Succeeding by Specializing?
Explaining Gendered Academic Career Trajectories

Erin Leahey, Ph.D.*
Jason Crockett
Laura Hunter

University of Arizona

Abstract. In this paper we take a longitudinal perspective to analyze gender differences in academic career attainment. We improve upon prior research both theoretically and methodologically. Theoretically, we introduce and conceptualize the influence of a heretofore-neglected factor in career attainment: the extent of research specialization. We conceive of the extent of research specialization as a form of professional capital that improves productivity and visibility, especially for men. Methodologically, we introduce a measure of research specialization and examine how men's and women's productivity and visibility unfold over time rather than examining discrete periods of scholars' careers. We find that specializing is most beneficial with regard to productivity – that is, it helps scholars publish more. Specialization's effects on visibility are less general: surprisingly, only women's visibility seems to benefit from specialization. We discuss these findings, their implications, and suggest avenues for future research on this important and newly recognized form of capital.

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Despite legislative and social gains in equality of opportunity, evidence suggests that women still fare worse than men in terms of career attainment, especially within scientific fields. Although scientists consistently receive among the highest of occupational prestige ratings, there exists within science a complex hierarchy allowing for wide disparities in career attainments – many of which occur along gender lines. Productivity (contributions to knowledge) and visibility (recognition by the scientific community) are the two critical dimensions of career attainment for PhD-holding, tenure-track scholars, and women consistently fall at the bottom of each of these distributions. The fact that women are less successful than men on these two critical dimensions of scholarly performance "demands explanations of *the processes* generating the inequality" (Long and Fox 1995:53).

Sociologists have documented a male advantage in terms of various forms of capital – human, social, and cultural – that help explain gender differences in career outcomes. Men have different types of human capital (Paglin and Rufolo 1990), including different content to their degrees (Kerckhoff and Bell 1998) and more specialized training (Tam 1997) relative to women. With regard to social capital, men have not only better social networks (Lin, Ensel, and Vaughn 1981), but tend to invoke them more freely than women (Wegener 1991), and this also helps explain variation in men's and women's career patterns. Women and men also possess difference amounts and perhaps kinds of cultural capital (Kanter 1977), and cultural proficiency is critical to workers' occupational futures (Deal and Kennedy 1982; Packard 1962). Especially for academics, these different amounts and types of capital are bound up with family responsibilities (Fox 2005), geographic moves and constraints (Rosenfeld 1981; Rosenfeld and Jones 1986), and institutional locations (Allison and Long 1990; Long and McGinnis 1981; Xie and Shauman 2003) – all of which help explain gender differences in career outcomes (Gerber and Schaefer 2004; Ishida, Spilerman, and Su 1997; Kerckhoff and Bell 1998; Monks 2000).

When applied to academic careers, these factors have partially and in some instances completely explained gender differences in productivity during short time intervals (Xie and Shauman 1998); however, a complete understanding of career processes requires greater attention to time. In sociology, cross-sectional studies of academic career outcomes vastly outnumber longitudinal studies, and the longitudinal investigations are typically approached in a discrete manner. For example, even when career history data are available, they are typically analyzed descriptively, with a focus on start points (such as prestige of first job), central tendencies (such as median salary), and differences between two time points (e.g., in productivity over the course of a few years) – see Long (1992), Prpic (2002) and Rosenfeld (1986) for examples. Although cumulative measures are typically dismissed in favor of time-

sensitive measures (Allison and Long 1987; Cole and Zuckerman 1984; Fox 1992, 2005; Reskin 1978; Xie and Shauman 1998), both require a pooling or discretization of over-time data, resulting in a loss of detailed, time-sensitive information. While a few studies have employed time-varying or time-sensitive measures of productivity and visibility as explanatory variables (Keith, Layne, Babchuk, and Johnson 2002; McBrier 2003), only one study to our knowledge has explicitly examined trajectories of academic rewards, and the focus here was on earnings (Bellas, Ritchey, and Parmer 2001) rather than the two critical dimensions of scientific careers that interest us: productivity and visibility. Attention to time is particularly important when examining gender differences, given women's more recent influx into scientific fields, and resultant differences in men's and women's career lengths (Prpic 2002).

A complete understanding of career processes also requires greater attention to other forms of capital that have been heretofore overlooked. Specifically, we conceive of the extent of specialization in scholars' work output -- their research -- to be a form of professional capital (Abbott 1991) that is related to, but distinct from human, social, and cultural capital factors that are theoretically relevant to career attainment. Scholars who take advantage of this form of professional capital by specializing (i.e., by limiting their research to only one or a few topics) should, we argue, reap various benefits. These benefits include enhanced productivity and increased visibility. Specializing should promote research productivity because it allows scholars to master the literature, become familiar with important debates and gaps in the literature, and recognize new developments – all of which can boost productivity by making successive papers on that topic much easier to write. Specializing should also promote visibility in the field. Scholars who specialize have greater opportunities to know (and be known by) key players in their subfield by attending small conferences and section meetings of larger conferences, reviewing peers' works in progress and manuscripts under review, and collaborating with researchers who share their interests.

We contend that the extent of specialization in scholars' research programs is critical to not only understanding individual variation in the shape of career trajectories, but also explaining gender differences in those trajectories. In the home (Budig and England 2001; Hakim 2000), schools (Davies and Guppy 1997; Kerckhoff and Bell 1998; Tam 1997), and workforce (Bellas 1994; Gjerberg 2001; Tomaskovic-Devey and Skaggs 2002), women and men are distributed unequally across areas – whether those areas are household tasks, majors, or jobs. This emphasis on areas of work and study is also found in studies of academics, which help us understand the consequences of gender differences in subfields and subfield prestige (Grant and Ward 1991; Grant, Ward, and Bottenfield 1993; Ward and Grant 1995). Men and women specialize in different areas of work and study, but we don't know how they fare with respect to another dimension of specialization: its extent. Because we conceive of specializing as a kind

of capital, and men are advantaged in terms of other forms of capital, we expect men to reap more from specializing than women.

Our goal in this paper is to substantially improve upon prior research that has examined gender differences in scientific careers. We do this both theoretically and methodologically. Theoretically, we introduce and conceptualize the influence of a heretofore-neglected factor in career attainment: the extent of research specialization. In the following sections we will further delineate this construct and its relationship to important career outcomes such as productivity and visibility, and we will also theorize about its relationship to gender, specifically why it might operate differently for male and female scholars. Methodologically, we develop a new measure to reflect this concept of research specialization, construct a unique longitudinal dataset, and employ a statistical method – hierarchical linear modeling – that is perfectly suited for analyzing longitudinal data. Using this method, we are able to distinguish between variation within individuals (that is, across their careers) and variation across individuals (and importantly, categories of individuals, such as men and women) and also assess whether key theoretical constructs – such as the extent of research specialization – help explain variation in career patterns.

KEY DIMENSIONS OF ACADEMIC SUCCESS

Perhaps more than financial gain, academic scientists compete for two valued goods: high research productivity and the scholarly recognition or visibility that hopefully accompanies it (Stephan and Levin 1992). Apparent in the popular adage "publish or perish," the quantity of scholarly work that academics produce is absolutely critical to their success. But the gross number of publications is not always the best measure of scholarly performance in research (Hess 1997:78). Impact on the field through scholarship is achieved not only by sheer quantity of research, but by its quality and its usefulness to others -- typically indicated by the prestige of the journal of publication or the number of citations the piece has garnered. In other words, although productivity is critical to academic success, all publications are not equal. Cole and Cole (1973), among others, argue that more than quantity of publications, the quality, impact, and usefulness of one's research to others is a better indicator of a scientist's contribution to the body of scientific knowledge (Long 1992; Wanner, Lewis, and Gregorio 1981). A scholar's accumulation of research that peers recognize as useful and high quality determines his or her visibility and reputation in the discipline. That is, whereas citations to a particular article may reflect its usefulness to other scholars and perhaps the quality or contentiousness of the work, cumulative number of citations garnered by an individuals' body of research is more likely an indicator of that scholars' overall visibility in the field.

Thus, productivity and recognition are two important criteria for excellence in research (Toren and Moore 1998) toward which scholars strive, and on which they are judged when it comes to distributing valued resources such as salaries, grants, prestigious awards, research assistance, and the like (Reskin 1977; Ward, Gast, and Grant 1992; Zuckerman 1977). The quantity and quality of research drive one's visibility, or reputation, in the field; visibility influences bargaining power in the academic marketplace (Ferber 1986); and bargaining power in turn influences salary determinations, the receipt of prestigious appointments, and promotions (Clemens, Powell, McIlwaine, and Okamoto 1995; Sonnert and Holton 1995). The importance of productivity and visibility for a scholar's career cannot be over-rated (Clemens et al. 1995; Sonnert 1995), especially for scholars housed in research universities – the population of interest here. Perhaps because of relative ease of data collection and measurement, productivity has been more widely studied than visibility. However, both are critical components of scholarly success (Clemens et al. 1995), and thus key dimensions along which inequality – particularly gender inequality – occurs. Because career advancement is dependent on publication productivity and visibility, women's disadvantage in these realms can have serious implications for the advancement of women in academe (Xie and Shauman 2003:177).

Differentials between male and female scientists in productivity, and to a lesser extent, visibility, have received a fair bit of scholarly attention. Whether self-reports (Fox and Faver 1985; Prpic 2002; Wanner et al. 1981; Xie and Shauman 1998) or the more typical bibiolmetric sources (Allison and Long 1990; Allison and Stewart 1974; Fox 1992; Grant and Ward 1991; Long 1978; Long and McGinnis 1981; Reskin 1977, 1978) are used to measure productivity, a persistent gender difference in productivity has been documented in various disciplines. Over 50 empirical studies have confirmed that female scientists publish less than male scientists, often as much as 50% less, and this large difference cannot be explained by differential devotion to home life and child-raising or by varying rates of collaboration (Cole and Zuckerman 1984). This is true even when period-specific measures (e.g., number of publications in the past three years) are used instead of the more disparate cumulative measures. As of 1984, efforts to explain this persistent difference were incomplete, and thus it was termed the "productivity puzzle" by Cole and Zuckerman (1984). Since then, scholars have been able to explain much if not all of the gender difference in productivity (Xie and Shauman 1998), but this is not the case for the gender difference in visibility as indicated by citation counts. Perhaps because of the labor-intensive data collection required, or debate over what citations actually mean (Ferber 1986; Reskin 1977), there is a paucity of research on scholarly visibility, especially as an outcome variable.[1] However, a large male advantage in citation counts over scientists' careers has been documented in

[1] A few economists have examined visibility's effects on salary levels (Diamond 1986; Hamermesh, Johnson, and Weisbrod 1982) and Reskin has examined the impact of early visibility on later productivity (Reskin 1977).

various disciplines by Long (1992) and Ferber (1986; 1988). For example, men's citation counts peak higher (Long 1992) and faster (Ward et al. 1992) than women's.

The interrelationship between productivity and visibility has been well documented, and we take it into consideration in our analysis. Reskin (1977) and Keith et al. (2002) found that earlier accomplishments and types of capital affect later career outcomes, sometimes differently for men and women. Others have even been able to document the mutually reinforcing relationship between productivity and visibility, which would be consistent with the Matthew Effect (Merton 1968) because early formal collegial recognition reinforces working habits that promote high productivity (Allison and Stewart 1974; Cole and Cole 1973; Reskin 1977). In other words, quantity and quality of output are highly correlated: "the more scientists have published, the more apt they are to be cited by others" (Cole and Zuckerman 1984:231). Thus, given that women publish less than men, and that output is highly related to visibility, this provides additional support for our expectation that women will accumulate less visibility over time than men.

However, because of data limitations and a historical lack of appropriate methodological techniques, few studies have explicitly examined *trajectories* of productivity and visibility over the course of scholars' careers. Most of the research on this topic has been conducted by economists (Levin and Stephan 1989, 1998; Stephan and Levin 1992) and psychologists (Simonton 1988), and the focus here is on "age" effects. Much of this research suggests that, perhaps because of decreasing returns to investment, scholars' level of investment in their research decreases as they age, and this lifecycle effect characterizes most scholars and disciplines (Levin and Stephan 1991). However, if, as sociologists suggest, non-financial incentives like status are paramount to individual scholars, and cumulative advantage is operating, then trajectories might vary tremendously, with initially advantaged scholars becoming more so with time, and initially disadvantaged scholars remaining marginal in terms of disciplinary impact. A few sociologists with access to rich, longitudinal data have been able to describe trends and "career age" effects (Long 1992). Few, however, have theorized a role for another important kind of capital – professional capital, particularly the extent of research specialization – and few have had access to recent statistical developments that permit an investigation of how both gender and specialization influence career trajectories. We agree that "research on the dissemination of scholarly work must take into account gender variations and explore where and why they occur" (Ward et al. 1992:297). To help explain why gender variations in trajectories occur, we incorporate a heretofore overlooked form of professional capital: the extent of research specialization.

INCORPORATING RESEARCH SPECIALIZATION

The idea of specialization, broadly conceived, has informed sociological and economic research on gender inequality for some time (e.g., in the home, educational system, and workforce). But the focus to date has been on *areas* of specialization to the neglect of another dimension of specialization: its *extent*.[2] This is particularly true in studies of academics, which focus on scholars' subfields, or specialty areas (Breiger 1976; Cappell and Gutterbock 1992; Cole and Cole 1968; Ennis 1992; Grant and Ward 1991; Grant, Ward, and Rong 1987; Moody 2004; O'Connor and Meadows 1976; Small and Griffith 1974b; Stokes and Hartley 1989; Wagner-Dobler 1997). These studies focus on specialty areas as the "building blocks of science" (Small and Griffith 1974a) and help us understand the social organization of disciplines (Cappell and Gutterbock 1992; Ennis 1992; Stokes and Hartley 1989; Wagner-Dobler 1997). However, these studies ignore a second dimension of specialization -- its extent – and thus do not close the gap between interest in scientific specialization and the number of concrete empirical investigations on the topic (Wagner-Dobler 1997).

The extent of specialization is a critical component of much more difficult-to-measure construct -- expertise (Collins and Evans 2002) -- and we expect it to reap many of the same benefits. Previous research has found that expertise positively affects legitimacy and credibility (Faulkner, Fleck, and Williams 1998), power, privilege, and influence (Turner 2001), status (Aiken and Sloane 1997), control (Braverman 1975), authority (Smith 2002), and -- most relevant to our work – productivity (Birnbaum 1981) and recognition (Rifkin, Dow, Carbaugh, Brunk, Brent, Brannigan, and Nurminin 1994). Thus, we expect that scholars who specialize to a high degree – regardless of research area – will derive benefits from doing so. Specifically, we expect the extent of research specialization to have a positive influence on productivity. Specializing allows a scholar to gain in-depth knowledge of a body of literature – including its central debates, theories, methods, and key players – and thus should make successive papers on that topic easier and more efficient to write, thereby increasing the quantity of research produced. We also expect the extent of specialization to positively influence visibility. Coming to know, and be known by, other scholars in a specialty area improves opportunities for advancement and publication, especially given that double-blind peer review is not always blind in practice.

[2] To our knowledge, no study of academics has incorporated the extent of specialization, but some studies of other professions are moving toward this focus. In the field of medicine, Weeks (2002) documented that financial returns emanating from additional specialty training are higher for procedure-based medicine than for primary-care medicine. Aiken and Sloane (1997) note and contribute to a large literature documenting the impact of specialization in health professions on economic rewards and other outcomes (Styles 1989). In the discipline of economics, only a few studies have examined the effects of specialized human capital investments (Antel 1986; Rosen 1983), and none has explored heterogeneity in individuals' work process and product. Using nationally representative data, Neal (1998) found that workers in highly specialized jobs have a comparative advantage.

Although there are likely several dimensions of the extent of research specialization, we focus on the extent to which a scholar repeatedly engages in research on the same *substantive topic,* for it is the communities surrounding such substantive research areas that may be critical to producing specialization's benefits. Certainly, other dimensions of specialization are possible. The extent of *teaching* specialization could assess whether faculty members teach the same course(s) repeatedly or diversify their teaching portfolio. The extent of *service* specialization might capture whether a scholar engages in the same kinds of department service (e.g., graduate studies director) year after year, or whether committee assignments are frequently rotated. Even within the realm of scholarship, different kinds of specialization are possible. For example, one could specialize to a great extent by method, by only engaging in experimental work, or only in field work. A scholar could also specialize theoretically by employing the same theoretical framework and premises even when studying a wide variety of substantive topics. However, we choose to investigate the extent of specialization in substantive research areas because these areas best correspond to accepted areas of expertise as delineated by American Sociological Association[3] – few of which embody a single method or a single theoretical perspective. Moreover, it is the invisible colleges and communication networks surrounding substantive research topics – rather than methods or theories – that should be most relevant to scholars' patterns of productivity and visibility.

We are particularly interested in how specialization operates over the course of scholars' career trajectories. Does specialization improve productivity and visibility to the same extent over scholars' careers? Or does the effect of specialization vary across time? Perhaps disciplinary norms encourage scholars to specialize at early career stages in order to get tenure. This early career stage link between specialization and promotion and tenure prospects has been recognized by the Center for Advanced Study in the Behavioral Sciences at Stanford University, which hopes to recruit promising young scholars who have "worked *narrowly* for 6-8 years to get tenure, [and] are now in a position to think more ambitiously about their work and to take greater intellectual risks..." (http://www.casbs.org/programs.php?snav=programsfellows.html). Similarly, breadth of research may be more valuable at later career stages when one is trying to achieve a full professorship. The statistical method we employ in this paper is particularly well-suited to investigating whether and how specialization's effects vary across scholars' careers.

In addition to specialization, we are also interested in how gender affects career trajectories, and how specialization and gender might interact. Based on a plethora of previous research on productivity (Fox 1992; Fox and Faver 1985; Prpic 2002; Reskin 1977, 1978; Xie and Shauman 1998) and a few

[3] See the list of sections (http://www.asanet.org/page.ww?section=Sections&name=Overview) and the newly devised list of specialty areas (http://www2.asanet.org/footnotes/septoct05/fn7.html).

studies of visibility (Ferber 1986; Long 1992; Ward et al. 1992), we expect women to be disadvantaged in terms of both of these career outcomes, and if cumulative advantage is operating, the gender differences may become larger with time. And given that we conceive of the extent of research specialization as a form of professional capital – essentially a resource – and that previously research has documented women's disadvantage in their access to various forms of capital (DiMaggio and Mohr 1985; Kanter 1977; Lin et al. 1981; Paglin and Rufolo 1990; Wegener 1991), we expect women to reap fewer benefits from specializing than men. These hypotheses dovetail with Reskin's (1978) and Fox's (1981) findings that rewards in science are not only distributed unequally across the sexes, but that men gain more than women from the same level of resources or capital. In extending Hodson's (1983) insight about how power relations influence the ability to tap resources, Johnsrud (1991) implies that women's disadvantaged status in academic science may limit their ability to tap their professional capital (i.e., the extent of research specialization) even when they possess it, and thereby gain less from it. Thus, our hypotheses about gender's effects on career trajectories, and especially our expectation that men will gain more from specializing than women do, emanates from a long line of research on "reward dualism," or the differential benefits that men and women receive from the same investments (Cannings 1988; DiPrete and Soule 1988; Fox 1981; Steinpreis, Anders, and Ritzke 1999).

Thus, we aim in this paper to fill in several gaps in literature on gender differences in academic careers. First, we introduce a theoretical construct – the extent of research specialization – and develop a measure of it. Second, we expand the research on scholarly visibility, for which gender differences remain largely unexplained, and incorporate two measures of visibility: citations and weighted publication counts. Third, we focus on career *trajectories*, which allow us to examine variation within and across individual careers, with special attention to differences between men and women. We expect that specialization, as a form of capital, will generally benefit scholar's career outcomes like productivity and visibility, especially for men. To test this hypothesis, we construct a unique and rich longitudinal dataset and employ a statistical method perfectly suited for examining change over the course of careers.

DATA AND METHODS

The sample we selected for this study – a 20% probability sample of tenure-track faculty at Research I universities – makes our test of gender and research specialization effects particularly stringent. Like most studies of academics, we begin with a cross-section of individuals currently in academe (Bayer and Astin 1975), and then collect retrospective data on publications and current data on salary to test the hypotheses of interest. This sample of individuals already in academe (n=233) is necessary given the publication-based measure of research specialization, which would be incalculable

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for individuals outside (or not yet in) academe who lack publications. Thus, the population from which we drew our sample is rather selective, and this is particularly true of the females, who are more likely than men to withdraw from science at various stages leading up to academic employment (National Research Council 2001; Preston 2004; Rosser 2004; Sonnert and Holton 1995) and are more likely to enter less prestigious institutional settings, such as teaching colleges (Grant and Ward 1991). Because the women in the sample have career patterns that most closely mirror men's, testing for any remaining gender differences is challenging. Moreover, by selecting only Research I universities (those which award 50 or more doctoral degrees per year in at least 15 disciplines – now referred to as extensive research universities (Carnegie Foundation for the Advancement of Teaching 2001)) and controlling for department prestige, we account for many resource-based influences on productivity and visibility. Because the vast majority of research takes place at Research I universities (Levin and Stephan 1989), such institutions serve as an appropriate context for investigating the impact of research specialization.

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Although extensions of this analysis to other fields will be fruitful, we begin with academics for several reasons. First, gender inequality in academia is particularly pronounced and lack of parity continues to befuddle administrators and educators at all levels (Bellas 1993, 1994, 1997; Etzkowitz, Kemelgor, and Uzzi 2000; Fox 1985, 1999; Fox and Stephan 2001; Horning 2003; Langton and Pfeffer 1994; Long 1992; Long, Allison, and McGinnis 1993; Preston 2004; Reskin 1976, 1977, 1978; Zuckerman, Cole, and Bruer 1991). The more hierarchical nature of academic science (Smith-Doerr 2004) relative to non-academic research suggests greater variation by gender in outcomes, which provides more room for explanation. Second, we focus on academics because we have developed a way to measure the extent of research specialization for authors of published research, which will be explained below. While measuring areas of specialization among a firm's employees seems feasible (perhaps by assessing job descriptions), it is more challenging to envision an accurate measure of the extent of specialization, except perhaps by gathering self-reported data on task homogeneity (e.g., types of surgery doctors engage in, or types of cases lawyers take). Third, academia is "fraught with difficulties which are not characteristic of most professional work" (Reskin 1977:491), such as high levels of competition, the focus on reputation and originality, lack of structure, and minimal public demands, thus warranting separate, in-depth study. Thus we agree with Xie and Shauman (1998:848) that, at least initially, "it is useful to restrict the population being studied to academic scientists, because publication is generally expected, facilitated, and rewarded for scientists employed in academic settings."

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Focusing our investigation on the disciplines of sociology (n=142) and linguistics (n=91) also adds to the stringency of our hypothesis tests, for in these disciplines, more than in the natural sciences, women have been incorporated to a greater extent. This is evident in an increasingly equitable gender

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distribution of recent PhDs over time: in 1973, less than 15% of the professionally young (PhD within the last 10 years), full-time, academic labor force in the social and behavioral sciences was women; this increased to 45% by 1995. This contrasts with much lower levels of integration in the natural science and engineering, where in 1995, women only constituted 20% and 11%, respectively (National Research Council 2001). Thus, lower levels of sex-segregation in sociology and linguistics relative to other fields like engineering (Etzkowitz, Kemelgor, Neuschatz, Uzzi, and Alonzo 1994) allow for sub-sample sizes large enough to obtain the statistical power needed for examining gender differences. While many previous studies of gender stratification in academe have focused on a single discipline (Keith et al. 2002; Long 1992; Reskin 1977), we examined two disciplines because processes of gender stratification have been found to differ across disciplines (Fox and Stephan 2001; Levin and Stephan 1989; Liebert 1976; Prpic 2002; Wanner et al. 1981), and the social sciences and the humanities have generally been neglected by the sociology of science and knowledge (Guetzkow, Lamont, and Mallard 2004). Although the two disciplines also differ in age (sociology is older) and size (sociology is bigger in terms of membership), they both sit at the crossroads of several different disciplines and are inherently diverse fields, making an investigation of individual-level specialization particularly informative.

Data Sources

Most of the data used for our analyses are culled from secondary sources. To construct the sampling frame, take the sample, and contact people, we obtained faculty members' names and contact information from university and **department websites** and also from disciplinary **guides to graduate programs** and **professional association membership directories**. We also used these sources, along with a short **web-based survey** and scholars' **curricula vitae**, to obtain information about each scholar's gender, doctoral institution, current institution, PhD year, and the like. To handle unmeasured heterogeneity that remains even among the rather homogeneous sample of extensive research universities, we control for department prestige of current and PhD-granting institutions, obtained from the **National Research Council** (Goldberger, Maher, and Flattau 1995).

All of the data needed to measure research productivity and research specialization (described in the next section) were collected from **discipline-specific electronic databases**: Sociological Abstracts (SA) and Linguistics and Language Behavior Abstracts (LLBA), both of which are managed by the same organization: Cambridge Scientific Abstracts (CSA). By entering academics' names, we accessed their entire publication histories. We include only peer-reviewed journal articles and research notes, which previous studies have found to be highly correlated with total productivity that might include

books, book reviews, and contributions to edited volumes (Reskin 1977, 1978).[4] For each article, we collected keywords used to describe each sampled academic's multiple publications.

We rely on the broad classification codes (see the entire list for sociology in Appendix A) rather than more detailed keywords because they are most comparable to recognized specialty areas in each discipline.[5] Fortunately the current lists of keywords are up-to-date and consistent across time; e.g., if a keyword used before 1980 morphed or was merged into a new keyword, then both pre- and post-1980 articles would be classified by the newer code. Because of the extensiveness of SA and LLBA's coverage (they index articles from 6000 and 2000 periodicals, respectively, over a period of over 30 years), they are more ideal than other databases such as the Social Science Citation Index and the Arts and Humanities Citation Index, which cover only 140 sociology journals since 1970, and 1138 arts and humanities journals since 1990.[6]

We collected data on citation counts and journal impact scores from the Institute for Scientific Information (ISI)'s Web of Science in order to measure visibility (Ferber 1986) or the extent to which a scholar's work is utilized by others (Allison and Long 1990). Although other databases are beginning to include citation data, currently the Web of Science provides the most comprehensive information. Citation data for sociologists were obtained from the **Social Science Citation Index**, and data for linguists were obtained from the **Arts and Humanities Index**. From ISI's **Journal Citation Reports**, we obtained information about each journal, specifically the impact-factor which indicates the number of times, on average, a recently published article in that journal has been cited.

The reliability and validity of these data are enhanced in two ways. First, often the same information was available from more than one source. For example, year of PhD receipt was often found on CVs and listed in professional association guides and publication lists were available from the disciplinary databases and CVs. Multiple sources also allowed us to fill in gaps when data from one source were missing. Second, we do not base our measures of research productivity on self-reports as several other scholars do (Fox and Faver 1985; Prpic 2002; Wanner et al. 1981; Xie and Shauman 1998). Recall error, social desirability bias, and other types of random and systematic error are common, and are likely exacerbated when respondents are asked about specialty areas and publications that span their entire career. Instead of relying on self-reports, we obtain this information from publicly

[4] Although books are occasionally indexed in CSA's databases, we do not incorporate their keywords into the measure of research specialization. Because method and evidence, not subject matter (embodied by the keywords used here), distinguish books from articles (Clemens et al. 1995), the exclusion of book should not bias the measure of research specialization.

[5] Although specialization scores depend on how detailed the keyword descriptors are (Blau 1977) our previous research has demonstrated that results are not dependent on whether broad or detailed keyword descriptors are used.

[6] The journals included in SA (see http://ca1.csa.com/csa/HelpV6/suppl/sociossl.shtml) and LLBA (see http://ca1.csa.com/htbin/sjldisp.cgi?filename=/wais/data/srcjnl/llbaset) are quite interdisciplinary. Thus even if women tend to publish in interdisciplinary journals more, as Grant and Ward suggest, their works will not be disproportionately excluded.

available electronic databases, as a few scholars have done (Long 1992; McBrier 2003; Reskin 1977). This, and in addition having a single organization -- Cambridge Scientific Abstracts (CSA) -- develop and apply the classification coding systems for both sociological and linguistics literatures, greatly reduces systematic and random measurement error.

Key Measures

Gender and the extent of research specialization are the key explanatory variables, and productivity and visibility are they key outcomes variables in our analysis. We mirror previous research in the way it operationalizes productivity and visibility, being careful to review concerns about measuring these concepts. Because the extent of research specialization has never been incorporated into quantitative studies of careers, we explain in detail how we measure this construct.

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Gender

The gender of respondents was, in most cases, evident from an examination of first names. In ambiguous cases, we determined gender from a question on the web-based survey or from Internet searches (which yielded pictures and/or short biographical sketches that used gender-specific pronouns).

The Extent of Research Specialization

We assess the extent of specialization, which taps differentiation in a scholar's research program, using keyword descriptors – specifically, the one or occasionally two classification codes that CSA applies to each article.[7] To construct a measure of the extent of research specialization, we compare the cumulative number of publications with the cumulative number of *unique* keyword descriptors.[8] Specifically, to differentiate scholars who specialize (i.e., devote a large portion of their research program to a small set of specialty areas) from those who branch out (i.e., write successive papers on

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[7] We weight co-authored and single-authored pieces equally, as Wagner-Dobler (1997) and others have, because whether one worked on a piece alone or in collaboration with others should not diminish or enhance the prominence of that subfield in one's research program.

[8] To our knowledge, only a few scholars have used keyword descriptors to identify areas of research specialization (for example, see Moody (2004) and Wagner-Dobler (1997)). Akers (1992:3) notes that "while there is much agreement over what constitutes sociological specialties, there is no single codified and wholly agreed upon list of them," and the same is probably true for Linguistics as well. A variety of strategies for measuring specialty areas have been proposed, but each varies considerably from the one proposed here. Bibliometric measures focus on communication in research literature, using citation as the mode of communication. Using this approach, networks of scientists working in the same areas can be identified, as can the number of specialty areas to which a particular scholar contributes (Stokes and Hartley 1989). Lists of recognized research specialties can also be obtained from respective professional associations. Many scholars have used membership in "sections" defined by the American Sociological Association as well as membership directories to classify scholars' research interests (Ennis 1992; Mullins 1970), but it would be impossible to construct a measure of the *extent* of specialization from such information, because scholars cannot join the same section twice.

new topics), we use the ratio of the cumulative number of unique keyword descriptors to the cumulative number of publications (# of unique keywords / # of publications) and subtract this value from one so that higher values indicate greater specialization. In Table 1 we describe the process of variable construction using data for three hypothetical sociologists. Underlined keyword descriptors are those that are new to the scholar's research program. Sociologist #1, who first began publishing in 1996, has the most diverse research program, covering seven unique subfields within sociology over the course of nine publications. Sociologist #3, who entered the field in 1984, has the most specialized research program, covering only two subfields (group processes and social network analysis) in his 12 publications since that time. Sociologist #2 has also only published in two subfields (1020: occupations and professions, and 2983: sociology of gender) but is professionally younger and has fewer publications, and thus his specialization score is not as high as that for Sociologist #3. Because articles receive at the most two classification codes that describe their content, the measure has a minimum value of "-1" for scholars who pursue a new subfield with each publication [e.g., (1-(2/1)) = -1] and a maximum value close to "1" for scholars who publish repeatedly on the same topic [e.g., (1-(1/12)) = 0.92].

Comment: Do we not used the percentile measures in this paper?

-- Table 1 about here--

Productivity

To tap productivity, we use the measure that is most common in the literature: a publication count (Allison and Long 1987; Ferber and Loeb 1973; Fox and Faver 1985; McBrier 2003; Prpic 2002; Reskin 1977, 1978; Wanner et al. 1981; Ward and Grant 1995; Xie and Shauman 1998). Also following previous research, we include only peer-reviewed journal articles and research notes, which previous studies have found to be highly correlated with total productivity that might include books, book reviews, and contributions to edited volumes (Reskin 1977, 1978).[9] Although no single measure of productivity is adequate or universally accepted (Fox 1983; Long 1992), quantity of journal publications is the single most commonly used measure. Alternative measures that account for co-authorship status and journal prestige have been found to be highly correlated with the raw publication counts (Cole and Zuckerman 1984). Because we are interested in career trajectories rather than biological age effects, and

[9] There are several reasons to focus on journal articles as a measure of research productivity. First, there are few reasons to believe that one sex favors book over article publishing (Cole and Zuckerman 1984), thereby making biased results unlikely. (One reason, more recently proposed by Linda Grant, is that feminist research that women tend to do may initially have had difficulty gaining access to journal space, thus relying more heavily on particular book presses). Second, the greater variation in article counts makes articles an ideal unit of measurement for a quantitative study interested in explaining variation (Fox 1985). Third, although publication in refereed scholarly journals is only one way to disseminate research, it is the means by which scholars become integrated in the citation network and also weighs heavily in scholarly evaluations (Ferber 1988; Grant and Ward 1991). Forth, because books rarely preclude the publishing of journal articles on the same topic, including both books and journals might artificially inflate scholars' specialization scores.

because scholars are typically evaluated on their entire career's worth of output, we use a cumulative count of publications in our analyses.

Visibility

In our analysis we use two measures of visibility proposed in the literature: a cumulative sum of journal-impact score weighted publications and a cumulative sum of citation counts.[10] The first measure relies on the impact factor that ISI's Journal Citation Reports provides for each journal, which is essentially the number of citations to items recently published in that journal divided by the number of recently published items; in essence, it captures the visibility of a journal. Like Levin and Stephan (1989) we capture visibility by counting publications after they have been weighted by their respective journal impact factor. In essence, articles published in high-impact journals like the *American Sociological Review* (in sociology) and *Language* (in linguistics) count more toward our impact-score-weighted count of publications than articles published in lower-tier journals.[11] Thus, our measure makes the reasonable assumption that scholars who publish in high impact journals personally reap benefits from the journal's visibility. Whereas some scholars have taken journal prestige into consideration when measuring scholars' visibility by limiting publication counts to articles published in highly visible journals (Keith et al. 2002; McBrier 2003), we use the impact-factor-weighted count because we believe that visibility can be enhanced by publishing in arenas other than a discipline's top journals.

Perhaps more than journal of publication, however, members of academic communities rely on citation counts to gauge not only the quality of journal publications, but also their authors' subsequent visibility within the field (Diamond 1986). Citation counts may also be tapping constructs that are related to visibility, such as disciplinary alliances (Stinchcombe 1982), attempts to flatter potential reviewers (Latour 1987), or the quality, usefulness, or controversial nature of the article (Ferber 1986; Najman and Hewitt 2003). However, they are relied upon heavily in promotion and tenure decisions, and have been shown to impact academic salary (Diamond 1986; Hamermesh et al. 1982; Sauer 1988). Unlike some studies that determine citation rates through a search on author name (Reskin 1978; Wanner et al. 1981), which only includes sole- and first-authored papers, we follow Long (1992) and Sonnert (1995) in obtaining citation rates for each article published by each sampled faculty member, and summing them to obtain a yearly count of the number of cumulative citations received by each individual.

[10] Because both of these measures tap a scholar's visibility, our expectations about the influence of gender and the extent of research specialization remain the same for both.
[11] For the lowest-tier journals that are not rated in the Journal Citation Reports, we assign a value (0.05) that lies just below the lowest impact factor but is greater than zero.

We account for the inter-relationship between visibility and productivity by incorporating lagged measures of one construct when attempting to explain variation in the other construct. Because, perhaps intuitively, the sheer quantity of publications fosters visibility and recognition by others in the scholarly community (Cole and Zuckerman 1984:231), we control for productivity when examining the effects of gender and specialization on visibility. Perhaps less intuitively, heightened visibility may also promote productivity through a reinforcement process (Cole and Cole 1973). Given the public nature of formal collegial recognition (as indicated by a reference to one's work), it should reinforce working habits that promote high productivity rates. In other words, visibility demonstrates merit to those who distribute resources such as promotions, grants, and research assistance (Reskin 1977) and thereby reinforces past productivity and facilitates future productivity as well. Given the empirical support for this process, termed the accumulative-advantage hypothesis by the Coles (1973) and the "Matthew effect" by Merton (1968), we also capture the feedback between productivity and visibility and their mutual reinforcement (Allison and Stewart 1974). To reduce concerns of reverse causality, we take Singer and Willett's (2003) advice to use lagged versions of the predictor variable in each model.

Control Variables

As mentioned above, our sampling procedure allows us to control for many structural influences on individuals' careers. All individuals in our analysis sample are employed at Research I Universities, which tend to be similar in terms of levels of resources, expectations, teaching hours, and the like. We also selected individuals in one of two fields: sociology and linguistics, primarily because the social sciences and humanities are typically overlooked in studies of scientific careers. We also wanted to limit differentiation in trajectories that could be attributed to disciplinary norms, because scholars in purely empirical fields like biology tend to produce their major contributions later in their careers, relative to more abstract fields like math and physics (Hess 1997), and scholars in natural sciences tend to reach their peak citation years earlier that scholars in the social sciences (Anderson 1991). Because some variation remains in our analysis sample after imposing these sampling criteria, we statistically control for discipline (sociology or linguistics), prestige of PhD-granting department, current department prestige, and whether the scholar moved to a higher- or lower-prestige department. We do not control for co-authorship and family status in this study because, as previous research suggests, in this rather elite population of at least minimally productive scholars at top tier research universities, these two factors are not relevant to career outcomes (Xie and Shauman 2003:184).

Whereas psychologists and economists studying productivity have focused on the effect of biological age, we are more interested in using career age to capture change, taking the sociological view that "it is not age per se that generates [a pattern of] productivity, but the fact that age reflects the

unfolding of a career" (Levin and Stephan 1989:533). Older individuals have more experience and history, which in turn affects resources and recognition. Xie and Shauman (2003:180) show that research productivity has a distinct career-cycle profile: increasing to a peak early, and then gradually declining. Therefore, we use year in one's career to log time. We also control for time between PhD receipt and the start of one's trajectory as well as academic rank because productivity and visibility may depend not only on career age but career stage (Wagner-Dobler 1997), and the two are not necessary perfectly correlated: women, in particular, tend to stay at each rank longer than men (Ward et al. 1992). Controlling for career age and stage is also important due to the gendered age structure that resulted from women's more recent entrance into academia (National Research Council 2001:130).

Statistical Model

To examine the effects of various relevant factors on academics' career trajectories, we employ hierarchical linear modeling (Bryk and Raudenbush 1992). While most sociological applications of hierarchical linear modeling (HLM) are interested in contextual effects, this method can also be adapted to study individual change over time, which is typically referred to as Linear Growth Modeling. This method is ideal because it allows us to examine career processes without resorting to categorizing that process into discrete time periods – which was more typical before the advent of HLM (Fox and Faver 1985; Keith et al. 2002; Reskin 1978). This statistical method is ideal for examining and explaining both within- and between-scholar variation in career trajectories. Linear Growth Modeling (Bryk and Raudenbush 1992; Singer and Willett 2003) allows us to not only descriptively examine the shape of trajectories, but also to test hypotheses about the factors of interest to us: gender and the extent of research specialization, while controlling for a host of other factors, including the mutually reinforcing relationship between productivity and visibility (Allison and Stewart 1974).

Our interest in trajectories of productivity and visibility requires that the time period of interest be defined precisely. The origin of the trajectory period is important to ascertain (Singer and Willett 2003). We follow the lead of other scholars (Toren and Moore 1998) by using the attainment of a certain threshold as our starting point for each trajectory. Each individual's trajectory begins when he or she has obtained a tenure-track academic position and the tenure "clock" has begun. Because we are interested in the extent of specialization, a measure that depends on potential repetition of research areas with subsequent publications, we add an additional criterion to our threshold: the individual must be in a tenure track position *and* have published two or more journal articles. Thus, as we define it, an academic's career trajectory begins when he or she has entered a tenure track position and has published at least two articles.

In addition to a starting point, we also believe that it is critical to define an endpoint to the trajectories of interest. Although HLM can handle unbalanced datasets (in which the number of points that contribute to the trajectory vary across individuals), we are keenly aware that the relatively recent influx of women into academic positions renders the typical male career trajectory much longer than the typical female trajectory. Because longer careers means greater opportunity to accumulate publications and citations, women – who have on average been in the field for a shorter period of time – would be artificially disadvantaged if we examined men's and women's complete career trajectories. For this reason, we limit the career trajectories to twenty years. This (right) truncation corresponds with the methodological decisions made by other scholars interested in gender differences (Long 1992).

The hierarchical linear model, when used to study individual change over time, can be understood as a two-level model in which individual academics are the larger, level II units and the academic's multiple scores on the dependent variable (cumulative publications, weighted publications, or number of citations) are the level I units. In other words, instead of having individuals nested within larger contexts, which is more typical when HLM is used by sociologists, we have distinct time-specific values of a variable nested within – or belonging to – individuals. Models are specified at each level, and then these models are combined to produce a composite model specification which is then estimated. The level I submodel describes how individuals change over time, while the level II submodel describes how these changes vary across individuals (Singer and Willett 2003). Thus, time-invariant individual-level predictors, such as gender, are included in the level II submodels. However, when individual-level predictors are time-varying they must be included in the level I submodel (Singer and Willett 2003) because the growth parameters that indicate the shape of the trajectory will vary depending on the value of the time-varying predictors.

The time-varying nature of most of our predictors gives them a unique effect on the "intercept" in hierarchical linear models for longitudinal analyses. Of course, when a predictor is time-varying – as is our measure of the extent of specialization – it can change throughout the course of a career. Therefore, estimating its main effect does not indicate the predictor's effect on the intercept (here, the origin of the trajectory) as is typical in linear growth models. Instead, a time-varying predictor can shift the entire trajectory – either up (if the coefficient if positive) or down (if the coefficient is negative) – holding the shape of it (that is, the rate of growth) constant. Thus, main effects of time-varying predictors suggest shifts among parallel trajectories across time, but no change in the rate of growth. For example, if specialization has a positive and significant main effect but no effect on the slope (i.e., no interaction with time), this indicates that scholars who become more specialized over time will enjoy a proportionate and stable increase in their trajectory of, say, productivity. That is, specialization yields a proportionate productivity boost in every career year. Only if specialization interacts with time (i.e.,

specialization significantly alters the slope defining the relationship between time and productivity) would the shape of the trajectory change across time. For example, if the interaction term between specialization and time is positive, this suggests that specialization improves productivity more in the later career years than in earlier years.

We model our dependent variables of interest (cumulative productivity and cumulative visibility), here symbolized by Y, for person *i* at time *t* for level I as:

$$Y_{ti} = \pi_{0i} + \pi_{1i} TIME_{ti} + \pi_{2i} TIME_{ti}^{2} + \pi_{3i} SPEC_{ti} + \pi_{4i} SPEC_{ti} * TIME_{ti} + \ldots + \pi_{qi} X_{qti} + e_{ti}$$

Thus, Y is a function of an intercept (π_{0i}, the grand mean of publications across academics when all predictors, including time, equal zero), TIME (π_{1i} and π_{2i}), the academic's extent of research specialization (SPEC) at time *t* (π_{3i}), the interaction of SPEC and TIME (π_{4i}), while controlling for other relevant variables (π_{qi}). In our analysis, the $TIME_{ti}$ variable (career age) is centered so that the intercept parameter π_{0i} can be interpreted as the number of publications at the start of the trajectory (when the scholar has achieved a tenure track position and has at least two publications). While the unit in this level I model is the "person-score," the unit in the level II model is the person. In the level II models, the outcome variables are the π parameters derived from the Level I model, which are person-specific and define the curvilinear trajectory:

$$\pi_{0i} = \beta_{00} + \beta_{01} FEMALE_{1i} + \ldots + \beta_{0q} X_{qi} + r_{0i}$$
$$\pi_{1i} = \beta_{10} + \beta_{11} FEMALE_{1i} + r_{1i}$$
$$\pi_{2i} = \beta_{20} + r_{2i}$$

Our hypotheses and the corresponding model specification above reflect our interest in the conditioning effects of gender (FEMALE) and the extent of research specialization (SPEC); the effect of other control variables are captured in the vector labeled "X_{qti}" in the Level I model (if they are time-varying predictors, such as our lagged variables capturing reinforcement processes) and "X_{qi}" in the level II model (if they are time-invariant, such as discipline and prestige of PhD-granting department). No predictors affect the rate of deceleration π_{2i},[12] although we allow a random component (r_{2i}) to be associated with this quadratic term. The random components of the Level II models (essentially the

[12] We tried specifying models with interactions between various predictors and $TIME^2$. However, the size of the $TIME^2$ coefficient was typically very small, and the random effect associated with it (r_{2i}) had a small variance, suggesting a limited role for interactions. Moreover, judging by the BIC statistic, models including these interaction terms fit significantly worse than models without them.

error terms r_{0i}, r_{1i}, and r_{2i}) contain the effect of unmeasured individual characteristics that do not change over time. We tried linear and log-linear time-specifications, but the same curvilinear time-specification (including TIME and $TIME^2$) fit the best for all three dependent variables (cumulative publications, cumulative weighted publications, and cumulative citations).

The models above allow for gender to influence both the overall level and the shape of scholars' trajectories of productivity and visibility. But what if the effect of specialization on the trajectories is gendered? What if the effect is larger, or stronger, for men than for women, as we hypothesize? After estimating the above model for each outcome of interest using the full sample, we proceed to estimate separate models for male and female scholars to test our hypothesis that a valued and potentially beneficial form of capital such as research specialization will be more beneficial to men than to women. That is, we expect men to gain more than women do from specializing to the same extent. We assess this by specifying models similar to the one above (removing the gender variable, of course) separately for men and women, and then comparing the size, direction, and statistical significance of specialization's coefficient.

RESULTS

Descriptive Results

Table 2 describes our sample of scholars over the career history included in our analysis (up to twenty years). Our total sample of individuals at year 1 is 233, which includes 142 sociologists and 91 linguists. Because we start academics' trajectories once they enter a tenure-track position and have at least two publications, some academics' trajectories begin when they are in associate or full professor positions – for example, if they spend time in applied positions and then move into a tenured academic position. For this reason, we control for academic rank in our statistical models. The gendered age structure in academia is reflected in the fact that we start with 89 women in year 1, but only 19 women have histories that reach year 20. As Table 2 shows, women make up 38% of our sample in the first year, whereas they are only 20% of our sample in year 20. On average, specialization tends to increase over time in our sample, especially within the first 10 years. Men, on average, are more specialized than women at the beginning and end of their careers. The average woman in our sample has fewer publications (raw and weighted) and citations than the average man, across all time-points. Differences, and a growing gap, are especially apparent over time in terms of visibility (as indicated by both impact-factor weighted publications and citations), while the gap for productivity is relatively small. Figures 1-3 demonstrate this difference over time for men and women, with each line representing predicted publications (raw or weighted) and citations using only time and $time^2$ as predictors. It is also worth

noting that compared to men in our sample, women earn their PhDs at more prestigious departments but work at less prestigious departments.

-- Table 2, and Figures 1-3 about here --

Multivariate Results

To examine the effects of research specialization and gender on career trajectories more systematically, we specify a series of hierarchical linear models wherein productivity and visibility trajectories essentially serve as the outcome variables of interest. We present results for each outcome variable (productivity, and our two measures of visibility: a count of impact-factor weighted publications and a citation count) in a separate table. For each outcome, we refer to the best fitting model for the full sample, which includes the predictors of interest -- gender and specialization -- and relevant control variables as Model 1. In this model, all covariates are allowed to have a main effect, and specialization, gender, and selected control variables are specified to affect the slope (that is, interact with time and potentially have disproportionate effects across time).[13] To capture the interrelationship between productivity and visibility (Allison and Stewart 1974; Cole and Cole 1973; Cole and Zuckerman 1984:231; Keith et al. 2002; Reskin 1977), we statistically control for lagged visibility when examining productivity trajectories and for lagged productivity when examining visibility trajectories. Then for each outcome variable, we estimate this best-fitting model for women (Model 2) and men (Model 3) to test assess whether men gain more from specializing.

Productivity

In the overall sample (Table 3, Model 1), we find that specialization significantly and positively affects both the level of productivity and the rate of productivity growth. In other words, as specialization increases, the level of productivity and the rate of growth in publications increase. Figure 4 portrays this relationship by showing the predicted cumulative publication trajectories over time for two hypothetical academics: one diverse scholar with a specialization score at the 25th percentile (< .22) and one specialized scholar with a specialization score at the 75th percentile (> .58) of the specialization distribution. The average level of productivity is higher, and the rate of growth over time is greater, for the specialized scholar (i.e., the two trajectories are not parallel because the specialized scholar's cumulative publications grow at a faster rate). Recall that because specialization is a time-varying

[13] To decide which control variable should interact with time, we relied on both the statistical significance of the interaction terms and improvement in model fit: if the term was significant or improved model fit, then we kept it in the model. As can bee seen from a comparison of Table 3-5, different control variables interacted with time depending on the outcome variable of interest.

variable, its main effect indicates a change in the level of the trajectory (not just its intercept, or start point) and its interaction with time indicates a change in the slope of the trajectory. Thus, academics can have discontinuous trajectories in which there are "jumps" in levels and rates of growth after becoming more specialized, or conversely, stagnation after becoming more diversified.

-- Table 3 and Figure 4 about here --

Gender differences in productivity trajectories are apparent when we examine the full sample (Table 3, Model 1). Although women do not have a significantly lower level of productivity, they experience a slower rate of growth over time in cumulative publications, as indicated by the negative and significant effect that gender has on the slope (-0.12). Thus, it is not gender alone (at any/every time period) that hurts women's productivity. Rather, the female disadvantage becomes apparent only over the course of careers: the small and insignificant gender gap widens over time because women experience less productivity growth than men. This suggest that studies that examine only short time intervals (Xie and Shauman 1998) may have missed significant gender differences in productivity that only emerge over longer time periods.

There is some evidence of "reward dualism," or the differential benefits that men and women receive from the same amounts of specialization. However, men do not always gain more than women (see Table 3, Models 2 and 3). For women, specialization significantly increases their level of productivity (0.80), but not their rate of growth. In other words, specialized women's productivity trajectories will be higher at all time points than diversified women's trajectories. For men, specialization increases the rate of growth (0.11) but not the level of productivity; that is, the disparity between specialized and diversified men increases over time. This finding -- that specialization helps men more with time (but not women) -- combined with the descriptive result that men tend to specialize more than women at all career points (see Table 2), helps explain the increasingly divergent productivity trajectories we saw between men and women (in Model 1).

Most of our control variables operated in the direction suggested by the literature, though a few effects were gendered.[14] First, in accordance with findings in previous research (Cole and Cole 1973), the number of citations (lagged one year) positively affected subsequent productivity, as indicated by the positive and significant, albeit very small, effect of citations on the level of productivity (0.009 in Model 1). Although positive feedback in terms of visibility boosted productivity levels for both men and

[14] One result that remained stable across both genders is the positive covariance of two random effects: that for the intercept and that for the slope (time's effect). This indicates that academics with higher initial levels of productivity, regardless of their sex, experienced higher rates of productivity growth. This finding supports Cole and Cole's accumulative-advantage hypothesis (Cole and Cole 1973) and Merton's (1968) "Matthew effect," in which advantage compounds over time.

women, it increased the rate of growth in productivity only for women (that is, the coefficient for "Cumulative Citations * Time" is statistically significant only for women). This suggests a small refinement of Cole and Cole's (1973) finding that visibility (measured via citations) reinforces men's productivity more so than women's. Second, taking a longer time between PhD receipt and the start of one's trajectory (that is, when one is in a tenure track position and has published two or more articles) is beneficial for productivity level (0.07 in Model 1) but detrimental for productivity growth (-0.02). Importantly, this finding holds only for women. Thus, taking time off (for family reasons, for a post-doc, or because of difficulty obtaining a tenure-track position) but continuing to publish allows women's cumulative publications to increase at every point in one's career, but it may also indicate less initiative, investment, or potential, thereby limiting women's productivity growth over time. Third, while there are no disciplinary differences in men's productivity, women in sociology are significantly less productive (-0.81) than women in linguistics. Finally, and perhaps most surprising, is that department prestige has a negative effect on women's productivity but not men's. We interpret these findings in the discussion section below.

Visibility

Specialization and gender have interesting effects on visibility. Although specialization promotes scholars' productivity, it appears to have an adverse effect on visibility. We expected specialization to boost visibility, but whether we use the sum of publications weighted by journal impact factor (Table 4, Model 1) or a citation count (Table 5, Model 1) to capture visibility, we find that scholars whose research programs are more specialized have less visibility in their scholarly community. This effect is the same across all time points in scholars' careers: in other words, the specialization variable does not significantly interact with time (i.e., career age). On average, women's visibility also decreases with time. For both measures of visibility, we find that gender has no statistically significant main effect on the level of visibility, but that it does significantly interact with time. So even though visibility losses are not associated with simply being female, women's rate of visibility growth declines considerably over the course of their careers.

-- Tables 4 & 5 about here --

There are other noteworthy gender differences in visibility trajectories (see models 2 and 3 in both tables). First, specialization's surprising negative effect on visibility trajectories appears to be stronger for men than for women: specialization's effect on citation counts is larger for men than for women, and specialization's effect on weighted publications is only significant for men. Men do not

only reap less visibility from specializing than women, they are in fact hurt more. Second, women who start at a higher level of visibility also have a higher rate of growth in visibility, while the same relationship is not present for men. This finding, which is robust to the measure of visibility used, is evident from the statistical significance of the covariance of two random components, the intercept's (r_{0i}) and slope's (r_{1i}), which is positive and statistically significant for women, but not for men. This finding reveals that early efforts to enhance visibility are especially critical for women. Third, while previous productivity boosts visibility for both men and women, it increases men's visibility levels more than women's (the effect of productivity on citations is 9.67 for men and 5.28 for women; and its effect on weighted productivity is 0.52 for men and 0.36 for women) and only men have decreasing returns to productivity over time (the coefficient for "cumulative publications * time" is significant and negative for men but not women in Tables 4 and 5).

Although we followed the lead of previous research in conceptualizing both impact-score-weighted publication counts and citation counts as measures of visibility (and these two variables are highly correlated at r = 0.86), one of our main findings does depend on which measure is used. We found that specialization decreases visibility overall (when the full sample of men and women is used), and this effect is particularly strong for men. However, the effect is only apparent for women when we use citations as a measure of visibility. Specialization does not have any effect on women's impact-score-weighted productivity count, our other measure of visibility. Specializing reduces men's chances of getting published in high-impact journals, but not women's chances.

Most of our control variables have the effects we would expect based on previous research. Not surprisingly, productivity (cumulative publications lagged) has a significant, positive effect on visibility, regardless of which measure of visibility is used.[15] Intuitively, publishing increases visibility levels for women and men, but it has a significant and negative effect on the rate of growth for men. In other words, productivity has (slightly) decreasing returns for men's visibility, but not women's. Relative to linguists, sociologists generally have higher levels of visibility and faster growth rates as well. We also find that it is only men's visibility that is disadvantaged when they move to less prestigious departments, and only in terms of citation counts, not impact-factor weighted publications. Moving to a less prestigious department has no impact on women's visibility. However, after tenure (during the associate professor years), only women's – but not men's – visibility is reduced; and this result holds for both measures of visibility.

[15] Productivity also seems to be capturing most of the over-time variation in visibility: when productivity controls are removed, the time and time^2 coefficients become statistically significant.

DISCUSSION

One goal of this study was to examine whether and how the extent of research specialization influences two important components of academic careers: productivity and visibility. Our results indicate that specialization's effects differ depending on the career outcome of interest. As expected, specialization positively and significantly affects productivity: relative to scholars with diversified research programs, scholars with more specialized research programs have not only higher overall levels of productivity, but also have faster growth rates. Thus, in-depth knowledge of a topic does appear to confer advantage in terms of writing efficiency. However, contrary to what we expected, specialization has a negative effect on scholars' visibility, as indicated by two measures of visibility: a journal impact-factor weighted sum of publications and citation counts. This suggests that while specialists may be relatively visible within their specialty areas (partly because of their high productivity), their work is unlikely to gain wide recognition from the larger academic community. Perhaps specialists' papers are more likely to appear in subfield-specific journals with a more restricted audience. Or even when specialists publish in journals with a more general readership, their work does not appeal to scholars in other subfields and fields as the work of generalists does. This interpretation resonates with the work of Clemens et al. (1995) and Lamont (1987) who found that it is more diversified scholars who speak to large scholarly audiences, conferring broad visibility.

By using hierarchical linear modeling, we were able to decompose gender differences into differences in level and rate of growth. In terms of productivity, for example, we found that specialization positively affects the level of productivity for women (but not men), and the growth rate of productivity for men (but not women). In terms of visibility, we found that specialization seems to be more detrimental to men's visibility than to women's, and that it does not significantly affect the growth rate in visibility for either gender. Many of our key findings, particularly the gender differences in productivity that emerged only after 6-7 years, would not be revealed in cross-sectional analyses of shorter duration data. For this reason we encourage future research on careers to use longitudinal data and appropriate statistical techniques, such as linear growth modeling, whenever possible.

Collecting and using two measures of one of our key outcomes variables – visibility – also proved fruitful. Although our two measures (a count of publications weighted by journal impact factor and citation counts) are highly correlated ($r = 0.86$), our results suggest that they should not be used interchangeably, at least when gender differences are of interest. When we used citation counts to measure of visibility, we found that specialization negatively affects both men and women's visibility; when we used a weighted publication count to measure visibility, only men's visibility was negatively affected. This suggests that specialist women are not, like specialist men, less likely to be published in

high-impact journals compared to their counterparts with diverse research programs, but they are less likely to be cited. The operation of double standards (Foschi 1994, 2000) might explain why specializing reduces men's chances of getting published in top journals (i.e., they are expected to produce theoretically broad work) yet has no effect on women' chances (i.e., they are expected to produce detailed, competent work), but further research is required to understand the underlying mechanisms. This interpretation is supported if a weighted publication count taps the quality of research, and if citations tap visibility more directly.

Although specialization was – contrary to our expectations – particularly harmful to men's visibility, we did find some evidence of reward dualism operating with respect to productivity. We hypothesized that men would gain more than women from equal investments in the kind of professional capital that specialization represents. Men did not gain more visibility, but they did gain more productivity from specializing than women did. Although women's productivity level increases when they specialize (+0.80 in Table 3, Model 2), men's productivity rate increases with specialization (+0.11 in Table 3, Model 3), and therefore men's productivity begins to surpass women's within 6-7 years, and it continues in that direction, resulting in large productivity differences by mid-career.

Comment: Ax the specific numerical results form discussion section?

Reward dualism surrounding the inter-relationship between productivity and visibility also seemed to be operating, but not always in favor of men. Specifying separate models for each gender revealed that men gain more visibility than women from the same investments in (lagged) productivity. This is the case whether we use weighted publications or citation counts to tap visibility. In essence, for each publication, men are more likely to get published in a top journal and to garner a greater number of citations relative to women. This gender difference diminishes over time (i.e., there are decreasing returns to men's larger visibility gains from productivity), suggesting a small refinement to the positive feedback, or cumulative advantage model put forward by Merton (1968) and the Coles (1973). Nevertheless, men's decreasing visibility returns to their productivity never eliminates their advantage over women. This may reflect women's lower propensity to submit their papers to high-impact journals[16] given the lack of evidence for gender discrimination in acceptance rates at prestigious journals like the *American Sociological Review* (Bakanic, McPhail, and Simon 1987). And while impact-weighted publications and citation rates may be tapping slightly different aspects of visibility, they are still highly correlated, and may be mutually reinforcing: submitting to high-impact journals less frequently may eventually harm women's citation rates as well. Another refinement to a cumulative advantage model emanates from our finding that previous recognition, or visibility, also reinforces

[16] Women may be less likely to submit their papers to high-impact journals because of lower confidence in their professional abilities and lower sense of entitlement (Babcock and Laschever 2003).

productivity levels for both men and women, though it only affected productivity rates for women. Just as women gained more visibility than men for equal investments in specialization, women also gained slightly more productivity than men from equal 'investments' in visibility. In other words, visibility seems to reinforce productivity to a slightly greater extent for women than for men.

The effects of a few of our control variables also varied by gender and deserve further investigation. Most surprising was that department prestige negatively effects women's productivity but not men's. Perhaps prestigious departments are more male-dominated and competitive, which helps men but disadvantages women, who (given their collaboration rates (Moody 2004)) may prefer collaborative over competitive environments. Perhaps the book culture that permeates the most prestigious departments in private institutions (Clemens et al. 1995) is particularly strong for women, suggesting that our article-based measure of productivity does not fully capture total productivity. Another notable gender difference was that women's visibility declined during their associate professor years, whereas men's visibility – at least in terms of citation counts – declined when they moved to a less-prestigious department. These two findings might be consistent with each other, given our finding that women begin their careers at less prestigious departments than men: when women get tenure at their less prestigious department, and men move to a less prestigious department after being denied (or choosing to not go up for) tenure at their more prestigious departments, visibility declines. Stagnation in terms of visibility for both women and men may result from changing life priorities (e.g., spending more time on family obligations) in mid-career and/or professional burnout.

Finally, although we choose to emphasize the unique contributions of the extent of research specialization on gendered career processes, we recognize that there remains ample room for additional explanation. This is particularly clear from the statistically significant random effects in all three sets of our linear growth models. A variety of efforts could contribute to more fully specified models and, more importantly, a broader and perhaps more generalizeable theory of how the extent of specialization affects career trajectories. Some of the disciplinary differences we found, for example, were gendered, and future research might investigate these interactions more fully, and perhaps widen the disciplinary scope to include the natural and life sciences in addition to the humanities and social sciences. Future research on the extent of specialization in academia could also examine other career outcomes, such as salary levels and promotion – especially promotion to tenure, given some of the career stage effects we found here. Perhaps the greatest contribution to a more general theory of specialization in work would be to develop a way to measure the extent of work specialization in non-academic professions, perhaps law and accounting.

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