.05 level; *: difference significant at 0.1 level.

Table 3.5: Estimation of Tenure Effect on the Extent of Specialization. After Tenure Publications: The First, Second and Third Year.

Group	Model 1 (i)		Model 2 (ii)		Model 3 (ii)		Sample Size (N)
	δ estimate	Standard error of regression	δ estimate	Standard error of regression	δ estimate	Standard error of regression	
1996	0.03 (0.07)	0.13	0.02 (0.07)	0.13	0.02 (0.07)	0.13	67
1999	0.03 (0.05)	0.12	0.03 (0.05)	0.12	0.02 (0.05)	0.11	89
2001	-0.06 (0.05)	0.14	-0.06 (0.05)	0.14	-0.06 (0.05)	0.14	111
2002	0.08 (0.06)	0.15	0.08 (0.06)	0.15	0.08 (0.06)	0.15	98
2003	0.10* (0.05)	0.14	0.10* (0.05)	0.14	0.09* (0.05)	0.14	118
2004	0.06 (0.05)	0.16	0.06 (0.05)	0.16	0.06 (0.05)	0.16	136
2005	-0.04 (0.05)	0.14	-0.04 (0.05)	0.14	-0.04 (0.05)	0.14	119
2006	0.00 (0.05)	0.13	0.00 (0.05)	0.13	0.00 (0.05)	0.13	98
2007	0.04 (0.06)	0.16	0.04 (0.06)	0.16	0.03 (0.06)	0.15	126
2009	0.06 (0.07)	0.14	0.06 (0.07)	0.15	0.06 (0.07)	0.14	98

In Model 1, δ is estimated without control variables. In Model 2, δ is estimated with control variables: gender, ranking of graduate department, and ranking of employing department during the observation. In Model 3, δ is estimated with control variables: gender, ranking of graduate department, ranking of employing department during the observation, and number of departments worked in before.

Table 3.6: Average Extent of Specialization before and after Tenure for Groups 1996, 1999, 2001, 2002, and 2003. After Tenure Publications: The Second, Third and Fourth Year.

Group	Extent of Specialization	Non-tenured Group (i)	Tenured Group (ii)	Difference, Tenured Group - Non-tenured Group (iii)
1996	EG Index before tenure	0.74 (0.12)	0.76 (0.12)	0.02 (0.17)
	EG Index after tenure	0.74 (0.12)	0.75 (0.09)	0.01 (0.18)
	Change in mean EG Index	-0.00 (0.17)	-0.01 (0.18)	-0.01 (0.25)
1999	EG Index before tenure	0.71 (0.13)	0.75 (0.12)	0.04 (0.18)
	EG Index after tenure	0.69 (0.12)	0.76 (0.11)	0.07* (0.16)
	Change in mean EG Index	-0.02 (0.18)	0.01 (0.16)	0.03 (0.24)
2001	EG Index before tenure	0.7 (0.15)	0.71 (0.17)	0.01 (0.23)
	EG Index after tenure	0.68 (0.13)	0.64 (0.14)	-0.04 (0.19)
	Change in mean EG Index	-0.02 (0.20)	-0.07 (0.22)	-0.05 (0.30)
2002	EG Index before tenure	0.70 (0.10)	0.67 (0.17)	-0.03 (0.20)
	EG Index after tenure	0.63 (0.13)	0.71 (0.17)	0.08* (0.21)
	Change in mean EG Index	-0.08 (0.16)	0.03 (0.24)	0.11* (0.29)
2003	EG Index before tenure	0.71 (0.11)	0.66 (0.17)	-0.05 (0.20)
	EG Index after tenure	0.66 (0.15)	0.68 (0.11)	0.02 (0.19)
	Change in mean EG Index	-0.05 (0.19)	0.02 (0.20)	0.07 (0.28)

This table summarizes the levels and changes in the average extent of specialization per scholar for each subset three years before tenure and the second, third and fourth year after tenure in groups 1996, 1999, 2001, 2002, and 2003. Columns (i) and (ii) are the average extent of specialization data for the tenured and non-tenured groups. The differences in average extent of specialization between tenured and non-tenured group are presented in column (iii). Rows 4, 7 and so on present the changes in average extent of specialization between pre-tenure and post-tenure period for each group. These entries are the differences between the averages extent of specialization for the two periods.

Standard errors are shown in parentheses. ***: difference significant at 0.01 level; **: difference significant at 0.05 level; *: difference significant at 0.1 level.

Table 3.7: Average Extent of Specialization before and after Tenure for Groups 2004, 2005, 2006, 2007, 2009. After Tenure Publications: The second, Third and Fourth Year.

Group	Extent of Specialization	Non-tenured Group (i)	Tenured Group (ii)	Difference, Tenured Group - Non-tenured Group (iii)
2004	EG Index before tenure	0.67 (0.16)	0.68 (0.15)	0.01 (0.22)
	EG Index after tenure	0.66 (0.16)	0.69 (0.12)	0.03 (0.20)
	Change in mean EG Index	-0.01 (0.23)	0.01 (0.19)	0.02 (0.30)
2005	EG Index before tenure	0.63 (0.14)	0.67 (0.14)	0.04 (0.20)
	EG Index after tenure	0.63 (0.17)	0.62 (0.16)	-0.01 (0.23)
	Change in mean EG Index	0.00 (0.22)	-0.05 (0.21)	-0.05 (0.30)
2006	EG Index before tenure	0.67 (0.12)	0.69 (0.10)	0.02 (0.16)
	EG Index after tenure	0.58 (0.18)	0.61 (0.15)	0.03 (0.23)
	Change in mean EG Index	-0.09 (0.22)	-0.08 (0.18)	0.01 (0.28)
2007	EG Index before tenure	0.65 (0.17)	0.66 (0.15)	0.01 (0.23)
	EG Index after tenure	0.59 (0.15)	0.62 (0.16)	0.03 (0.22)
	Change in mean EG Index	-0.06 (0.23)	-0.04 (0.22)	0.02 (0.32)
2009	EG Index before tenure	0.65 (0.16)	0.63 (0.17)	-0.02 (0.23)
	EG Index after tenure	0.60 (0.14)	0.61 (0.15)	0.01 (0.21)
	Change in mean EG Index	-0.05 (0.21)	-0.02 (0.23)	0.03 (0.31)

This table summarizes the levels and changes in the average extent of specialization per scholar for each subset three years before tenure and the second, third and fourth year after tenure in groups 2004, 2005, 2006, 2007, and 2009. Columns (i) and (ii) are average extent of specialization data for tenured and non-tenured group. The differences in the average extent of specialization between tenured and non-tenured groups are presented in column (iii). Rows 4, 7 and so on present the changes in the average extent of specialization between the pre-tenure and post-tenure periods for each group. These entries are the differences between the average extent of specialization for the two periods.

Standard errors are shown in parentheses. ***: difference significant at 0.01 level; **: difference significant at 0.05 level; *: difference significant at 0.1 level.

Table 3.8: Estimation of Tenure Effect on the Extent of Specialization. After Tenure Publications: The Second, Third and Fourth Year.

Group	Model 1 (i)		Model 2 (ii)		Model 3 (ii)		Sample Size (N)
	δ estimate	Standard error of regression	δ estimate	Standard error of regression	δ estimate	Standard error of regression	
1996	-0.008 (0.06)	0.11	-0.009 (0.06)	0.11	-0.014 (0.06)	0.11	67
1999	0.02 (0.05)	0.12	0.02 (0.05)	0.12	0.02 (0.05)	0.12	88
2001	-0.05 (0.06)	0.14	-0.05 (0.05)	0.14	-0.04 (0.05)	0.14	108
2002	0.10* (0.06)	0.14	0.10* (0.06)	0.14	0.10* (0.06)	0.14	95
2003	0.07 (0.05)	0.14	0.06 (0.05)	0.14	0.06 (0.05)	0.14	117
2004	0.02 (0.05)	0.15	0.02 (0.05)	0.15	0.02 (0.05)	0.15	141
2005	-0.05 (0.06)	0.15	-0.06 (0.06)	0.15	-0.05 (0.06)	0.15	118
2006	0.008 (0.06)	0.15	0.003 (0.06)	0.15	-0.003 (0.06)	0.14	99
2007	0.03 (0.06)	0.16	0.02 (0.06)	0.15	0.02 (0.06)	0.16	129
2009	0.03 (0.07)	0.16	0.03 (0.07)	0.16	0.03 (0.07)	0.16	86

In Model 1, δ is estimated without control variables. In Model 2, δ is estimated with control variables: gender, ranking of graduate department, and ranking of employing department during the observation. In Model 3, δ is estimated with control variables: gender, ranking of graduate department, ranking of employing department during the observation, and number of departments worked in before.

Standard errors are shown in parentheses. ***: difference significant at 0.01 level; **: difference significant at 0.05 level; *: difference significant at 0.1 level.

Table 3.9: Average Extent of Specialization before and after Tenure for Groups 1996, 1999, 2001, 2002, and 2003. After Tenure Publications: The First, Second, Third and Fourth Year.

Group	Extent of Specialization	Non-tenured Group (i)	Tenured Group (ii)	Difference, Tenured Group - Non-tenured Group (iii)
1996	EG Index before tenure	0.74 (0.12)	0.76 (0.12)	0.02 (0.17)
	EG Index after tenure	0.75 (0.11)	0.77 (0.10)	0.02 (0.15)
	Change in mean EG Index	0.01 (0.16)	0.01 (0.16)	0.00 (0.23)
1999	EG Index before tenure	0.71 (0.13)	0.75 (0.12)	0.04 (0.18)
	EG Index after tenure	0.71 (0.12)	0.78 (0.09)	0.07** (0.15)
	Change in mean EG Index	0.00 (0.18)	0.03 (0.15)	0.03 (0.23)
2001	EG Index before tenure	0.70 (0.15)	0.71 (0.17)	0.01 (0.23)
	EG Index after tenure	0.70 (0.12)	0.65 (0.14)	-0.05 (0.18)
	Change in mean EG Index	0.00 (0.19)	-0.06 (0.22)	-0.06 (0.29)
2002	EG Index before tenure	0.70 (0.10)	0.67 (0.17)	-0.03 (0.20)
	EG Index after tenure	0.65 (0.12)	0.70 (0.16)	0.05 (0.20)
	Change in mean EG Index	-0.05 (0.16)	0.03 (0.23)	0.08 (0.28)
2003	EG Index before tenure	0.71 (0.11)	0.66 (0.17)	-0.05 (0.20)
	EG Index after tenure	0.67 (0.15)	0.72 (0.10)	0.05* (0.18)
	Change in mean EG Index	-0.04 (0.19)	0.06 (0.20)	0.10** (0.28)

This table summarizes the levels and changes in the average extent of specialization per scholar for each subset three years before tenure and the first, second, third and fourth year after tenure in groups 1996, 1999, 2001, 2002, and 2003. Columns (i) and (ii) are the average extent of specialization data for the tenured and non-tenured groups. The differences in average extent of specialization between tenured and non-tenured group are presented in column (iii). Rows 4, 7 and so on present the changes in average extent of specialization between pre-tenure and post-tenure period for each group. These entries are the differences between the average extent of specialization for the two periods.

Standard errors are shown in parentheses. ***: difference significant at 0.01 level; **: difference significant at 0.05 level; *: difference significant at 0.1 level.

Table 3.10: Average Extent of Specialization before and after Tenure for Groups 2004, 2005, 2006, 2007, and 2009. After Tenure Publications: The First, Second, Third and Fourth Year.

Group	Extent of Specialization	Non-tenured Group (i)	Tenured Group (ii)	Difference, Tenured Group - Non-tenured Group (iii)
2004	EG Index before tenure	0.67 (0.16)	0.68 (0.15)	0.01 (0.22)
	EG Index after tenure	0.66 (0.15)	0.72 (0.11)	0.06 (0.19)
	Change in mean EG Index	-0.05 (0.22)	0.06 (0.19)	0.11 (0.29)
2005	EG Index before tenure	0.63 (0.14)	0.67 (0.14)	0.04 (0.20)
	EG Index after tenure	0.66 (0.12)	0.66 (0.11)	0.00 (0.16)
	Change in mean EG Index	0.03 (0.18)	-0.01 (0.18)	-0.04 (0.25)
2006	EG Index before tenure	0.67 (0.12)	0.69 (0.10)	0.02 (0.16)
	EG Index after tenure	0.61 (0.17)	0.66 (0.12)	0.05 (0.21)
	Change in mean EG Index	-0.06 (0.21)	-0.03 (0.16)	0.03 (0.26)
2007	EG Index before tenure	0.65 (0.17)	0.66 (0.15)	0.01 (0.23)
	EG Index after tenure	0.61 (0.15)	0.66 (0.15)	0.05 (0.21)
	Change in mean EG Index	-0.05 (0.23)	0.00 (0.21)	0.04 (0.31)
2009	EG Index before tenure	0.65 (0.16)	0.63 (0.17)	-0.02 (0.23)
	EG Index after tenure	0.61 (0.13)	0.63 (0.12)	0.02 (0.18)
	Change in mean EG Index	-0.04 (0.21)	0.00 (0.21)	0.04 (0.30)

This table summarizes the levels and changes in average extent of specialization per scholar for each subset three years before tenure and the first, second, third and fourth year after tenure in groups 2004, 2005, 2006, 2007, and 2009. Columns (i) and (ii) are average extent of specialization data for the tenured and non-tenured groups. The differences in average extent of specialization between tenured and non-tenured group are presented in column (iii). Rows 4, 7 and so on present the changes in average extent of specialization between pre-tenure and post-tenure period for each group. These entries are the differences between the averages extent of specialization for the two periods.

Standard errors are shown in parentheses. ***: difference significant at 0.01 level; **: difference significant at 0.05 level; *: difference significant at 0.1 level.

Table 3.11: Estimation of Tenure Effect on the Extent of Specialization. After Tenure Publications: The First, Second, Third and Fourth Year.

Group	Model 1 (i)		Model 2 (ii)		Model 3 (ii)		Sample Size (N)
	δ estimate	Standard error of regression	δ estimate	Standard error of regression	δ estimate	Standard error of regression	
1996	0.003 (0.06)	0.11	0.001 (0.06)	0.11	-0.03 (0.06)	0.11	68
1999	0.03 (0.05)	0.12	0.03 (0.05)	0.12	0.03 (0.05)	0.12	94
2001	-0.05 (0.05)	0.14	-0.06 (0.05)	0.13	-0.05 (0.05)	0.13	113
2002	0.07 (0.06)	0.14	0.07 (0.06)	0.13	0.07 (0.06)	0.14	102
2003	0.10** (0.05)	0.14	0.10** (0.05)	0.13	0.10** (0.05)	0.13	123
2004	0.04 (0.05)	0.15	0.04 (0.05)	0.15	0.04 (0.05)	0.15	144
2005	-0.04 (0.05)	0.13	-0.04 (0.05)	0.13	-0.04 (0.05)	0.12	122
2006	0.02 (0.05)	0.13	0.02 (0.05)	0.13	0.02 (0.05)	0.13	105
2007	0.04 (0.05)	0.15	0.04 (0.05)	0.15	0.04 (0.05)	0.15	132
2009	0.04 (0.06)	0.14	0.04 (0.06)	0.14	0.05 (0.06)	0.14	89

In Model 1, δ is estimated without control variables. In Model 2, δ is estimated with control variables: gender, ranking of graduate department, and ranking of employing department during the observation. In Model 3, δ is estimated with control variables: gender, ranking of graduate department, ranking of employing department during the observation, and number of departments worked in before.

Standard errors are shown in parentheses. ***: difference significant at 0.01 level; **: difference significant at 0.05 level; *: difference significant at 0.1 level.

4 RESEARCH SPECIALIZATION AND PRODUCTIVITY

4.1 Introduction

One of the most consistent findings in the literature on research productivity is that female researchers tend to publish at lower rates than male researchers (Fox 1983; Fox & Faver 1984; Xie & Shauman 1998; Zainab 1999; Nakhaie 2002; Mairesse & Pezzoni 2015). Such differences have been reported in numerous studies of diverse countries (Prpić 2002; Ledin *et al.* 2007; Abramo *et al.* 2009; Larivière *et al.* 2011) and disciplines (Bordons *et al.* 2003; Leahey 2006; Peñas & Willett 2006; Taylor *et al.* 2006), spanning decades (Bentley 2011; van Arensbergen *et al.* 2012) and using a wide range of measures (Long 1992; Powell *et al.* 2009).

This well-established finding leads to the following questions: Why do male researchers achieve better performance than female researchers? Which factors lead male researchers to produce more? After reviewing many explanations in the literature, I assert that documenting gender difference in productivity is one thing, while accounting for it is another. The variation in publication may be clear; the explanations are not.

Previous research into gender differences of productivity have considered many factors. Zukerman (2001) categorized related explanations into four different types: scientific ability, self-selection, social selection, and accumulated disadvantage. However, investigations into supposed related factors from the above four categories do not show conclusive results (Xie & Shauman 1998; Fuchs *et al.* 2001; Wenneras & Wold 2001; Prpić 2002; Stack 2004; Fox 2005; Brink *et al.* 2006; Van Den Brink & Stobbe 2009; Hunter &

Leahey 2010). Despite these efforts, the persistently inadequate explained gender differences in academic publication still remain of concern to researchers.

Ellison (2000) pointed out a fairly common perception is that economics research is becoming more complex and the field more specialized over the last few decades. There is also widespread anecdotal evidence that specialization matters, and the productivity gains realized from specializing seem intuitive. In addition, females might self-select to work more broadly, while male economists prefer to work restrictedly on limited topics. However, there do not appear to have been many detailed studies that have actually tried to measure the degree of research specialization and utilized it to test the effects in research performance by gender. Empirical research developing and measuring the degree of individuals' research specialization is surprisingly sparse. The most-related study to this research might be Leahey (2006) who examined the extent of the specialization index by comparing the cumulative number of publications to the cumulative number of unique keyword descriptors for journal articles. In her study, a probability sample of academics in two disciplines (sociology and linguistics) was used to address the question of whether the extent of research specialization explains the process gender affecting productivity. The basic finding is that the extent of research specialization plays an important role, as being more focused on a restricted number of subfields improves men's productivity.

Figure 4.1 motivates the paper, as it provides an overview of productivity and extent of specialization measures attained by female and male economists every three years after graduation in one of the ten fields. The EG index and QJE publications measure the extent of specialization and productivity, explained in the following, but the figure provides

evidence that female economists seem to specialize less and publish less generally with a few exceptions. In addition, although values for different triennial periods under observations show variations within each sub-discipline, they are usually consistent with the general results. This leads to the question of whether gender differences in productivity are due to the gender difference in the extent of specialization. It is likely that female and male economists specialize to different degrees and the extent to which one's research program is specialized affects productivity rates.

In this paper, I contribute to the extant literature examining gender difference in productivity in three aspects. First, in addition to Leahey's (2006) study which is based on the sample from sociology and linguistics, I study researchers from economics to check how the extent of specialization affects female and male economists' research performance.

Second, I extend the understanding of this process by further inquiring into how the extent of specialization mediates the gender effect on productivity across generations. Several studies have shown that gender difference in productivity changes over time (Bentley 2011; van Arensbergen *et al.* 2012). As this study tries to find how the degree of specialization explains productivity, an analysis of different generations will inform the related question as to whether the effect is persistent.

At last, I turn to the subfields in which economists work. Economics has gradually grown into a large discipline ,and main trends have changed over the last decade (Karbownik & Knauff 2009). There exists gender differences in the distribution of academics across areas of specialization in economics research (Hamermesh 2005). Even though the fraction of female economists chose women's topics—e.g., female labor supply

behavior, gender discrimination, economics of the family, etc.—is smaller today, such topics are still disproportionate among new female PhDs. Dolado, Felgueroso, and Almunia (2012) also noted that women are unevenly distributed across fields. In addition, sub-disciplines in Economics are heterogeneous. For example, research methods, strategies and publication and citation patterns may differ substantially between *Econometrics* and *Economics History and Thought*. Hence, a field study with a discipline-context control may be valuable.

The remainder of the paper is organized as follows. Section 4.2 documents the main facts about the distribution of female and male economists across fields; it also analyzes how female and male economists differ in productivity and extent of specialization by time and field. Econometric results are presented in Sections 4.3. Finally, section 4.4 concludes.

4.2 Data Summary

4.2.1 Number of Publications by Gender and Field

Table 4.1 presents the number difference among publications in all and one of the ten fields for female and male economists. One can observe significant differences between female and male economists in terms of frequencies of the fields. In all fields, male economists publish more than female economists. *Labor and Consumer Economics* has the largest number of articles published by female economists, and the share is also the highest, 22.84%, but it is still a very small share compared to male economists, which is 77.17%. The number of articles belongs to *Economic History and Thought* is the smallest, but the share of female economists is 22.52%, which is just less than the share in *Labor and Consumer Economics*. Female economists publish the least in *Resource and Agricultural*

Economics, and only with a share of 7.26%. The share of female economists in all other seven fields varies between 9% and 16%.

4.2.2 Mean Values of Extent of Specialization and Publication Quality

For the purpose of this study, analyses are arranged in the following ways. First, I considered all 699 faculty together in the sample. Then I divided the sample according to graduation year and fields. I listed the means of the whole sample in all tables used to present the means of extent of specialization and productivity for comparison. As a whole sample, the mean QJE publications is 0.14 for female and 0.19 for male. Females on average publish 35 percent less than males. Standard deviations indicate greater variability among females.

Data from Tables 4.2 and 4.3 show substantial differences in the extent of specialization and productivity for all four cohorts. Cohorts are grouped according to the year they received their doctoral degree. Of all four cohorts, males are more focused than females. The difference between male and female economists is significant in the 1995-1999 cohort. The specialization indices are highest in the 1990-1994 cohort and decrease as graduation year increases for both genders. Male economists have higher productivity in all four cohorts, although the differences are not substantial. Higher levels of specialization accompany higher productivity of all four cohorts, suggesting that the extent of specialization might affect productivity positively.

Tables 4.4 and 4.5 indicate the mean values for the extent of specialization and productivity by field. Compared to Tables 4.2 and 4.3, when data are disaggregated by fields, the data show several interesting points. Firstly, there are significant differences in

the extent of specialization between genders for *IO/ Business Economics, Microeconomics Theory, Trade and Development* and *Economic History and Thought*. For *Public Economics*, both female and male economists share the same extent of specialization. The EG index is 0.69, which indicates that the frequency with which I see pairs of papers by the same author being in the same subfield of *Public Economics* matches what would be expected if 69 percent of authors wrote all of their papers in a single subfield and 31 percent of authors wrote in subfields that were completely uncorrelated from paper to paper. For *Labor and Consumer Economics* and *Macroeconomics*, females have more narrowed research than male. Of all other fields, males tend to be more focused on a restricted number of subfields, whereas females' research are characterized by more breadth. In addition, when sorted by fields, the data of specialization index show strong heterogeneity among fields. Both females and males work most narrowly within the field of *Econometrics*, while doing the opposite within *Economic History and Thought*. The Ellison-Glaeser indices for each gender in *Econometrics* are female with 0.79 and male with 0.80, compared to *Economic History and Thought*, 0.42 and 0.53 respectively.

Secondly, data of the average production of both male and female reveal gender differences in productivity. According to an analysis of the whole sample, females on average publish 35 percent less than males, and the standard deviations indicate greater variability among females. However, when the data are disaggregated by fields, the picture is different. To my surprise, females do not publish less than males in all ten fields. Females have more or equal articles as males in four fields: *Labor and Consumer Economics, Resource and Agriculture Economics, Economic History and Thought* and *Financial Economics.* This finding has not been observed before, since most previous studies do not

consider differences between subfields in economics (Fox 1983; Fox & Faver 1984; Xie & Shauman 1998; Zainab 1999; Nakhaie 2002; Mairesse & Pezzoni 2015).

Thirdly, it is evident that productivity is correlated to the extent of specialization, although the direction might vary among fields. Independent of gender, higher degree of specialization results in higher productivity in *Labor and Consumer Economics, IO/ Business Economics, Microeconomic Theory, Trade and Development, Public Economics, Econometrics* and *Financial Econometrics*. The opposite is true for the areas of *Macroeconomics, Resource and Agriculture Economics* and *Economic History and Thought.*

4.3 Empirical model and results

4.3.1 Econometric Model

Figure 4.2 presents a simple model for illustrative purposes. Gender's effect on productivity could be examined in a simple model. However, this direct effect could hide important indirect effects which are an important part of understanding the difference. This study aims to find out how gender difference in productivity confounds other gender-related factors, specifically the extent of specialization. The simple model illustrated in Figure 4.2 might not be sufficient for the analysis necessary to figure out the mediate effects of extent of specialization.

The model presented in Figure 4.3 decomposes gender's effect on productivity into two parts: a direct effect and an indirect effect through the extent of specialization. In this setup, I am able to find out the relative importance of the indirect effect of gender on

productivity through the extent of specialization. When gender's indirect effect is large, I can understand the process by which how gender's effect on productivity works.

I used path analysis, a simultaneous equation modeling, to assess the mediating effects of the extent of research specialization. Xie and Shauman (1998) pointed out that, in order to analyze how the extent of research specialization mediates gender difference in research productivity, the following condition would have to be satisfied: the effect of the extent of research specialization has on productivity should be in the opposite direction compared to the effect gender has on the extent of research specialization. This condition is satisfied in this study, since I expected the extent of specialization to affect productivity positively and to be negatively related to gender.

The model is specified in the following two equations:

$$P_i = \alpha + \beta_1 G_i + \beta_2 S_i + \gamma' Z_i + \varepsilon_i \quad (1)$$

$$S_i = \alpha + \beta_1 G_i + \epsilon_i \quad (2)$$

The dependent variable, P_i in equation (1) is the accumulated productivity of individual i in the observed period. G_i indicates gender. S_i is the index of extent of research specialization in the period when the productivity is measured. The vector of individual-level controls, Z_i, includes career age, current position rank, rankings of current employing department and PhD granting department.

4.3.2 Results

The separate effect of each independent variable on productivity (QJE equivalent publications) is indicated in Table 4.8, Table 4.9 and Table 4.10.

4.3.2.1 Whole Sample

I begin the analysis with the whole sample. I have already seen from the descriptive tables (Tables 4.6 and 4.7) that men and women differ greatly in their productivity and women may tend to have less specialized research. Results from the model show the expected direction of the effect. The extent of specialization variable is clearly the strongest predictor of productivity. Male economists specialize more than female economists and the extent of specialization increases productivity. Each of the effect is statistically significant at the 0.01 level. For the whole sample, both genders' direct and indirect effects on productivity are significant, and the indirect effect on productivity through specialization is almost three times larger than gender's direct effect on productivity. Except ranking of current employing department, all other control variables, including career age, current position rank and ranking of PhD granting department, are positively associated with productivity.

4.3.2.2 An Analysis of Different Cohorts

Table 4.8 provides information for the four-generation samples. In line with the whole sample, the extent of specialization is also the strongest predictor of productivity for all generations. The effect differs among four generations. It has the largest effect in the 2000-2004 cohort, and the least effect in the youngest generation, 2005-2009. When comparing the degree of effect that the extent of specialization has on productivity between different generations, the effect on the 1990-1994 cohort is more than two times larger than the 1995-1999 cohort and even larger between the 1990-1994 cohort and other two younger generations. All in all, the effect of the extent of specialization on productivity might be on

the long-run side. The effect of restricting one's research to a limited number of topics becomes more obvious as time goes by.

The result also demonstrates what I found descriptively: females tend to publish fewer articles than men, a result consistent between older and younger generations. The direct effects of gender on productivity are substantial and significant for the 1990-1994 cohort, 1995-1999 cohort and 2000-2004 cohort; while the indirect effects on productivity are mild and only significant for the 1995-1999 cohort. Both indirect and direct effects have the expected direction for the youngest generation, 2005-2009 cohort, although they are not significant. In addition, no matter the older or younger generation, gender's indirect effect on productivity is less than the direct effect, which suggests that, although female economists tend to specialize to a lower degree and this might mean a lower productivity rate, other factors should be considered before concluding. The analysis shows that the extent of specialization is important to the gender difference in the process of research.

Different from the whole sample, the ranking of PhD-granting departments and current employing departments generally does not promote productivity rate. Career age is positively associated with productivity for the younger cohorts, 2000-2004 and 2005-2009 cohorts, but it fails to achieve significance for the older cohorts, 1990-1994 and 1995-1999 cohorts. Arguably, time devoted to research is an important factor for publication rate; however, the marginal effect of time is decreasing and finally diminishing. Being associate or full professor increases productivity significantly across all generations. Higher rank might give economists more opportunity to access resources to enhance their productivity rate.

4.3.2.3 A More Detailed View of Specific Fields

Previous analysis is done at the level of the Economics discipline as a whole. What would happen if I focused on specific disciplines? The results from Table 4.9 and Table 4.10 for different fields are mixed. I noticed that specialization has a significant positive effect in all fields except *Economic History and Thought*. According to the coefficients, the relationship of extent of specialization to productivity is strongest for the *Econometrics* (4.42). This might be due to the characteristics of *Econometrics*. Research in *Econometrics* tries to find models or estimators that have desirable statistical properties. Thoroughly understanding knowledge in a specific topic requires a great deal of time and effort. Researchers might benefit from limiting their research topics and digging deeply.

How the extent of specialization mediates the effects of gender on productivity differs greatly among fields. Some fields even show opposite results. First, in line with the whole sample, in three fields, *Microeconomics Theory, Trade and Development* and *IO/Business Economics*, gender's indirect effects on productivity are significant. Male economists are more focused in these fields than female economists and have a higher productivity rate. Second, per the descriptive table, female and male economists do not differ significantly in their productivity in the following four fields: *Macroeconomics, Financial Economics, Public Economics* and *Econometrics*. Model results are consistent with the descriptive data. Gender's indirect and direct effects on productivity are both insignificant, although they are in the expected direction. Third, so far, all model results show that females are less focused and miss out on important ways to improve their productivity. However, the model performs in the opposite way in *Labor and Consumer Economics, Resource and Agricultural Economics* and *Economic History and Thought*. As

with other fields, females tend to not work more broadly. However, what's different is that females publish more than males in these fields even with lower degrees of specialization, especially in *Labor and Consumer Economics* and *Economic History and Thought*, the two fields wherein the direction in which gender affects specialization differs from what I expected. Both gender's direct and indirect effect on productivity is positive. In addition, the direct effect is significant.

Other factors, including career age, current position rank and rankings of current employing department and PhD-granting department, becomes insignificant except current position rank in *Econometrics, Labor and Consumer Economics, Microeconomics* and *Macroeconomics* and PhD-granting department ranking in *Microeconomics* and *Public Economics* .

To summarize, the model evaluating the impacts of the extent of research specialization as an intervening factor performs well in explaining gender differences in productivity for the whole sample and four different generations. Male economists specialize more and thereby publish more, when controlling for other factors. However, how the differences in the research processes influence productivity are not consistent when I deal with different fields. In *Microeconomics Theory, Trade and Development* and *IO/Business Economics*, females significantly specialize in lower levels and publish less. In *Labor and Consumer Economics*, females have both higher productivity and the extent of research specialization. In *Financial Economics, Public Economics* and *Econometrics*, although there are gender differences in productivity and extent of specialization, effects are not significant. Findings from *Resource and Agricultural Economics* and *Economic*

History and Thought are contrary to the expectation and different from all other fields: females specialize less, whereas they have higher quality of publications.

4.4 Conclusion

The main objective of this study is to explain gender difference in productivity via gender differences in the extent of research specialization. I began with the expectation that female and male economists employ different research processes. Female and male economists specialize to different degrees, resulting in different productivity rate. For this purpose, I performed the analysis on different levels.

First, I analyzed economists across ten fields and twenty-five years, finding that the extent of specialization is a critical intervening variable in economics, which is in line with Leahey's (2006) study in the sociology of science. Working in the same area or closely related area repeatedly promotes productivity, but females tend to spread out their research; therefore, they have lower productivity. This mediating effect is large and statistically significant. Second, when I conducted the analysis for different generations grouped according to graduation years, the results are the same as the whole sample. Moreover, the extent of research specialization has a larger effect on productivity for the older generation relative to younger generations. As experience accumulates, having specialized research promotes even more productivity, both for female and male economists. Third, findings from ten fields are varied. For *Macroeconomics, Financial Economics, Public Economics* and *Econometrics*, gender, extent of specialization and productivity are related in the expected direction, but not significantly. For *Microeconomics Theory, Trade and Development, IO/Business Economics, Labor and Consumer Economics, Resource and*

Agricultural Economics and *Economic History and Thought*, extent of specialization proves to be a critical variable, although total effect of gender's direct and indirect effect on productivity is not all the same and sometimes even opposite in some fields.

In the future, further investigations of disposition characteristics of female and male scholars might help to reveal why females tend to specialize different from male even when they work in the same field. Characteristics of specific fields might play an important role in explaining why higher degrees of specialization will enhance productivity rates in some fields, while decrease it in other fields. For example, methods used in *Econometrics* and *Economic History and Thought* to conduct research differ substantially.

Table 4.1: Number and Percentage of Publications by Gender and Field

Field	All	Female	Male
All	11230 (100)	1603 (14.27)	9627 (85.73)
Labor and Consumer Economics	2361	539 (22.83)	1822 (77.17)
Macroeconomics	1906	215 (11.28)	1691 (88.72)
IO/ Business Economics	1250	152 (12.16)	1098 (87.64)
Microeconomic Theory	1176	123 (10.46)	1053 (89.54)
Trade and Development	1088	152 (13.97)	936 (86.03)
Public Economics	1082	107 (9.89)	975 (90.11)
Econometrics	1080	137 (12.69)	943 (87.31)
Financial Economics	529	83 (15.69)	446 (84.31)
Resource and Agricultural Economics	496	36 (7.26)	460 (92.74)
Economic History and Thought	262	59 (22.52)	203 (77.48)

Numbers in parenthesis are the percentage of articles published by each gender in each field. Others are the number of articles published by each gender. Fields are presented in order of frequency for all economists.

Table 4.2: Average Extent of Specialization of Economists by Cohort: 1990-1994, 1995-1999, 2000-2004, and 2005-2009

Graduation Year	Female	Male	p-value
1990-1994	0.77 (0.08)	0.80 (0.08)	0.17
1995-1999	0.73 (0.10)	0.76 (0.08)	0.06
2000-2004	0.70 (0.11)	0.72 (0.10)	0.34
2005-2009	0.61 (0.19)	0.64 (0.14)	0.15
1990-2009	0.68 (0.16)	0.72 (0.12)	<0.0001

This table presents summary statistics of the Ellison-Glaeser index for the full sample and the difference in means for female and male economists computed by each cohort. Values are the unweighted means of the indices across female/male economists with at least two such publications.

Table 4.3: Average Productivity of Economists by Cohort: 1990-1994, 1995-1999, 2000-2004, 2005-2009

Graduation Year	Female	Male	*p*-value
1990-1994	0.15 (0.09)	0.16 (0.09)	0.70
1995-1999	0.13 (0.07)	0.15 (0.07)	0.16
2000-2004	0.14 (0.06)	0.16 (0.07)	0.35
2005-2009	0.15 (0.10)	0.16 (0.04)	0.61
All	0.15 (0.09)	0.16 (0.08)	0.17

This table presents summary statistics of QJE Publications for the full sample and the difference in means for female and male economists in each cohort adjusted by journal ranking and co-authors.

Table 4.4: Average Within-field Specialization of Economists by Gender and Field

Field	Female	Male	p-value
Labor and Consumer Economics	0.64 (0.16)	0.63 (0.12)	0.66
Macroeconomics	0.65 (0.16)	0.64 (0.16)	0.03
IO/ Business Economics	0.58 (0.21)	0.65 (0.16)	0.05
Microeconomic Theory	0.68 (0.17)	0.76 (0.14)	0.01
Trade and Development	0.52 (0.21)	0.60 (0.20)	0.02
Public Economics	0.69 (0.20)	0.69 (0.19)	0.97
Econometrics	0.79 (0.14)	0.80 (0.11)	0.92
Financial Economics	0.65 (0.24)	0.66 (0.18)	0.83
Resource and Agricultural Economics	0.52 (0.28)	0.63 (0.20)	0.15
Economic History and Thought	0.42 (0.28)	0.53 (0.26)	0.10
All	0.68 (0.16)	0.72 (0.12)	<0.0001

This table presents summary statistics of Ellison-Glaeser index for the full sample and the difference in means for female and male economists computed by treating publications in a field as the universe. Values are the unweighted means of the indices across female/male economists with at least two such publications in one of ten fields.

Table 4.5: Average Productivity of Economists by Gender and Field

Field	Female	Male	p-value
Labor and Consumer Economics	0.16 (0.14)	0.14 (0.10)	0.40
Macroeconomics	0.14 (0.11)	0.16 (0.11)	0.17
IO/ Business Economics	0.14 (0.09)	0.16 (0.14)	0.39
Microeconomic Theory	0.10 (0.07)	0.16 (0.12)	0.02
Trade and Development	0.12 (0.16)	0.14 (0.10)	0.46
Public Economics	0.13 (0.20)	0.14 (0.13)	0.68
Econometrics	0.13 (0.07)	0.16 (0.09)	0.10
Financial Economics	0.15 (0.11)	0.15 (0.13)	0.99
Resource and Agricultural Economics	0.14 (0.10)	0.10 (0.08)	0.14
Economic History and Thought	0.16 (0.13)	0.14 (0.15)	0.75
All	0.14 (0.09)	0.19 (0.04)	0.06

This table presents summary statistics of QJE Publications for the full sample and the difference in means for female and male economists in a field adjusted by journal ranking and co-authors.

Table 4.6: Variable Description and Means by Cohort: 1990-1994, 1995-1999, 2000-2004, 2005-2009

Variables	All	1990-1994	1995-1999	2000-2004	2005-2009
Productivity	0.15	0.16	0.14	0.15	0.16
QJE publications	(0.08)	(0.09)	(0.07)	(0.07)	(0.10)
Gender	0.20	0.19	0.18	0.17	0.26
Female=1; Male=0	(0.40)	(0.39)	(0.38)	(0.38)	(0.44)
Specialization	0.72	0.79	0.76	0.71	0.63
Extent of specialization, EG index	(0.13)	(0.08)	(0.08)	(0.10)	(0.16)
Career age	13.75	22.00	16.88	12.08	7.09
Years since PhD	(5.68)	(1.39)	(1.41)	(1.38)	(1.34)
Current position rank	1.17	1.72	1.67	1.18	0.40
Assistant=0; Associate=1; Professor=2	(0.78)	(0.52)	(0.51)	(0.61)	(0.56)
Current employing department	71.97	65.17	81.05	65.82	75.47
RePEc ranking of department prestige	(66.56)	(63.08)	(69.78)	(65.03)	(67.27)
PhD-granting department	39.41	38.36	34.22	43.30	40.46
RePEc ranking of department prestige	(54.64)	(55.97)	(46.88)	(57.88)	(56.15)

This table presents summary statistics of the variables used in the path analysis for all sample and different cohosts. Cohorts are grouped by graduation year. Values in brackets are standard deviation.

Table 4.7: Variable Description and Means by Field

Variables	All	EHT	EM	FE	IO/BE	LCE	MACRO	MICRO	PE	RAE	TD
Productivity	0.15	0.15	0.16	0.15	0.15	0.15	0.16	0.15	0.14	0.10	0.14
QJE productivity	(0.08)	(0.15)	(0.09)	(0.13)	(0.14)	(0.11)	(0.11)	(0.12)	(0.14)	(0.08)	(0.11)
Gender	0.20	0.23	0.16	0.16	0.15	0.20	0.18	0.14	0.13	0.11	0.19
Female=1; Male=0	(0.40)	(0.42)	(0.36)	(0.37)	(0.35)	(0.40)	(0.36)	(0.34)	(0.34)	(0.31)	(0.39)
Specialization	0.72	0.50	0.80	0.66	0.64	0.64	0.64	0.74	0.69	0.61	0.58
Extent of specialization, EG index	(0.13)	(0.26)	(0.12)	(0.19)	(0.17)	(0.16)	(0.16)	(0.14)	(0.19)	(0.21)	(0.20)
Career age	13.75	15.53	14.65	15.64	15.38	14.32	14.88	14.46	15.15	15.56	15.27
Years since PhD	(5.68)	(5.15)	(5.94)	(5.28)	(5.69)	(5.52)	(5.84)	(5.54)	(5.62)	(5.63)	(5.73)
Current position rank	1.17	1.45	1.33	1.45	1.33	1.27	1.30	1.32	1.39	1.37	1.35
Assistant=0; Associate=1; Professor=2	(0.78)	(0.68)	(0.75)	(0.68)	(0.75)	(0.77)	(0.76)	(0.74)	(0.72)	(0.69)	(0.75)
Current employing department	71.97	64.06	72.44	60.55	69.40	69.18	69.31	60.96	68.74	92.27	71.56
RePEc ranking of department prestige	(66.56)	(63.39)	(68.43)	(63.50)	(66.86)	(67.49)	(66.34)	(61.44)	(69.81)	(71.90)	(67.60)
PhD-granting department	39.41	38.12	42.52	45.43	36.92	36.93	48.83	42.30	42.57	40.73	38.33
RePEc ranking of department prestige	(54.64)	(58.89)	(55.76)	(60.21)	(52.86)	(54.36)	(57.26)	(54.65)	(58.87)	(54.33)	(56.65)

This table presents summary statistics of the variables used in the path analysis for all sample and different fields. Values in the brackets are standard deviation

Table 4.8: Model Results by Cohort: 1990-1994, 1995-1999, 2000-2004, 2005-2009

	Variables	All	1990-1994	1995-1999	2000-2004	2005-2009
Effects on Productivity	Gender Female=1; Male=0	-0.14*** (0.05)	-0.22** (0.11)	-0.17* (0.02)	-0.24*** (0.02)	-0.09 (0.09)
	Specialization Extent of specialization, EG index	1.99*** (0.15)	4.44*** (0.52)	2.43*** (0.44)	1.80*** (0.32)	1.46*** (0.25)
	Career age Years since PhD	0.04*** (0.004)	-0.002 (0.028)	-0.01 (0.03)	0.05** (0.02)	0.13*** (0.03)
	Current position rank Assistant=0; Associate=1; Professor=2	0.33*** (0.04)	0.24** (0.08)	0.45*** (0.08)	0.25*** (0.06)	0.21*** (0.08)
	Current employing department RePEc ranking of department prestige	-0.001*** (0.0003)	-0.0009 (0.0006)	-0.0006 (0.0006)	-0.002*** (0.0005)	-0.0006 (0.0006)
	PhD-granting department RePEc ranking of department prestige	0.0004 (0.0004)	-0.0007 (0.0007)	0.002 (0.0008)	0.0003 (0.0006)	0.0004 (0.0007)
	Constant	-0.19 (0.12)	-0.99 (0.77)	0.16 (0.57)	0.04 (0.38)	-0.52* (0.28)
	R Squared	0.54	0.36	0.36	0.33	0.28
Effects on Specialization	Gender Female=1; Male=0	-0.04*** (0.01)	-0.02 (0.02)	-0.03* (0.10)	-0.02 (0.09)	-0.04 (0.03)
	Constant	0.72*** (0.006)	0.80*** (0.007)	0.76*** (0.007)	0.72*** (0.008)	0.64*** (0.01)
	R Squared	0.02	0.02	0.02	0.03	0.02
	N	699	147	157	188	207
	Chi-square(df)	1386.17(21)	119.54(21)	168.17(21)	162.62(21)	171.39(21)
	AIC	252.85	65.05	91.71	76.35	74.03

This table presents estimate of the variables used in the path analysis for all sample and different cohosts. Cohorts are grouped by graduation year.

Standard errors are shown in parentheses. ***: difference significant at 0.01 level; **: difference significant at 0.05 level; *: difference significant at 0.1 level.

Table 4.9: Model Results by Field: Economic History and Thought, Econometrics, Financial Economics, Industry Organization/ Business Economics

	Variables	All	EHT	EM	FE	IO/BE
Effects on Productivity	Gender Female=1; Male=0	-0.14*** (0.05)	0.06 (0.16)	-0.04 (0.21)	-0.03 (0.13)	0.18 (0.13)
	Specialization Extent of specialization, EG index	1.99*** (0.15)	0.08 (0.24)	4.42*** (0.61)	0.95*** (0.25)	2.04*** (0.27)
	Career age Years since PhD	0.04*** (0.004)	0.01 (0.02)	-0.02 (0.02)	0.005 (0.01)	0.003 (0.01)
	Current position rank Assistant=0; Associate=1; Professor=2	0.33*** (0.04)	-0.08 (0.12)	0.42*** (0.14)	-0.004 (0.09)	0.11 (0.08)
	Current employing department RePEc ranking of department prestige	-0.001*** (0.0003)	-0.001 (0.001)	-0.001 (0.001)	-0.002 (0.001)	0.001 (0.001)
	PhD-granting department RePEc ranking of department prestige	0.0004 (0.0004)	0.001 (0.001)	0.001 (0.001)	-0.001 (0.001)	-0.001 (0.001)
	Constant	-0.19 (0.12)	0.31 (0.25)	-2.43*** (0.53)	-0.05 (0.24)	-0.73*** (0.22)
	R Squared	0.54	0.03	0.34	0.13	0.18
Effects on Specialization	Gender Female=1; Male=0	-0.04*** (0.01)	-0.11* (0.07)	-0.02 (0.03)	-0.01 (0.04)	-0.07** (0.03)
	Constant	0.72*** (0.006)	0.53*** (0.03)	0.80*** (0.01)	0.66*** (0.02)	0.65*** (0.01)
	R Squared	0.02	0.03	0.01	0.01	0.02
	N	699	86	134	157	281
	Chi-square(df)	1386.17(21)	78.18(21)	176.89(21)	166.00(21)	268.50(21)
	AIC	252.85	68.07	67.05	90.10	68.14

This table shows estimate of the variables used in the path analysis for all sample and different fields: Economic History and Thought, Econometrics, Financial Economics, Industry Organization/ Business Economics

Standard errors are shown in parentheses. ***: difference significant at 0.01 level; **: difference significant at 0.05 level; *: difference significant at 0.1 level.

Table 4.10: Model Results by Field: Labor and Consumer Economics, Macroeconomics, Microeconomics, Public Economics, Resource and Agriculture Economics, Trade and Development

	Variables	LCE	MACRO	MICRO	PE	RAE	TD
Effects on Productivity	Gender Female=1; Male=0	0.29*** (0.09)	-0.12 (0.13)	-0.04 (0.15)	-0.24 (0.16)	-0.02 (0.32)	-0.14 (0.14)
	Specialization Extent of specialization, EG index	3.30*** (0.24)	2.88*** (0.29)	2.83*** (0.36)	2.24*** (0.28)	2.74*** (0.44)	1.66*** (0.26)
	Career age Years since PhD	0.003 (0.009)	0.006 (0.01)	0.02 (0.01)	0.006 (0.01)	0.007 (0.02)	-0.001 (0.01)
	Current position rank Assistant=0; Associate=1; Professor=2	0.19*** (0.07)	0.19** (0.08)	0.17* (0.09)	0.12 (0.10)	0.08 (0.19)	0.10 (0.10)
	Current employing department RePEc ranking of department prestige	0.001 (0.0005)	-0.001 (0.001)	-0.001 (0.001)	-0.001 (0.001)	-0.001 (0.001)	-0.001 (0.001)
	PhD-granting department RePEc ranking of department prestige	-0.002 (0.001)	0.001 (0.001)	0.002** (0.001)	0.002** (0.001)	0.001 (0.002)	-0.001 (0.002)
	Constant	-1.27*** (0.19)	-1.01*** (0.24)	-1.67*** (0.31)	-1.11*** (0.26)	-0.92** (0.41)	-0.28 (0.23)
	R Squared	0.37	0.30	0.30	0.30	0.34	0.18
Effects on Specialization	Gender Female=1; Male=0	0.01 (0.02)	0.002 (0.03)	-0.07** (0.02)	-0.001 (0.04)	-0.11 (0.07)	-0.08** (0.04)
	Constant	0.63*** (0.01)	0.64*** (0.01)	0.76*** (0.01)	0.69*** (0.01)	0.62*** (0.02)	0.60*** (0.02)
	R Squared	0.02	0.02	0.03	0.0001	0.03	0.03
	N	373	278	200	183	83	219
	Chi-square(df)	501.47(21)	371.82(21)	230.08(21)	214.61(21)	125.21(21)	242.01(21)
	AIC	91.94	102.26	74.81	86.41	72.75	86.83

This table shows estimate of the variables used in the path analysis for all sample and different fields: Labor and Consumer Economics, Macroeconomics, Microeconomics, Public Economics, Resource and Agriculture Economics, Trade and Development

Standard errors are shown in parentheses. ***: difference significant at 0.01 level; **: difference significant at 0.05 level; *: difference significant at 0.1 level.

Figure 4.1: Productivity and the extent of specialization for female and male economists

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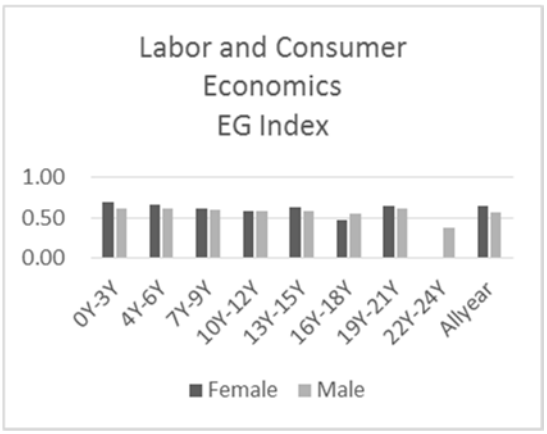

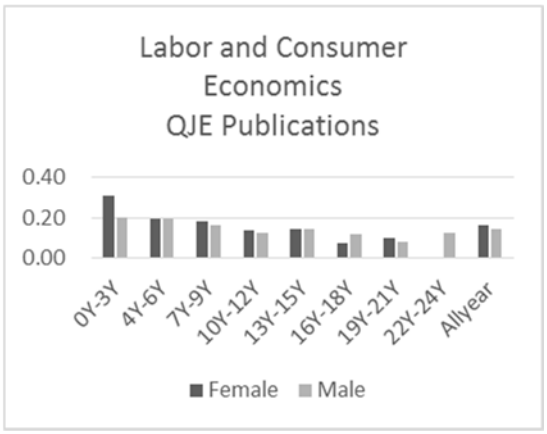

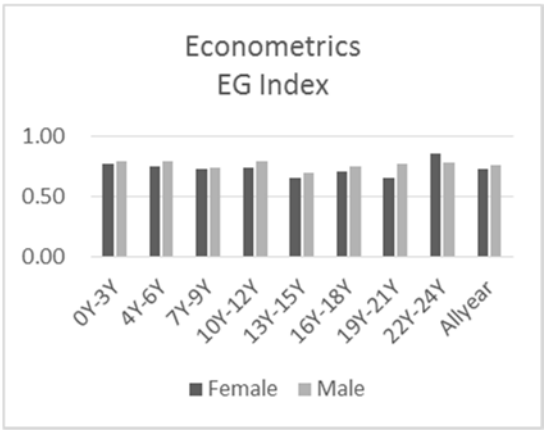

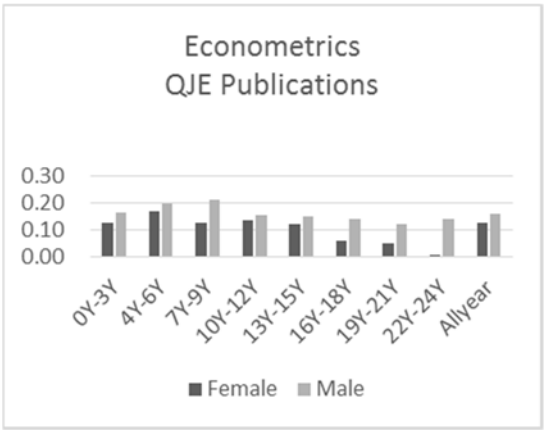

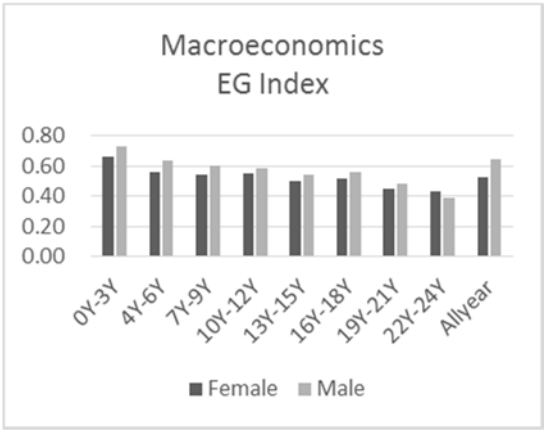

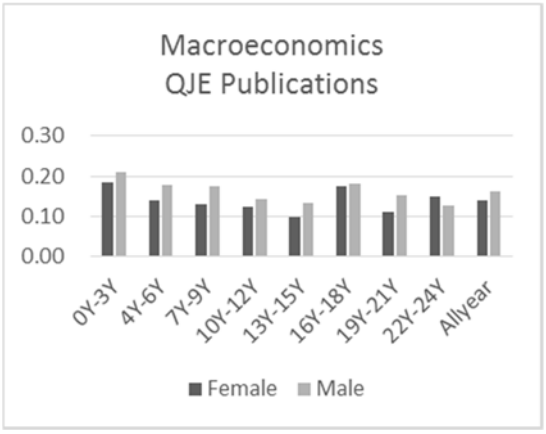

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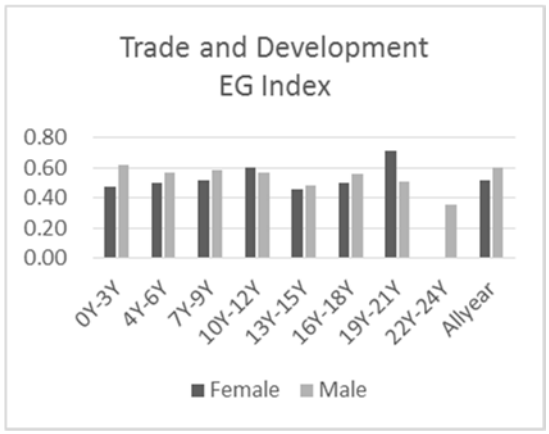

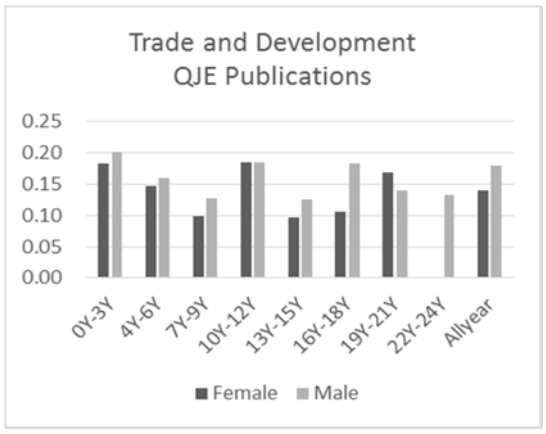

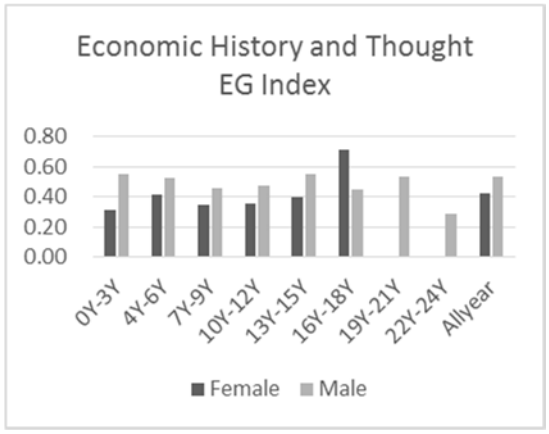

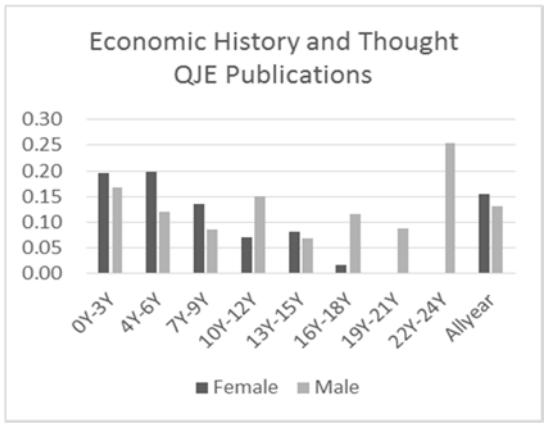

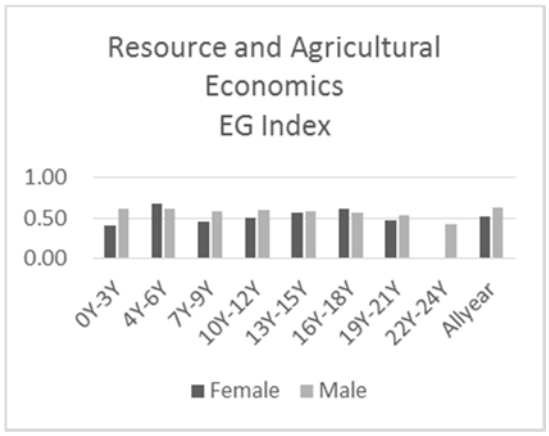

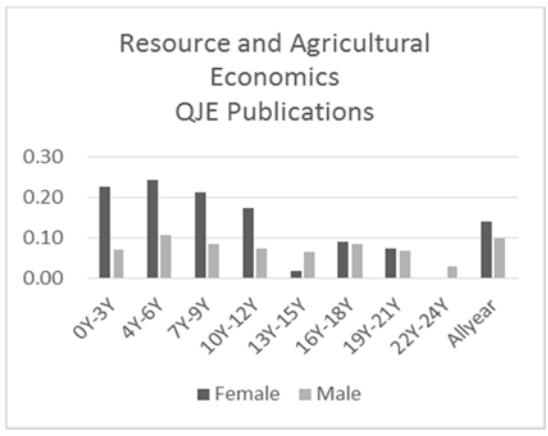

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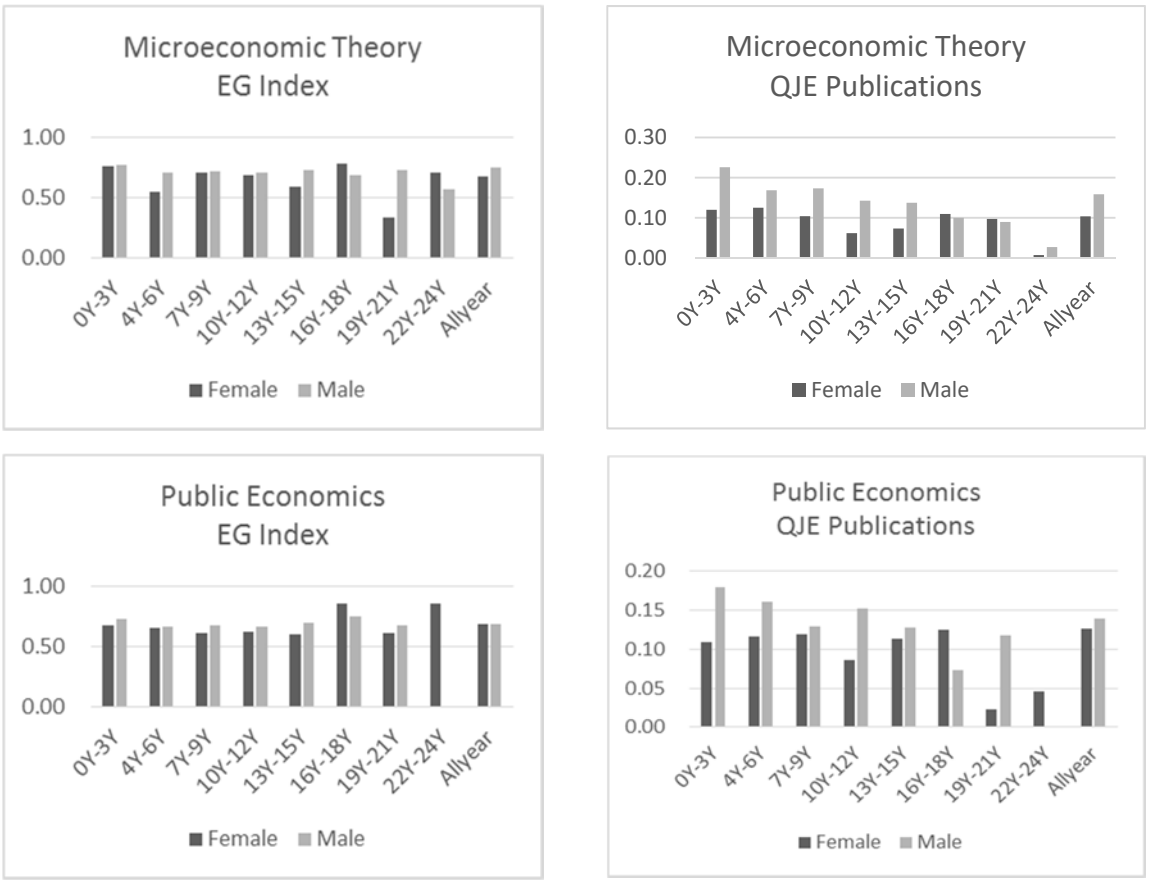


This figure graphs the productivity and the extent of specialization for female and male economists every three years after graduation across ten fields. I decide to focus on every three year for productivity and extent of specialization analysis since the three-year reference period is sufficient to accommodate the time lags between research, submission and publication (Kyvik 1990; Fox & Mohapatra 2007). Another reason is some departments would conduct pre-tenure evaluation around the third year, and tenure or promotion decisions are mostly based on the evaluation of cumulative productivity around the sixth year. For economists who earn promotion to full professor, it mostly happens around the twelfth year. It would be nice to examine an individual's productivity at those points.

Figure 4.2 Illustration of a simple model of the relationship between gender and productivity

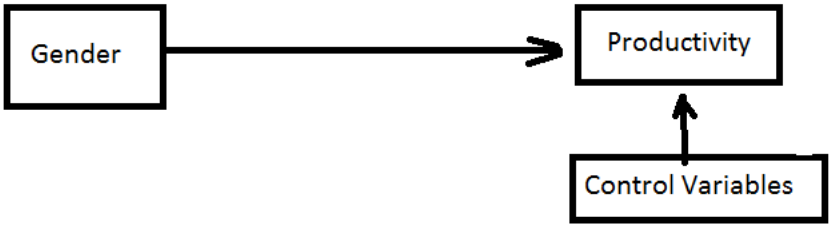
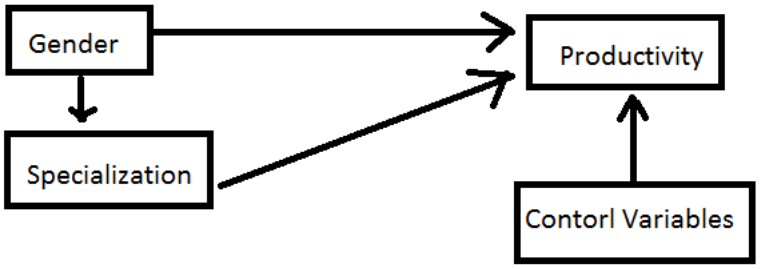


Figure 4.3 Illustration of a path analysis model of the relationship between gender and productivity



5 SPECIALIZATION AND ADVANCEMENT FOR ECONOMISTS IN ACADEMICS

5.1 Introduction

Biennial reports provided by the National Science Foundation (NSF) have consistently shown that, since 1982, and through the most recent report (NSF, 2015), female scientists continue to be less likely than their male colleagues to be full professors and more likely to be assistant professors.

Fewer female scholars are present in the academy than in the workforce as a whole, particularly in the higher levels of academy. Although the number of female scholars hold higher position in academics is increasing, gender inequalities still exist. Female scholars are still a minority in full professorial positions (Hachen 1988; Spurr 1990; Long *et al.* 1993; Martin 1994; Long & Fox 1995; Pergamit & Veum 1999). For example, Mason and Goulden (2003) found that, between 1975 and 1998, the proportion of tenured male faculty members stayed steady at between 60 and 70%, and the proportion of tenured female faculty members stayed steady at between 40 and 50%.

Studies on the gender difference in careers of scholars grew out of questions as to why there seemed to be a smaller proportion of female academic scientists being promoted. Since research performance is essential for promotion, this has been one of the most frequently investigated areas in which researchers looked for differences that might explain women's lower promotion prospects. Although some studies have found no gender differences in publication numbers (Williamson & Cable 2003), most studies have suggested that women produce fewer research papers than men across different disciplines,

decades and countries (Reskin 1978; Rodgers & Maranto 1989; Long & Fox 1995; Asmar 1999; Prpić 2002; Stack 2004; Posen *et al.* 2005; Peñas & Willett 2006). However, even after taking publication rates into account, studies still find that women are promoted more slowly than men and are significantly less likely to achieve promotion at any stage within an academic career (Long *et al.* 1993; Toren & Moore 1998). This leads to investigations into other factors that might be related.

Personal and structural factors, including prestige of a doctoral institution, family roles or work experience, have been investigated for a better understanding of promotion processes that might give rise to gender differences in outcomes (Xia & Shauman 1998). However, even after controlling for these possibly related factors, men were still more likely to be found at higher ranks in academy (Ward 2001). Rosenfield (1991) noted that "The persistent effect of sex even after controls for a number of supposedly relevant variables suggests there is still more to learn about the promotion process" (p. 20).

Specialization has become an important topic in labor economics (Rosen 1983; Neal 1998; Acemoglu & Pischke 1999; Cappelli 1999; Autor 2001; Taylor *et al.* 2006). It has also been linked to individual career performance (Booth *et al.* 2002; Zuckerman *et al.* 2003). This research adds to the literature by considering the role of the extent of specialization in the promotion process. In addressing this issue, a sample of economists from the top 86 US Economics departments was analyzed. The primary focus was to assess the extent to which advancement in academia for men and women may be influenced by the extent of specialization. The few previous studies have taken into account how repeatedly engaging in research on the same substantive topic may benefit a scholar's

career process. One related study is Leahey(2008), which developed a simplified measure of the extent of specialization and found that specialization has strong and significant effects on the "risk" of receiving tenure. In this study, a more defined measure of specialization—the Ellison-Glaeser index—was incorporated into the analysis. Different from Leahey's (2008) simple measure of the extent of specialization, the Ellison-Glaeser index is unaffected by the number of papers by an author and by the number and the size of the fields used in the breakdown. This research also adds to previous literature by explicitly considering the role of the extent of specialization across different cohorts. The sample by Leahey (2008) only consisted of PhD recipients in sociology from 1972 to 1976. This study includes faculty in Economics who graduated between 1990 and 2006 to investigate whether gender difference in promotion or the influence of the extent of specialization on the gender gap in the probability of promotion has been changing or relatively stable at different decades. Throughout the analysis, the panel nature of the data was used to take individual heterogeneity into account. Two key promotions in academy was considered using event history modeling: (a) from tenure-track to tenure status and (b) from tenure status to full professorship position.

Section 5.1 presents data summary. The details of the dependent variable will be discussed in section 5.3. Following that, the theoretical model for the analysis will be outlined in section 5.4. In section 5.5, an analysis of promotion to tenure status and then to full professorship positions for female and male scholars will be presented. Whether differences in the extent of specialization contribute to the gender difference in the likelihood of advance in academics is analyzed. This section also considers the effect of

research specialization across cohorts. Finally, some general conclusions will be discussed in Section 5.5.

5.2 Data Summary

Table 5.1 shows the percent of the sample in each category. Compared to male economists, a smaller percentage of female economists hold positions as assistant, associate and full professors, and the differences are statistically significant. Moreover, the percentage of female economists decreases as advancing to higher rank in Economics. Female economists are significantly less likely to obtain more prestigious academic positions.

5.3 Dependent Variable

Units of analysis for this study are person-years at "risk" for a promotion: (a) from tenure-track to tenured status and (b) from tenured status to full professorship. I considered economists at risk for transition to tenured status while they remain on tenure-track, but untenured, positions. Economists at risk for transition to full professorship are those remaining in associate professor positions, but not granted full professorship yet. The dependent variable has a value of 1 for person-years in which promotion occurred, otherwise 0.

5.4 Empirical Method

I sought to explain three outcomes: (a) the effect of research specialization on the likelihood of promotion from a tenure-track position to a tenured position and its variation among different cohorts; (b) the effect of research specialization on the likelihood of promotion from tenured position to full professorship and its variation among different

cohorts; and (c) the possible gender difference in whether and when previous two promotions happen.

Ever since the seminal work by Long *et al*. (1993), longitudinal models have been frequently used to address the time to promotion differences between male and female scholars (Xie & Shauman 2003; Marison *et al*. 2011; Wolfinger *et al*. 2008). Longitudinal models utilize information from time-varying variables and how their changes over time affect the likelihood of promotion to tenure. My analyses are very much an extension of those performed by Long *et al*. (1993) and others. I followed their specifications to apply the same functional form for time dependency for both promotions I model. Since academic promotions usually take effect between the end of one academic year and the beginning of the next, I employed a discrete time event history analysis. This is an ideal method for understanding the risk factors associated with an event(Allison 1982; Singer & Willett 2003).

The probability to be promoted to a higher rank should be zero at the beginning of the position of assistant/associate professor and peak around six years and then level off. Data from this sample show that the mode value of years taken to obtain tenure is seven years and the mode value from associate to full professorship is five years. The maximum number of years to get tenure is 10 years and the minimum is three years, while the maximum number of years to obtain full professorship is also 10 years and the least time from associate to full professorship is just one year.

It is reasonable to assume that, independent of changes in other variables, a scholar's likelihood of promotion will change over time. Although a higher order

polynomial in time might catch the changes in the expected probability of promotion over time more comprehensively, a second-order polynomial might be sufficient to represent a trend of increasing probabilities followed by decreasing probabilities (Leahey 2008). The following is the description of the model:

Let $t = 1,2,3 \ldots$ represent the successive year in a given academic rank. The discrete time hazard function, denoted by P_t , is the conditional probability that an event (e.g., promotion to associate professor) occurs in year t, given that it has not occurred prior to t. The dependence of P_t on explanatory variables is assumed to follow a logit model,

$$log\left[\frac{P_{it}}{1-P_{it}}\right] = \alpha + \beta_1 year + \beta_2 year^2 + \beta_3 x_{it1} + \cdots + \beta_k x_{itk}, \quad (1)$$

where the subscript i indicates the individual and the subscript t indicates the year in a given rank. The coefficient β_1 and β_2 capture the change in the baseline of a scholar's probability of promotion over time. $\beta_3 \ldots \beta_k$ indicate the effects of the explanatory variables on the chance of promotion. Once I get estimates of β_k, I could calculate P_t by the following equation (2):

$$P_t = \frac{e^{\beta_k}}{1+e^{\beta_k}} \qquad (2)$$

5.5 Results

The results of promotion from a tenure-track position to a tenured position are presented first, followed by results of promotion from tenured position to full professorship. For each part, I start by presenting descriptive statistics for related variables and examining whether there exist gender differences. Then, I analyze the effects of variables on the likelihood of promotion, especially the effect of extent of research specialization.

5.5.1 Promotion to Tenured Position

5.5.1.1 Descriptive Description

Table 5.2 compares means for female and male economists who are on tenure-track positions. Following Long *et al*. (2003), for time-varying variables, values are presented for both the year economists have their first publication and the last year in the same rank or at the end for observation period. For promotion to tenured professors, the observation starts at the first year economists have their first publication, and ends at seventh year of graduation. The reason why I chose a seven-year observation period is that evaluations for tenure are usually conducted around then, if one accounts for parental leave. Besides, in my sample, most economists obtain tenure at their seventh year. I performed analyses for a 10-year period; however, results are not significantly different from what I show in the following.

For the whole sample, female and male economists are significantly different in non-time varying variables including prestige of PhD-granting institution and current employing institution. Female economists graduate from more prestigious departments than male economists. However, female economists hold assistant professor positions in less prestigious departments compared to male economists. This suggests female economists might need more rigorous training to prove their ability. Male economists are more likely to move than female economists. At the beginning of their career as assistant professors, female and male economists are not distinguished in terms of extent of specialization, but they do show significant differences in the year get tenured. Male economists have significantly larger numbers of publications and higher quality than female economists both at the beginning and the end of their tenure-track position.

Comparisons for both gender in different cohorts vary. For the cohort 1990-1994, unlike the whole group, female economists move between more institutions than male economists. Other variables have the same pattern as the whole group, but the difference is only significant for prestige of PhD-granting institution, current employing institution, and the first-year quality of publication. For the cohort 1995-1999, female economists have a higher level of extent of specialization and quality of publications. The cohorts 2000-2004 and 2005-2009 show the same results as the whole group.

5.5.1.2 Estimate the Effect of Extent of Specialization on Promotion to Tenured Position

Table 5.3 presents the combined sets of independent variables as predictors of chances for promotion among tenure-track faculty in economics. I reported the findings on the influences of both non-time varying variables and time-varying variables. I focused on the extent of research specialization, while, at the same time, referring to other variables that are informative. Variables with positive coefficients increase the likelihood of obtaining tenure, while variables with negative coefficients decrease the likelihood of obtaining tenure.

Different from Leahey (2008), I find that, just as the descriptive statistics show (Table 5.2), the extent of research specialization has a positive effect on promotion to tenured position for economists. The effects are significant for the whole sample as well as for cohort 1990-1994 and cohort 2005-2009. For the whole sample, holding other variables constant, a 0.01 unit increase in the extent of research specialization increases the probability of promotion by 10.82%, compared to a 9.91% increase for the cohort 1990-1994 and an even higher 17.17% increase for the cohort 2005-2009.

Coefficients for the variables year in rank and $(\text{Years in Rank})^2$ suggest that the increased expected probability of promotion is high at the beginning, but starts to decrease after a certain point. This result is statistically significant for all in the sample and consistent across all four cohorts, suggesting that it takes time to get tenure in academics, but promotions happen within a time frame.

Female economists have a lower probability of promotion than male economists for the whole sample and all cohorts except the cohort 2000-2004. Whether female economists are advantaged as the cohort 2000-2004 or disadvantaged as the other three cohorts in the promotion processes, neither effect is significant. Although I have found a decreasing portion of female economists holding the associate professor position (Table 5.1), female economists do not have significantly lower or higher probability than male economists to be promoted.

The effects of the department prestige of one's PhD-granting institution and current employing institution are mixed among the whole sample and different cohorts, but none of them has a significant effect on one's "risk" of tenure. The number of previous academic appointments decreases the probability to get tenure in that year. As Leahey (2008) showed, moving between institutions appears to be detrimental to the chances of tenure, although moving to a less prestigious department offsets this decreased chance somewhat. The results concerning the effects of productivity, especially the quality of published articles, on the risk of tenure are aligned with previous studies: productivity has a strong and positive effect on the probability of promotion.

5.5.2 Promotion to Full Professorship

5.5.2.1 Descriptive Description

The sample consisted of faculty holding the associate or full professor position in 2014. The observation starts the year they receive tenure until the year they obtain full professorship or the end of observation period, which, in this case, is five years. Most full professorships were granted in the fifth year after tenure in my sample. Data for a 10-year observation are also analyzed, which show similar pattern as the five-year observation.

Table 5.4 shows that female and male associate professors do not differ significantly in the prestige of PhD granting institution, but male associate professors do have more prestigious current employing departments. Once tenured, female economists are more likely to move between institutions than male economists, but the difference is not significant. In the first year as an associate professor, male economists are already more specialized and have higher productivity than female economists, and the difference is significant until they obtain full professorship.

Most results for different cohorts are similar to the whole sample group, with a few exceptions. For the cohorts 1995-1999 and 2005-2009, female economists have significantly less prestigious PhD-granting institution than male economists. For the cohort 2005-2009, female economists, compared to male economists, even show more prestigious current employing institution. Time-varying variables show same difference as the whole sample, although not all differences are significant as for the whole sample.

5.5.2.2 Estimate of the Effect of Extent of Specialization on Promotion to Full Professorship

Table 5.5 presents coefficients from the event history model for the time to be promoted to full professorship starting from the beginning of the associate professor position. The same combined sets of non-time-varying variables and time-varying variables are included. Coefficients have the same meaning as in previous analyses for promotion to a tenured position.

For the whole sample and all four cohorts, the extent of research specialization has a stronger positive effect on the promotion to full professor than previous promotion. For the whole sample, holding other variables constant, a 0.01 unit increase in the extent of research specialization has the same effect on the chance of promotion as previous promotion, which is around 10.24%. The strongest effect appeared in the 1995-1999 cohort, wherein a 0.01 unit increase in the extent of research specialization could increase the probability by 36.33%.

Positive coefficients for the variable year in rank and negative coefficient for the variable $(\text{Years in Rank})^2$ suggest, in the time structure of promotion, that the probability of promotion from associate professor to full professorship increases as time passes, but the increase of the probability levels off at some point.

In the promotion process to full professorship, female economists have a lower probability for promotion to full professorship than male economists for the whole sample and all cohorts. However, just as with previous promotion to tenured position, a female's

disadvantaged effect is not significant. Gender could not explain why even smaller numbers of female economists have full professorship.

The effects of the departmental prestige of one's PhD-granting institution and current employing institution are mixed among the whole sample and different cohorts. The prestige of the current employing institution has a negative effect on the whole sample and the cohorts 1990-1994 and 2000-2004. A more prestigious department might have a more selective process for full professorship. Contrary to previous studies, such as Long *et al*. (2003), my data show that the prestige of one's PhD-granting institution has a negative effect on one's promotion to full professorship.

Different from promotion to tenured position, the number of previous academic appointments increases the probability to become full professor in that year. Long *et al*. (2003) pointed out that promotion would be expedited if other institutions attempt to entice promising associate professors by using promotion to full professor as an incentive. This reason might best explain moving in the promotion to professor. The effects of both productivity variables are both strong and significantly for promotion to full professorship.

5.6 Conclusion

As shown above, the results of existing studies attempting to understand what contributes to the gender difference in the "risk" of getting tenure are inconclusive. Prior research generally agrees that productivity in the form of journal publications explains success, although other factors, such as institutional characteristics, remain undecided. However, even after controlling for related variables, gender differences still exist. Based on a sample of US economists in academia, this study has aimed to evaluate how one

possible factor, the extent of research specialization, affects female and male scholars' likelihood of promotions in academia differently.

First, as I expected, the extent of specialization has a positive influence on the chance of being promoted. Being more specialized and focusing on a limited number of subfields give one an advantage during promotion process. Economists who conduct research in several different fields might spread their time too much and consequently may not publish as much as required for promotion, especially for promotion to a tenured position. Both male and female economists benefit from being more specialized. A more diverse research choice is detrimental for advancement in academics. Second, my study confirms the effect of journal publications on advancement in academia. Both the number of journal articles and the quality of publications improve the likelihood of promotion. Third, compared to male economists, female economists are not significantly disadvantaged in the promotion process. Perhaps, just as McDowell *et al*. (2001) show, by the late 1980s, promotion likelihood for female economists had been improved a lot. Fourth, changing institutions has a positive effect during the process to a tenured position, while a negative effect per full professorship. This suggests that changing institutions may be governed by different mechanisms. More information about institutional changes and organizational practices will provide a better understanding of how they interact with individual efforts which create gender difference in promotion prospects.

Finally, results for different cohorts in both promotion processes vary. The extent of research specialization does not always have strong positive effect among all cohorts, nor does it have any trends among cohorts. Other variables, such as number of previous

academic appointments, may even have the opposite effect on the probability to be promoted among cohorts. This suggests that we need a more detailed analysis of individual academic careers across generations to understand cohort effect.

Table 5.1: Percent of Sample Holding Given Academic Ranks in Top Economics Department in 2014

Academic Rank	Male		Female	
	Number	Percent	Number	Percent
Assistant Professor	109	68.55	50	31.45
Associate Professor	195	78.31	54	21.69
Full Professor	240	86.96	36	13.04
Total Sample (Number)	544		140	

Table 5.2: Gender Comparison for Variables Used in the Analysis of Promotion to Tenured Position

		Total Sample			1990-1994			1995-1999			2000-2004			2005-2009		
Variable	Year in Rank	Male		Female	Male		Female	Male		Female	Male		Female	Male		Female
Non-time Varying																
Prestige of PhD department		2.44 (1.65)	**	2.32 (1.49)	2.48 (1.72)	***	1.95 (1.33)	2.29 (1.48)	*	2.48 (1.41)	2.49 (1.71)		2.42 (1.74)	2.50 (1.65)		2.36 (1.42)
Prestige of current employing department		3.40 (1.69)	***	3.77 (1.56)	3.34 (1.67)	***	3.99 (1.48)	3.67 (1.75)		3.81 (1.51)	3.23 (1.61)	**	3.57 (1.63)	3.40 (1.69)	***	3.74 (1.57)
Number of previous academic appointments		0.75 (0.80)	***	0.66 (0.80)	1.07 (0.88)		1.15 (1.07)	0.95 (0.86)		0.97 (0.76)	0.69 (0.72)	***	0.53 (0.60)	0.36 (0.57)		0.31 (0.52)
Time Varying																
Extent of specialization	First	0.15 (0.29)		0.13 (0.28)	0.17 (0.34)	*	0.17 (0.32)	0.14 (0.30)		0.16 (0.32)	0.13 (0.27)	*	0.05 (0.17)	0.15 (0.28)		0.14 (0.28)
	Last	0.74 (0.11)	***	0.69 (0.15)	0.81 (0.07)		0.78 (0.08)	0.76 (0.08)		0.74 (0.11)	0.72 (0.10)	*	0.68 (0.11)	0.67 (0.14)	*	0.62 (0.18)
Number of Articles	First	0.42 (1.12)	*	0.26 (0.61)	0.41 (0.93)		0.22 (0.42)	0.37 (1.03)		0.26 (0.53)	0.41 (1.34)	*	0.13 (0.43)	0.49 (1.11)		0.36 (0.79)
	Last	7.92 (4.35)	***	6.16 (3.29)	8.16 (4.59)		7.15 (3.61)	8.98 (4.93)	*	7.22 (3.22)	8.49 (3.89)	***	5.58 (2.17)	6.24 (3.57)		5.45 (3.50)
Quality of Publications	First	0.08 (0.20)	*	0.04 (0.12)	0.09 (0.24)	*	0.03 (0.10)	0.06 (0.19)		0.08 (0.19)	0.07 (0.18)	*	0.03 (0.08)	0.09 (0.21)	**	0.03 (0.09)
	Last	2.01 (1.30)	***	1.56 (1.08)	1.96 (1.22)		1.67 (1.04)	2.10 (1.26)		1.89 (1.31)	2.32 (1.33)	**	1.70 (1.06)	1.65 (1.26)	*	1.27 (0.93)

This table summarizes means, standard deviations, and difference-of-mean tests for variables used in analysis of promotion to tenured position for the whole sample and cohorts 1990-1994, 1995-1999, 2000-2004 and 2005-2009.

Standard errors are shown in parentheses. ***: difference significant at 0.01 level; **: difference significant at 0.05 level; *: difference significant at 0.1 level.

Table 5.3: Estimation of Variables in Analysis: Promotion to Tenured Position

Variable	All	1990-1994	1995-1999	2000-2004	2005-2009
Years in Rank	2.53***	1.91***	3.90***	2.86***	3.06***
	(0.29)	(0.45)	(0.71)	(0.61)	(0.82)
(Years in Rank)^2	-0.15***	-0.12***	-0.24***	-0.17***	-0.21***
	(0.02)	(0.03)	(0.05)	(0.04)	(0.06)
Gender	-0.20	-0.16	-0.13	0.22	-0.33
	(0.15)	(0.30)	(0.29)	(0.29)	(0.34)
Extent of Research Specialization	2.47***	2.39*	0.39	0.59	2.90**
	(0.53)	(1.34)	(1.21)	(0.30)	(1.26)
Cumulative Publication Numbers	0.04*	0.06*	0.01	0.09**	-0.00
	(0.02)	(0.03)	(0.04)	(0.04)	(0.05)
Cumulative Publication Quality	0.54***	0.50***	0.47***	0.66***	0.88***
	(0.07)	(0.14)	(0.14)	(0.14)	(0.20)
Number of Previous Academic Appointment	-0.16**	-0.04	-0.43	-0.60***	-0.15
	(0.07)	(0.12)	(0.15)	(0.17)	(0.24)
Prestige of PhD-Granting Institution	0.00	0.12	-0.12	0.01	0.12
	(0.04)	(0.07)	(0.09)	(0.07)	(0.09)
Prestige of Current Employing Institution	-0.00	-0.21	0.02	0.08	0.15
	(0.04)	(0.08)	(0.08)	(0.09)	(0.11)

This table presents effects of different non-time-varying and time-varying variables on likelihood of promotion to associate professor for the whole sample and cohorts 1990-1994, 1995-1999, 2000-2004 and 2005-2009.

Standard errors are shown in parentheses. ***: difference significant at 0.01 level; **: difference significant at 0.05 level; *: difference significant at 0.1 level.

Table 5.4: Gender Comparison for Variables Used in the Analysis of Promotion to Full Professorship

		Total Sample			1990-1994			1995-1999			2000-2004			2005-2009		
Variable	Year in Rank	Male		Female	Male		Female	Male		Female	Male		Female	Male		Female
Non-time Varying																
Prestige of PhD department		2.42 (1.62)		2.37 (1.54)	2.55 (1.76)	***	1.90 (1.38)	2.20 (1.37)	***	2.70 (1.48)	2.58 (1.70)		2.36 (1.53)	2.29 (1.60)	*	3.08 (1.89)
Prestige of current employing department		3.50 (1.73)	***	3.87 (1.56)	3.46 (1.64)	***	4.09 (1.47)	3.85 (1.74)		3.86 (1.50)	3.24 (1.67)	***	3.80 (1.65)	3.19 (1.97)		3.05 (1.78)
Number of previous academic appointments		0.79 (0.83)		0.85 (0.90)	1.01 (0.87)	*	1.15 (1.04)	0.87 (0.86)		0.97 (0.79)	0.57 (0.70)	**	0.38 (0.57)	0.44 (0.61)		0.45 (0.85)
Time Varying																
Extent of specialization	First	0.65 (0.28)	*	0.58 (0.31)	0.69 (0.29)	*	0.54 (0.36)	0.65 (0.28)		0.60 (0.31)	0.62 (0.28)		0.60 (0.28)	0.63 (0.25)		0.58 (0.28)
	Last	0.77 (0.09)	*	0.75 (0.08)	0.81 (0.06)		0.79 (0.06)	0.78 (0.07)		0.77 (0.08)	0.75 (0.08)		0.73 (0.09)	0.71 (0.11)		0.70 (0.08)
Number of Articles	First	7.55 (4.95)	**	5.81 (3.91)	7.31 (5.23)		5.42 (4.49)	8.01 (5.25)		6.26 (4.15)	7.57 (4.64)	**	5.68 (3.21)	6.96 (4.45)		5.83 (3.88)
	Last	14.48 (6.81)	***	11.35 (4.39)	15.45 (6.89)	**	11.67 (4.76)	16.30 (7.28)	**	13.33 (4.81)	13.99 (6.14)	***	10.16 (2.97)	9.60 (4.44)		8.75 (3.25)
Quality of Publications	First	1.94 (1.46)	*	1.51 (1.32)	1.75 (1.33)		1.31 (1.30)	1.86 (1.38)		1.46 (1.33)	2.11 (1.57)		1.68 (1.30)	2.07 (1.61)		1.66 (1.49)
	Last	3.66 (2.13)	**	2.96 (1.88)	3.77 (2.28)	*	3.01 (1.76)	3.77 (2.02)		3.24 (2.00)	3.82 (2.13)	*	2.99 (2.00)	2.78 (1.89)		2.22 (1.62)

This table summarizes means, standard deviations, and difference-of-mean tests for variables used in analysis of promotion to tenured position for the whole sample and cohorts 1990-1994, 1995-1999, 2000-2004 and 2005-2009.

Standard errors are shown in parentheses. ***: difference significant at 0.01 level; **: difference significant at 0.05 level; *: difference significant at 0.1 level.able 4 Gender Comparison for Variables Used in the Analysis of Promotion to Full Professorship.

Table 5.5: Estimation of Variables in Analysis: Promotion to Full Professorship

Variable	Whole Sample	1990-1994	1995-1999	2000-2004	2005-2009
Years in Rank	0.84*** (0.14)	0.89*** (0.23)	1.38*** (0.30)	0.40 (0.31)	0.02 (1.69)
(Years in Rank)^2	-0.05*** (0.01)	-0.06*** (0.02)	-0.09*** (0.02)	-0.01 (0.03)	0.07 (0.28)
Gender	-0.35 (0.21)	-0.43 (0.35)	-0.34 (0.34)	-0.07 (0.44)	-13.21 (251.5
Extent of Research Specialization	2.42** (0.99)	2.84 (1.95)	3.62* (1.91)	1.09 (1.63)	4.26 (5.12)
Cumulative Publication Numbers	0.04** (0.01)	0.06*** (0.02)	0.03 (0.02)	-0.01 (0.04)	-0.61 (0.40)
Cumulative Publication Quality	0.12** (0.05)	0.00 (0.07)	0.43*** (0.09)	0.17 (0.11)	1.52 (0.84)
Number of Previous Academic Appointment	0.22*** (0.08)	0.22* (0.12)	-0.09 (0.08)	0.45** (0.20)	1.83 (1.23)
Prestige of PhD-Granting Institution	-0.10* (0.05)	-0.03 (0.07)	-0.18 (0.10)	-0.05 (0.10)	0.33 (0.44)
Prestige of Current Employing Institution	-0.21*** (0.05)	-0.37*** (0.10)	-0.07 (0.08)	-0.25* (0.13)	0.12 (0.49)

This table presents the effects of different non-time-varying and time-varying variables on likelihood of promotion to full professor for the whole sample and cohorts 1990-1994, 1995-1999, 2000-2004 and 2005-2009.

Standard errors are shown in parentheses. ***: difference significant at 0.01 level; **: difference significant at 0.05 level; *: difference significant at 0.1 level.

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APPENDICES

APPENDIX 1: Economics Department

Harvard U, MIT, U CA, Berkeley, Princeton U, U Chicago, Stanford U, NY U, Columbia U, Yale U, Boston U, Brown U, U MI, U PA, Dartmouth College, U CA, San Diego, Northwestern U, Columbia U, GSB, Boston Col, UCLA, Cornell U, U WI-Madison, U CA, Davis, Duke U, Georgetown U, MI State U, NY U, SSB, Vanderbilt U, U MD, U Southern CA, PA State U, U CA, Santa Barbara, Rutgers U, U MN, IA State, OH State U, AZ State U, U CA, Irvine, U VA, John Hopkins U, GA State U, Washington U, St Louis, U TX, Austin, U CA, Santa Cruz, U Washington, U Notre Dame, IN U, George Washington U, U CO, Carnegie Mellon U, U IL, Urbana-Champaign, Chapman U, U Southern CA,MSB, U Rochester, Williams College, U Pittsburgh, TX A&M U, U OR, Brandeis U, CA Institute of Technology, Syracuse U, Clemson U, U WY, U Houston, Tufts U, Purdue U, U CT, U AZ, U MS, U CA, Riverside, George Mason U, Fl State U, Rice U, U KY, U DE, Wellesley College, U NC, CUNY, U IL, Chicago, SUNY, Albany, U WI, Tulane U, Brigham Young U, Southern Methodist U, Appalachian State U, American U, U MI, RSB

APPENDIX 2: JEL Codes Aggregation

Economic History & Thought

A1, A11, A12, A13, A14, A2, A21, A22, A23, B10, B11, B12, B13, B15, B20, B21, B22, B23, B25, B31, B32, B40, B41, B52, B53, N00, N01, N10, N11, N12, N13, N14, N15, N16, N17, N20, N21, N22, N23, N24, N25, N26, N27, N30, N31, N32, N33, N34,N35, N36, N37, N40, N41, N42, N43, N44, N45, N46, N47, N50, N51, N52, N53,N54, N55, N56, N57, N60, N61, N62, N63, N64, N65, N66, N70, N71, N72, N73,N74, N75, N76, N77, N80, N81, N82, N83, N84, N85, N91, N92, N93, N95, P10,P11, P12, P13, P14, P16, P17, P19, P20, P21, P22, P23, P24, P25, P26, P27, P28,P30, P31, P32, P33, P34, P35, P36, P37, P42, P43, P44, P46, P48, P51, P52.

Econometrics

C00, C01, C10, C11, C12, C13, C14, C15, C16, C19, C20, C21, C22, C23, C24, C25,C30, C31, C32, C33, C34, C35, C40, C41, C42, C43, C44, C45, C46, C49, C50, C51,C52, C53, C59, C80, C81, C82, C87, C88, C90, C91, C92, C93.

Microeconomic Theory

C60, C61, C62, C63, C65, C67, C68, C69, C71, D00, D01, D02, D50, D51, D52, D53,D57, D58, D59, D80, D81, D82, D83, D84, D85, D86, C70, C72, C73, C78, C79.

Labor & Consumer Economics

D10, D11, D12, D13, D14, D18, D19, D30, D31, D33, I00, I10, I11, I12, I18, I20,I21, I22, I28, I29, I30, I31, I32, I38, J00, J10, J11, J12, J13, J14, J15, J16, J17, J18,J19, J20, J21, J22, J23, J24, J26, J28, J30, J31, J32, J33, J38, J40, J41, J42, J43, J44,J45, J48, J50, J51, J52, J53, J54, J58, J60, J61, J62, J63, J64, J65, J68, J70, J71, J78,J80, J81, J82, J88, M50, M51, M52, M53, M54, M55, Z10, Z11, Z12, Z13.

IO / Business Economics

D20, D21, D23, D24, D40, D41, D42, D43, D44, D45, D46, D49, L10, L11, L12, L13,L14, L15, L16, L17, L19, L20, L21, L22, L23, L24, L25, L26, L30, L31, L32,

L33,L40, L41, L42, L43, L44, L51, L52, L53, L60, L61, L62, L63, L64, L65, L66, L67,L68, L69, L70, L71, L72, L73, L74, L80, L81, L82, L83, L84, L85, L86, L88, L89,L90, L92, L93, L94, L95, L96, L97, L98, M10, M11, M12, M13, M14, M21, M30,M31, M37, M40, M41, M42, O30, O31, O32, O33, O34, O38.

Public Economics

D60, D61, D62, D63, D64, D70, D71, D72, D73, D74, D78, D79, H00, H10, H11,H20, H21, H22, H23, H24, H25, H26, H27, H29, H30, H31, H32, H39, H40, H41,H42, H43, H44, K00, K10, K11, K12, K13, K14, K19, K20, K21, K22, K23, K31,K32, K33, K34, K35, K36, K39, K40, K41, K42, K49.

Macroeconomics

D90, D91, D92, E00, E01, E10, E11, E12, E13, E17, E19, E20, E21, E22, E23, E24,E25, E26, E30, E31, E32, E37, E40, E41, E42, E43, E44, E47, E50, E51, E52, E58,E60, E61, E62, E63, E64, E65, E66, F30, F31, F32, F33, F34, F35, F36, F37, F40,F41, F42, F43, F47, H50, H51, H52, H53, H54, H55, H56, H57, H60, H61, H62,H63, H70, H71, H72, H73, H74, H75, H76, H77, H81, H82, H83, H87, O40, O41,O42, O43, O47.

Trade & Development

F00, F01, F02, F10, F11, F12, F13, F14, F15, F16, F17, F18, F20, F21, F22, F23,F24, O10, O11, O12, O13, O14, O15, O16, O17, O18, O19, O20, O21, O22, O23, O24,O51, O52, O53, O54, O57, R10, R11, R12, R13, R14, R15, R20, R21, R22, R23,R28, R30, R31, R32, R33, R38, R40, R41, R42, R48, R50, R51, R52, R53, R58.

Financial Economics

G00, G10, G11, G12, G13, G14, G15, G18, G19, G20, G21, G22, G23, G24, G28, G29,G30, G31, G32, G33, G34, G35, G38.

Resource & Agricultural Economics

Q01, Q10, Q11, Q12, Q13, Q14, Q15, Q16, Q17, Q18, Q20, Q21, Q22, Q23, Q24, Q25,Q26, Q27, Q28, Q30, Q31, Q32, Q33, Q34, Q38, Q41, Q42, Q43, Q48, Q50, Q51, Q52,Q53, Q54, Q55, Q56, Q57, Q58.

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