EVALUATING HIGHER EDUCATION’S
TWO-BODY PROBLEM

By
JARED LYNN WOOLSTENHULME

A dissertation submitted in partial fulfillment of
the requirements for the degree of
DOCTOR OF PHILOSOPHY

WASHINGTON STATE UNIVERSITY
School of Economic Sciences

JULY 2013
To the Faculty of Washington State University:

The members of the committee appointed to examine the dissertation of JARED LYNN WOOLSTENHULME find it satisfactory and recommend that it be accepted.

__________________________
Jill J. McCluskey, Ph.D., Co-Chair

__________________________
Benjamin W. Cowan, Ph.D., Co-Chair

__________________________
Jia Yan, Ph.D.
ACKNOWLEDGMENT

The completion of this dissertation represents a significant achievement in my life. It would not have been possible without the help of many individuals. First, I wish to thank the faculty and staff at the School of Economic Sciences for the outstanding education they provided. I also wish to thank my fellow students for their feedback and willingness to discuss and help analyze portions of the paper that were particularly challenging for me.

Specifically, I wish to thank my committee members, Jill McCluskey, and Ben Cowan, and Jia Yan for the feedback, guidance, and help they provided throughout my career at WSU. Jill and Ben made important contributions to the first chapter and they each provided additional feedback and guidance on the subsequent chapters. Jia was a valuable resource as I worked through my econometric analysis and was always available for me. I also wish to thank Ron Mittelhammer and Robby Rosenman for the help they provided in working through some of the theoretical portions of the papers. I am grateful to Andrew Cassey for helping me find the right paper that became the basis of my theoretical model in my first chapter.

Additionally, I am grateful to the administrative staff in the various divisions at WSU who helped me in collecting the necessary data to complete this work. Tori Byington was instrumental in this effort and I thank her. Danielle Englehardt provides a fantastic service for the graduate students in the School of Economic Sciences and I wish to thank her for all of her efforts. Ben Weller, and Tom and Jamie Dahl also deserve thanks for the work they do.
I received helpful advice from colleagues at Brigham Young University. I thank Phil Erickson, Brigham Frandsen, Joseph McMurray, and Michael Ransom for their suggestions, feedback, time. Finally, I am grateful to my wife and my children for their patience and love through the many long hours I spent in my office and their unwavering support as I pursued this accomplishment.
EVALUATING HIGHER EDUCATION’S
TWO-BODY PROBLEM

Abstract

by Jared Lynn Woolstenhulme, Ph.D.
Washington State University
July 2013

Co-Chairs: Jill J. McCluskey and Benjamin W. Cowan

Academic couples make up a significant portion of the academic labor market. Unlike other dual-career households, academic couples must not only find employment in the same region, but often in the same institution. Previous work has not considered how outcomes may be different when dual career households work for the same employer. In the first chapter, we develop a theoretical model of the academic labor market in which couples wish to remain together but may be heterogeneous in their level of productivity. We consider two evaluation policies for hiring academic couples, an independent and an average policy. The predictions of the model are sensitive to the choice of evaluation policy. We test for differences in productivity using annual publications as a proxy for productivity. We find that couples have more publications per year than their peers.

In the second chapter I test the theory that high mobility costs for academics result in negative returns to seniority. Academic couples are more limited in their job prospects such that their expected market wage, if they were to move, is lower than their colleagues’ which results in a higher probability of remaining at the current institution. A greater probability of remaining means the university can offer a lower wage to couples each year
than they could for other faculty and maintain the same probability that the couple will accept. I first estimate the relative probability of leaving the university and find that couples are much less likely to leave than their colleagues. I then estimate a wage equation similar to previous literature and find evidence that academic couples are penalized more for each additional year of seniority relative to other academics but the result is not robust across multiple specifications.

In the third chapter I compare outcomes of couples hired into the same department with couples hired into different departments. I suspect outcomes may be different when multiple department heads are involved in hiring and salary decisions rather than a single department head. I find no statistical differences in annual publications, salary and employment duration. I then discuss policy implications.
Table of Contents

Acknowledgment ........................................................................................................... iii

Abstract .......................................................................................................................... v

List of Tables .................................................................................................................. x

List of Figures ................................................................................................................ xii

CHAPTER 1 : EVALUATING THE TWO-BODY PROBLEM ........................................ 1

1 Introduction ................................................................................................................ 2

2 The Model ................................................................................................................... 5

2.1 Setup ......................................................................................................................... 5

2.2 The case with no joint hires ................................................................................. 6

2.3 Academic couples and an independent hiring policy ............................................ 8

2.4 Couple and single candidates in the same market ............................................... 11

2.5 How expected productivity levels compare within each school ....................... 12

2.7 Relaxing key assumptions ..................................................................................... 15

3 Data ........................................................................................................................... 18

3.1 Methodology .......................................................................................................... 22

4 Results and Discussion ............................................................................................. 23
4.1 Productivity Results ......................................................................................... 23

4.2 Is it a marriage effect? ...................................................................................... 27

5 Summary and Conclusions ............................................................................... 29

References ............................................................................................................. 32

Appendix .................................................................................................................. 34

A.1 Deriving the general solution for university thresholds when couples are
    evaluated independently ....................................................................................... 34

A.2 A comparison of expected productivities ............................................................. 35

A.3 A numerical illustration ..................................................................................... 39

A.4 An average hiring policy .................................................................................... 40

CHAPTER 2 : WHAT’S THE PRICE OF BEING AN ACADEMIC PARTNER? ..........79

Abstract .................................................................................................................. 79

1 Introduction .......................................................................................................... 80

2 Theory ................................................................................................................... 82

  2.1 The probability of staying at one’s current institution ...................................... 82

  2.2 Are academic couples willing to accept a below-market wage? ...................... 89

3 Data ...................................................................................................................... 91

4 Methods ................................................................................................................. 93

5 Results .................................................................................................................. 98
List of Tables

Table 1.1 – Variable Names and Definitions................................................................. 57
Table 1.2 – Summary Statistics ......................................................................................... 58
Table 1.3 – Mean Comparison of Publications by Joint Hire Status................................. 59
Table 1.4 – Marginal Effects for Publications per Year, Poisson Model ......................... 60
Table 1.5 – Publications by Gender .................................................................................. 61
Table 1.6 – Summary Statistics for the Marital Status Data............................................. 62
Table 1.7 – Marginal Effects for Publications Using the Marital Data Subsample .......... 63
Table 1.8 – Comparison of Expected Productivity, $\Gamma(a = 2, b = 2)$, $\alpha = 0.10$, and $K = 5$
Universities under an Independent Hiring Rule ............................................................... 64
Table 1.9 – Comparison of Expected Productivities for Couples and Singles Using Independent and Average Evaluation Policies ............................................................. 65
Table 1.10 – List of Departments by Field of Study.......................................................... 66
Table 1.11 – List of STEM Departments at WSU by College.......................................... 69
Table 2.1 – Variable Names and Definitions.................................................................... 108
Table 2.2 – Summary Statistics for Aggregated Fields of Research ............................... 109
Table 2.3 – Summary Statistics for New Hires, 1999-2011 .............................................. 110
Table 2.4 – Results of the Analysis of Employment Duration ........................................... 111
Table 2.5 – Results for Initial Salary ................................................................................ 112
Table 2.6 – Job Titles for Non-Tenure Track Partner Hires .............................................. 113
Table 2.7 – Results of $\ln(Annual\ Salary)$ Comparison .................................................. 114
Table 3.1 – Variable Names and Descriptions................................................................ 129
Table 3.2 – Summary Statistics for those with publication data ........................................ 130
Table 3.3 – Results From the Salary Analysis ........................................................................ 131
Table 3.4 – Results from the Publications Analysis ................................................................. 132
List of Figures

Figure 1.1 – Desired Solution for the Highest Ranked School.......................... 70
Figure 1.2 – Potential Couple Types.................................................................. 71
Figure 1.3 – Equilibrium Threshold Values Under an Average Hiring Policy ...... 72
Figure 1.4 – A Comparison of the Expected Average Rank of Couples and the Expected Rank of Singles as a function of University Prestige.......................... 73
Figure 1.5 – Example Independent Threshold Values..................................... 74
Figure 1.6 – Example Average Threshold Values............................................. 75
Figure 1.7 – Changes in Threshold Values.......................................................... 76
Figure 1.8 – Expected Productivity Comparison.............................................. 77
Figure 1.9 – Regions of integration with an Average Policy.............................. 78
Figure 2.2.1 – How $q$ Affects the Wage Offered to Couples............................... 115
Figure 2.2.2 – Decision Tree for an Academic Couple ...................................... 116
Figure 2.2.3 – Smoothed Estimates of the Probability of Leaving...................... 117
Figure 3.1 – A Comparison of the Probability of Leaving................................. 134
Dedication

This dissertation is dedicated to my wife and my children who are the motivation in my life and to the memory of my friend, Tesfaye Deboch.
CHAPTER 1 : EVALUATING THE TWO-BODY PROBLEM: JOINT HIRE PRODUCTIVITY WITHIN THE UNIVERSITY

Abstract

Academic couples are different from other dual-career couples. Not only must they find employment in the same region, but often in the same institution. Previous work has not considered how outcomes may be different when dual career households work for the same employer. We develop a theoretical model of the academic labor market in which couples wish to remain together but may be heterogeneous in their level of productivity. We consider two evaluation policies for hiring academic couples, an independent policy in which couples must qualify for the position on their own merits, and an average policy where the strength of one may compensate for the weakness of the other. The predictions of the model are sensitive to the choice of evaluation policy. When universities strictly use an independent approach, the model predicts that couples will be more productive than their colleagues within the same institution in all but the most prestigious school. When universities strictly use an average approach, couple productivity will be greater in the lowest ranked school, roughly equal in all of the middle ranked schools, and lower in the top ranked school. We test for differences in productivity using annual publications of faculty hired since 1999 at Washington State University as a proxy for productivity. We find that couple hires have more publications per year than their peers.
1 Introduction

Working couples often face the challenge of finding two jobs in the same location. 72 percent of individuals employed in academia face this same challenge (Scheibinger, Henderson, and Gilmartin 2008). Half of those – or 36 percent of all academics – have a partner who is also in academia. These dual-career academic couples face an especially difficult job search because academic institutions in the U.S. are often geographically isolated.¹

There is evidence that the desire to remain together for some couples is strong enough that one or both members of the couple will choose to accept a less prestigious offer in order to remain with their partner. In a survey of over 9,000 academics, Scheibinger, Henderson, and Gilmartin (2008) found that 20 percent of the couples in the sample reported such behavior. Clearly this sort of behavior has the potential to alter the distribution of faculty quality that would be seen if all candidates behaved as if they were single. To compete for high-quality candidates, many universities have adopted official partner accommodation policies that allow greater flexibility in finding a position for the partner of a desired candidate.² A commonly cited concern with joint hiring through these policies is the stigma of “less good” that may be attached to the partner hire because she was not recruited through the traditional method (Scheibinger, Henderson, and Gilmartin 2008).

Our research question is, “How does the productivity of individuals hired as part of a couple compare to their colleagues within the same institution?” Little work has been done thus

---

¹ See Helppie and Murray-Close (2010) and Scheibinger, Henderson, and Gilmartin (2008) for statistical and anecdotal evidence of this behavior. There is also evidence that even in locations with multiple universities, academic couples still prefer to work at the same institution.

² See Wolf-Wendel, Twombly, and Rice (2004) for a thorough discussion of the various types of policies that exist
far to rigorously sort out the effects on faculty quality of the presence of academic couples from either a theoretical or empirical perspective. Guler, Guvenen, and Violante (2012) demonstrate that dual career searchers face increased challenges in locating suitable employment because they must restrict their search to a common region or pay a cost of living apart. Costa and Kahn (2000) and Li (2009) analyze the effects of dual career couples and dual career academic couples, respectively, on the geographic distribution of the labor force and both find that couples – whether academic or otherwise - are more likely to migrate towards cities where employment opportunities are more abundant. Each of these studies adds to the knowledge base of the effects of dual career couples but fail to address consequences of searching for positions within a single firm. Scheibinger, Henderson, and Gilmartin (2008) make some empirical progress in analyzing the productivity of “second hires” (i.e. those whose partners were first recruited by the hiring institution). They find that after disaggregating the data by field and accounting for gender and rank, productivity levels among second hires are not significantly different from those among their peers.

We add to the literature on the consequences of joint searches and hiring practices in the following ways. First, we construct a theoretical model of hiring in the academic labor market where under plausible assumptions, the presence of academic couples allows at least some universities to recruit highly productive candidates who otherwise would have refused the employment offer. The key mechanism that drives this result is the willingness of one of the partners in some academic couples to accept an offer from a less prestigious school in order to be near her partner (a preference expressed by couples analyzed in Helppie and Murray-Close, (2010) and Scheibinger, Henderson, and Gilmartin, (2008)).
We evaluate the model under the assumption that universities evaluate each candidate in an academic couple independently, or as if each were a single candidate. This evaluation rule does not ignore partner accommodation policies. Those policies are designed to provide a position where timing or mismatch of specialty might otherwise prevent the hire from occurring. Then given that a position exists, the evaluation rule requires that the individual qualify for it based upon her own merits. We maintain this assumption because the institution analyzed in this study (Washington State University) explicitly states, “No unit is required to participate in this program” as part of their accommodation policy. We also examine a likely alternative evaluation rule where the university considers the average merits of the two candidates. Furthermore, since many academic couples are hired into different departments and often different colleges (Ferber and Loeb 1997), we believe that independent hiring is a reasonable proxy for university hiring rules regarding couples in many circumstances. Our model predicts that all but the most elite universities benefit from the presence of academic couples of heterogeneous quality: in those institutions, joint hires will be more productive than their peers, on average.

Our second contribution to the literature is to examine whether joint hire individuals are different in their productivity relative to their non-joint hire colleagues empirically. To our knowledge, such an analysis has not been performed. We use a 13 year panel of administrative data representing the entire population of new tenure-stream faculty hires at Washington State University (WSU) for our analysis that includes information on whether individuals were hired as part of a couple. While we recognize that our data comes from only a single institution (and therefore the results are not necessarily generalizable to the population of universities), but WSU seems to be similar to many rural institutions which increasingly face the challenge of accommodating couple candidates.
We find that at WSU, the average individual hired as part of an accommodated couple publishes more articles per year and is more likely to obtain a grant relative to a comparable colleague hired in the traditional way.\(^3\) Additionally, we examine differences by whether an individual was the primary hire in a couple (meaning she was the first person offered a position) or the partner hire (meaning she was offered a position as part of the negotiation process for her partner’s job). We find that the higher productivity of academic couples is indeed driven by primary hires (who are plausibly often those individuals who would be difficult to recruit if they were not part of a couple), but that partner hires are generally not statistically distinct from individual hires, and in some cases they perform just as well as their traditionally hired colleagues.

2 The Model

2.1 Setup

In this market let there exist \( K \) universities with denoted by \( k \in \{1, 2, \ldots, K\} \). Each school has exogenously given initial levels of prestige denoted by \( \rho_k \), and can be ranked and ordered according to their level of prestige from lowest to highest, \( \rho_1 < \rho_2 < \ldots, < \rho_K \). There are \( N \) job candidates, each with individual productivity denoted by \( \theta_i \), which is continuously distributed along any positive valued probability density function, \( \theta_i \sim f(\theta) \). We assume there is no unemployment, normalize the number of job candidates such that \( N=1 \), and assume the \( K \)

\(^3\) Official records for those hired as couples were first kept in 1999.
universities equally divide the number of job vacancies. For simplicity, we focus on rankings and assume that job candidates simply prefer higher ranked universities to lower ranked universities. Similarly, universities prefer more productive candidates to less productive candidates.  

2.2 The case with no joint hires

Suppose initially there are only non-couple candidates in the market. Each school is aware of its ranking and must hire $1/K$ fraction of the job candidates. The timing is as follows: All candidates send applications to all schools, thus the distribution of candidate productivity is known by all schools. Each school must then make offers to its preferred candidates. Each school seeks to hire the most productive candidates it can subject to the constraint that it fills all of its positions. Therefore, given knowledge about the productivity distribution of the candidate pool, each school will choose a minimum threshold level of productivity, denoted by $\tau_k$, and make offers to all candidates whose productivity is weakly greater than that minimum threshold level. A simple argument demonstrates that this is the optimal behavior for each school.

**Lemma 1:** Each school, $k$, chooses a minimum threshold level of productivity, $\tau_k$, and makes offers to all candidates whose individual level of productivity is weakly greater than this minimum threshold.

**Proof:** The distribution of candidate productivity is known by each school and candidates prefer higher ranked universities to lower ranked schools. Thus the highest ranked school need only extend offers to the most productive candidates sequentially beginning with the highest ranked

---

4 We do not focus on salaries in this model.
and proceed down the distribution until enough offers have been made to fill its open positions. The point in the distribution where the top ranked school makes its last offer is the minimum threshold of the top school. Any other allocation of offers would result in the top school making offers to candidates with productivity levels lower than they could have recruited. The next lowest ranked school recognizes that the top candidates will receive and accept offers from the top ranked school and as a result it will choose to extend offers to candidates with productivity levels below the threshold of the top school until all of its positions are filled. The process continues for each successively lower ranked school until the lowest ranked school must extend offers to the only candidates left in the pool who are at the bottom of the productivity distribution.

Thus in equilibrium, each school, \( k \), sets a minimum threshold level of productivity, \( \tau_k \), which guarantees it will receive \( 1/ K \) candidates as given by Equation (1.1).

\[
\int_{\tau_k}^{\tau_{k+1}} f(\theta) d\theta = \frac{1}{K}
\]  

(1.1)

The upper bound, \( \tau_{k+1} \), represents the threshold set by the school ranked just above school \( k \), hence each school takes its upper bound as exogenously given when solving for its own minimum threshold. For the highest ranked school, the upper bound is infinity. Thus, each school will choose \( \tau_k \) to guarantee it fills all open positions. The solution for the highest ranked school, \( k = K \), is to choose \( \tau_K \) so that the density to the right of \( \tau_K \) is equal to \( 1/ K \) as shown by Equation (1.2) and pictured in the left hand side of Figure 1.1.

\[
\int_{\tau_K}^{\infty} f(\theta) d\theta = \frac{1}{K}
\]  

(1.2)
Equation (1.2) can be rearranged such that the school is choosing its minimum threshold level so that the area under the distribution to the left of the threshold is equal to \((K - 1)/K\) as follows:

\[
\int_0^{\tau_k} f(\theta) d\theta = \frac{K - 1}{K}
\]  \hspace{1cm} (1.3)

Equation (1.3) is depicted on the right hand side of Figure 1.1 and is a convenient form to use when solving for the minimum thresholds of the other universities as we need only know the school ranking to obtain a solution. Thus for any school, \(k = \{1, 2, \ldots, K\}\), the minimum threshold it chooses must solve Equation (1.4):\(^5\)

\[
\int_0^{\tau_k} f(\theta) d\theta = \frac{k - 1}{K}.
\]  \hspace{1cm} (1.4)

2.3 Academic couples and an independent hiring policy

We now allow a portion of the job candidates to form couples. Our baseline model stipulates that all universities evaluate couples independently as if each candidate were single. That is, each member of a couple must meet a university’s minimum threshold to receive an offer.\(^6\) We assume that a fraction, \(\alpha\), of job candidates are part of an academic couple (hence, \(1 - \alpha\) is the proportion of non-couple job candidates). We also assume that the decision to form a

\(^5\) We illustrate with a simple example. Assume that there are five schools. Then school \(k = 5\) (the highest ranked school) will want to choose \(\tau_5\) so that \(1/5\) of the distribution is to the right or, equivalently, \((5-1)/5= 4/5\) of the distribution is to the left of \(\tau_5\). The second best out of the five schools, \(k = 4\) will choose \(\tau_4\) so that \((4-1)/5=3/5\) of the distribution will be to the left of its threshold and so on until the lowest ranked school, \(k = 1\), chooses \(\tau_1\) to be equal to \((1-1)/5=0\) so that none of the distribution is to the left of its threshold.

\(^6\) Washington State University’s official accommodation policy has language suggesting independent hiring (we outline this policy below).
couple is independent of the productivity level of each person, and we assume that couples’ preferences are such that they will only accept offers from the highest ranked school where both partners are extended an offer. In reality, couples’ preferences over staying together may be more complicated. For example some may place a higher priority on their individual careers and are more willing to live apart. Others may be able to live together while working at institutions of different quality that are located near each other.\textsuperscript{7} We abstract from these nuances for simplicity and note that the presence of couples who strongly favor living and even working together combined with the relative geographic isolation of many institutions in the U.S., suggest our model may have explanatory power in spite of its limitations. We later discuss some of the ramifications of relaxing these assumptions.

Initially, let us suppose that $\alpha = 1$, meaning all candidates are part of an academic couple. As before, the cutoff for each school is determined by setting its minimum threshold low enough so as to attract $1/K$ individuals to that school. For clarity we add subscripts to denote the different partners in a couple. Let $\theta_x$ represent the productivity of candidate $x$ and $\theta_y$ represent the productivity of candidate $x$’s partner. Then the left-hand side of Figure 1.2 is a visual representation of a generic joint density of couple productivity in the academic labor market. The minimum thresholds for each of the $k$ universities are marked on the two axes and form the grid pattern that is displayed on the right-hand side of Figure 1.2. The spacing between the threshold values in the grid will vary depending on the distribution that is assumed to overlay this grid.\textsuperscript{8}

\begin{itemize}
    \item[\textsuperscript{7}] See Helppie and Murray-Close, (2010) for examples.
    \item[\textsuperscript{8}] Figure 1.2 is only meant to illustrate the concept and is not necessarily drawn to scale.
\end{itemize}
One consequence of independent hiring is that the minimum thresholds apply equally to both members of the couple. On the right-hand side of Figure 1.2, each square represents a couple “type”: one in which one partner falls between $\tau_k$ and $\tau_{k+1}$ and the other falls between $\tau_j$ and $\tau_{j+1}$ (for all $k$ and $j = 1, ..., K$). Couples who fall near the main diagonal (from the bottom-left to the top-right) represent those partners whose productivity levels are very similar. The highest offers received by each of the individuals in these couples come from the same school. Those cells that are off of the main diagonal represent couple types in which one candidate is able to attract an offer from a more prestigious university than her partner. When all universities apply an independent evaluation policy, the L-shaped shaded regions shown by the different shades of gray illustrate how all universities except for the top school are able to attract candidates who otherwise would accept an offer from a more prestigious school. A highly productive individual who is part of an off-diagonal couple will go to a lower ranked school (relative to what she would choose if she were single) in order to remain with her partner.

For example, the the darkest shaded region in the right hand side of Figure 1.2 represents all possible couple types who would choose to accept an offer from the least prestigious school. At least one member of each couple in this region has a level of productivity below the threshold of the second lowest-ranked school. This partner will not receive offers from any of the other schools. Therefore, her partner will forgo a more prestigious offer in order to be together. This is in contrast to the unshaded region in the top-right corner. This region represents those who will receive offers from the highest ranked school, but since no universities lie above it, the top school does not have the opportunity to hire any members of couples it could otherwise not attract.
In a world where only couple candidates exist, each school chooses $\tau_k$ to solve Equation (1.5).

$$\int_0^{\tau_k} f(\theta_x) d\theta_x \cdot \int_0^{\tau_k} f(\theta_y) d\theta_y + 2 \cdot \int_0^{\tau_k} f(\theta_x) d\theta_x \cdot \int_{\tau_k}^{\infty} f(\theta_y) d\theta_y = \frac{k-1}{K}$$  \hspace{1cm} (1.5)

The first term in Equation (1.5) represents the probability that individual $x$’s productivity lies below the minimum threshold and that her partner’s productivity also lies below the threshold. The second term incorporates the potential each school has for hiring the off-diagonal couples where one member of the couple has a level of productivity below the threshold but her partner has a level of productivity that is greater than the threshold. Each university chooses $\tau_k$ so that the proportion of couple candidates described by Equation (1.5) is equal to $(k-1)/K$ which ensures that each school fills all open positions.

### 2.4 Couple and single candidates in the same market

We now assume the labor market is composed of both couples and singles such that $0 < \alpha < 1$. Universities use the same minimum threshold to evaluate both non-couple and couple candidates since they continue following an independent policy. Then school $k$ will choose $\tau_k$ to satisfy Equation (1.6):

$$(1+\alpha)\int_0^{\tau_k} f(\theta) d\theta - \alpha \int_0^{\tau_k} f(\theta) d\theta \int_0^{\tau_k} f(\theta) d\theta = \frac{k-1}{K}$$  \hspace{1cm} (1.6)

---

9 Due to symmetry, we multiply the second term by 2 rather than include an additional term where only the $x$ and $y$ subscripts are switched.
The precise derivation of (1.6) is found in Section A.1 of the Appendix. Each school chooses \( \tau_k \) so that the weighted sum of the couple and single densities to the left of its threshold is equal to 
\[
(k - 1)/K.
\]

The new threshold values are a function of the proportion of couples in the labor market, \( \alpha \). In Section A.3 of the Appendix, we demonstrate using a numerical example that as the share of couple candidates in the academic labor market increases, the minimum thresholds set by the higher-tier universities decreases. This happens because as highly productive individuals who are part of the off-diagonal couple types choose to go to lower-tier schools, vacancies are created in the higher-tier schools. Thus the higher-tier universities must lower their thresholds enough to fill those anticipated vacancies.

2.5 How expected productivity levels compare within each school

In this section we show how the productivity of those candidates hired as part of a couple compares to those hired as single candidates within the same institution. For a single candidate we calculate the expected value conditioned on being hired by school \( k \) :

\[
E[\theta | \theta \in (\tau_k, \tau_{k+1})]
\]

(1.7)

For a couple candidate we calculate the expected value given that they come with a partner and that both are hired by school \( k \):

\[
E[\theta_x | (\theta_x \in (\tau_k, \tau_{k+1}) \text{ and } \theta_y \in (\tau_k, \infty)) \text{ or } (\theta_x \in (\tau_{k+1}, \infty) \text{ and } \theta_y \in (\tau_{k+1}, \tau_{k+2}))]
\]

(1.8)
We then compare the two values. In order to do this, we re-weight the densities for each school so that the density claimed by each school integrates to one and can be used to calculate a proper expectation.

For a single candidate at school \( k \), the expected value is calculated using Equation (1.9).

\[
\frac{\int_{r_k}^{r_{k+1}} \theta f(\theta) d\theta}{\int_{r_k}^{r_{k+1}} f(\theta) d\theta}
\]

Due to the symmetric nature of the distribution, for either candidate hired as part of a couple at school \( k \), we can represent the expected value of a candidate who is part of a couple using Equation (1.10).

\[
\frac{\int_{r_k}^{r_{k+1}} \theta_x f(\theta_x) d(\theta_x) \int_{r_k}^{\infty} f(\theta_y) d(\theta_y) + \int_{r_k}^{r_{k+1}} \theta_y f(\theta_y) d(\theta_y) \int_{r_k}^{r_{k+1}} f(\theta_x) d(\theta_x)}{\int_{r_k}^{r_{k+1}} f(\theta_x) d(\theta_x) \int_{r_k}^{\infty} f(\theta_y) d(\theta_y) + \int_{r_k}^{r_{k+1}} f(\theta_y) d(\theta_y) \int_{r_k}^{r_{k+1}} f(\theta_x) d(\theta_x)}
\]

We compare these two expected productivities and derive Lemma 2 in Section A.2 of the Appendix. A numerical example that illustrates the theory is also available in Section A.3 of the Appendix.

**Lemma 2:** For all universities except the top-ranked institution, the expected level of productivity for a candidate hired as part of a couple is greater than the expected level of productivity for a single candidate within the same school. In the highest ranked school, the expected levels of productivity are equal for the two types of candidates.

We are also interested in comparing expected productivities given that an individual is always the higher quality or lower quality candidate in a couple with non-couple hires. Under an
An independent hiring policy we can express the expected productivity of a candidate who is always the higher quality candidate in school \( k \) as:

\[
E(\theta_x | \theta_x \geq \theta_y \text{ & hired by school } K) = \frac{\int_{\theta_{x}}^{\infty} \theta_x f(\theta_x) d\theta_x \int_{\theta_y}^{\infty} f(\theta_y) d\theta_y}{\int_{\theta_x}^{\infty} f(\theta_x) d\theta_x \int_{\theta_y}^{\infty} f(\theta_y) d\theta_y}
\]

We likewise can express the expected productivity of a candidate who is always the lower quality candidate in school \( k \) as:

\[
E(\theta_x | \theta_x \leq \theta_y \text{ & hired by school } K) = \frac{\int_{\theta_{x}}^{\infty} \theta_x f(\theta_x) d\theta_x \int_{\theta_y}^{\infty} f(\theta_y) d\theta_y}{\int_{\theta_x}^{\infty} f(\theta_x) d\theta_x \int_{\theta_y}^{\infty} f(\theta_y) d\theta_y}
\]

We make direct comparisons of expected productivity for each type of couple candidate with the expected productivity of a single candidate in Section A.2 of the Appendix and derive Lemma 3.

**Lemma 3:** For all universities except the top-ranked institution, the expected level of productivity for a candidate who is hired as part of a couple, given that she is the higher quality partner in the couple, is greater than the expected level of productivity for a single candidate within the same school. In the highest ranked school the expected levels of productivity are equal.

For all schools, the expected level of productivity for a candidate who is hired as part of a couple, given that she is the lower quality partner in the couple, is equal to the expected level of productivity for a single candidate within the same school.
2.7 Relaxing key assumptions

The result that the expected productivity of a couple candidate will exceed the expected productivity of a single candidate in any given school (except in the very top school where they are equal) holds regardless of the distributional assumption. It is the presence of “mixed quality” couples who strongly desire to live and/or work together and independent hiring on the part of universities that drives the results. Under the assumption that couple candidates are evaluated independently of one another, it is the minimum of quality within a couple that determines the couple’s job placement.

The prediction that couple hires are of (weakly) higher quality in all institution types no longer holds if we consider a different rule for evaluating couples. As one possible alternative, suppose universities hire based on the couple’s average productivity. For example, consider the couple marked \((x,y)\) in Figure 1.3. Candidate \(x\) is highly productive and individually would receive an offer from the highest ranked school. Candidate \(y\) is not very productive and individually would receive an offer only from the lowest ranked school. Under an independent hiring policy, the only institution willing to hire both members of the couple would be the lowest ranked school because no other school is willing to accept a lower quality candidate in order to recruit a higher quality candidate. Under an average hiring policy however, the next-to-highest ranked school will hire them. The couple’s average level of productivity is greater than the next-to-highest ranked university’s established minimum threshold; it is willing to accept a less productive candidate in order to recruit a top candidate it otherwise could not attract. Under an average hiring policy it is more difficult to compare the average expected productivity of couple hires and single hires within the single institution under a general distribution. Figure 1.3
illustrates how the minimum thresholds for couples are established when universities use and average hiring policy for couples.

In Section A.4 of the Appendix we show that in the lowest ranked universities, expected productivity will be higher for couples than for singles and as the prestige of the university increases the difference between couples and that it increases monotonically. We also demonstrate that in the highest ranked university the expected average productivity of couple candidates will be lower than that of single candidates. This result suggests that there is at least one point in the prestige distribution where the expected productivities are equal. We further anaylze how the expected productivity of a couple behaves throughout by instead looking at how the rank of individuals within the productivity distribution compares for couples and singles. We find that the crossing point where the expected average rank of couples within the productivity distribution is equal to the expected rank of a single candidate within the productivity distribution occurs in the median school. Figure 1.4 illustrates how the expected average rank of couples compares to that of singles under an average hiring policy.

We also compare primary and partner candidates to single candidates. Similar to the result from the independent policy, we find that under an average hiring policy the expected productivity for a couple candidate given that she is the higher quality partner, is greater than the expected productivity of a single candidate hired by the same school. However, we also find that the expected productivity for a couple candidate, given that she is the lower quality partner, is less than the expected productivity of a single candidate hired by the same school. These results are formally derived in section A.4.2 of the Appendix. Thus the choice of hiring rule used by universities to evaluate couple candidates has a substantial effect on how couple candidates compare to single candidates.
We have assumed that couples must be hired into the same institution (type) to remain together. Others have noted that urban areas are especially attractive to dual-career couples due to the increased chance of finding a satisfying job in each person’s line of work (Costa and Kahn 2000; Li 2009). Li (2009) models the academic labor market with couples and singles and finds that urban universities benefit at the expense of rural universities when more couples are added to the market.

The effect of allowing couples to work in different institution types (if they live in a large city, for example) would reduce the number of mixed-quality couples who wound up working in the same institution (type). However, given that many U.S. colleges and universities are geographically isolated, we are doubtful that the ability of couples to sometimes find jobs at two different institutions wholly eliminates the need for one member of the couple to accept a less prestigious job to remain with her partner (as evidenced in Helppie and Murray-Close (2010)).

Couples’ matching behavior may also affect the outcome. We have assumed that couples form independent of productivity levels. However this may not be the case. To the degree that couples engage in assortative matching, the differences in productivity between couples and singles within the same school will decrease or increase. If individuals form a couple mostly with those who have similar levels of productivity, then there will be fewer “mixed quality” couples in the market and the difference between couples and singles will be smaller. On the other hand, if opposites attract in the academic labor market then more mixed quality couples will exist and the difference will increase.

Our theory predicts that if couples in the academic labor market have strong preferences to remain together and universities evaluate each candidate independent of the other, they should exhibit higher levels of productivity than their otherwise equal single colleagues in non top-tier
schools. We empirically examine this implication using administrative data from Washington State University.

3 Data

Washington State University began keeping detailed records on couples who were hired using an established partner accommodation policy beginning in 1999. This policy allows the provost’s office to provide temporary funding to cover a portion of the salary for the partner of a desired candidate in order to help a receiving department hire the partner until a permanent position becomes available. The stated policy seems to imply that departments who are asked to consider a partner candidate can do so without consideration of her partner:

“Partner and spouse accommodation and assistance is a nonmandated program available throughout the multicampus University system to assist units in recruiting and retaining employees. No unit is required to participate in this program. Prospective employees are not to view partner and spouse accommodation and assistance as an entitlement.” (emphasis added)

Conversations with university administrators have verified that although departments are encouraged to participate when possible, no unit is ever pressured to hire someone they do not feel is qualified. Using records kept regarding this policy, we are able to identify those faculty members who were hired through the use of this policy as well as whether an individual was the primary hire or the partner hire in the couple. It is the only administrative data available at WSU
that contains information about couple hires. Our other variables come from separate administrative databases at WSU.

The productivity measures that are available to us come from a self-reporting system that was implemented online in 2005 for the College of Agriculture, Human, and Natural Resource Sciences (CAHNRS). In 2007 WSU-Vancouver adopted the system and in 2008 it was implemented for all WSU faculty excluding the business school. Faculty members use this system to track various productive activities such as grants awarded, book publications, book chapters, journal articles, conference presentations, student evaluations, and the like. The self-reported nature of these variables is not disconcerting to us because this database is used in annual reviews and in tenure and promotion decisions; it is cross-validated by department heads for accuracy. We use the number of peer reviewed publications per year as the dependent variable in our analysis on productivity. We recognize that this measure does not perfectly capture productivity; however in a large research university such as WSU and in particular the Science, Technology, Engineering, and Math (STEM) disciplines, the number of publications is an important measure of the productivity of a tenure-stream faculty member. We examine differences in productivity for tenure stream faculty across all departments as well as only within the STEM disciplines who were hired during the years 1999-2011. Publications as a measure of productivity seems most applicable in STEM disciplines. Table 1.1 describes the variables used in our analysis.

10 There may have been couples who both independently sought positions and secured employment without seeking help via this policy. Couples such as this would not be identified in our data.

11 We do not have information about the quality of the publications, only the quantity in a particular year.

12 Table 1.1I identifies which departments are classified as STEM at WSU.
The variable *JointHire* represents an individual who was hired either as the primary or the partner candidate in a couple via WSU’s partner accommodation policy. *Admin* is an indicator variable denoting whether or not an individual was serving in an administrative position that year. *Female* is an indicator for females, and *Prior* captures the number of years of professional experience an individual had prior to their work at WSU. It is calculated by subtracting the individual’s degree year from their WSU hire year. *Rank* is a series of indicator variables for those whose rank is Assistant, Associate, or Full Professor in a particular year. *Publications* is the sum of all peer reviewed journal articles, book chapters, and books that were published, or accepted for publication, in a given year. We include indicator variables for each year in the study to control for secular influences in our data that may have changed over time as well as indicator variables for an individual’s original hire year for similar reasons. We also include indicator variables for field of discipline as defined in Table 1.10. Joint hiring varies considerably across fields of study as does productivity as we have measured it. Including the field indicator variables accounts for the potential that joint hiring occurs predominantly in either the most or least productive fields.

Table 1.2 contains summary information about the data including information about how the composition of faculty in the data set divides among those who are joint hires and those who are not for all observations as well as STEM only observations. It also contains information about how joint hire individuals are divided between primary hires and partner hires. Primary hire (or first hire) refers to the individual who first was offered a position at WSU. Partner hires (or second hires) are those who were offered a job second as part of the negotiation process. The total number of unique individuals hired at WSU between 1999 and 2011 is 896. Since our productivity data begins in 2005, we only use those individuals hired since 1999 who were still
here in 2005, which is 784 faculty. Additionally we have publications data only for the CAHNRS faculty in 2005-2006 with WSU Vancouver added in 2007. Because of a lack of productivity data for many depart

Of the 682 individuals in our data, 90 of them, or 13 percent, were hired as part of a joint hire couple which is in line with the estimate of 13 percent given by Scheibinger, et al. (2008) for the proportion of all new hires that were part of a joint hire during the decade of the 2000’s. 71 out of the 90 joint hires were primary hires and 19 were partners. Out of 263 individuals hired into STEM fields, a larger share (19%) were joint hires. More males were hired than were females and on average those hired into STEM fields have more years of prior experience and publish more frequently each year relative to all fields, but otherwise the summary statistics are comparable between the two groups.

To get an idea of how joint hires and non-joint hires perform in terms of productivity, we conduct a simple means comparison test of publications per year (between 2005 and 2011) and present the results in Table 1.3. In a simple comparison of raw means, we find that joint hire individuals publish on average 0.61 more articles per year across all fields, and 0.37 more in STEM fields, than those who were not joint hires. In the next section, we use multiple regression methods to control for other influences that might contribute to differences in observed productivity.

13 There were 112 individuals who were hired between 1999 and 2004 who left the university prior to 2005 which represents 12.5 percent attrition.

14 The reason for having more primary hires than partner hires is that our data includes only tenure-track faculty. There are many partner hires who were hired into non-tenure track (e.g. clinical, administrative) positions and do not show up in our data.
3.1 Methodology

We assume that the number of publications produced per year follows a poisson process where the number of occurrences of the event $y$ over a fixed exposure period (one year in our data) has the probability:

$$\Pr(Y = y) = \frac{e^{-\mu} \mu^y}{y!}, \ y = 0, 1, 2,...$$ (2.1)

where $\mu = \mathbf{x} \beta$ and $y = \text{pubs}$. A key feature of the Poisson distribution is that the mean and variance are equal. As shown in Table 1.2, the mean number of publications per year is 2.58 while the variance (not shown) is $3.41^2 = 11.62$ which is clearly larger than the mean. To account for this overdispersion in the data, we maintain the conditional expectation assumption that $E(y | \mathbf{x}) = \exp(\mathbf{x}' \beta)$ but we relax the equivariance assumption by using a robust estimator for the variance.

The Poisson distribution also assumes that each event is independent of the others. However, it is highly likely that observations of the same individual across multiple years are serially correlated. We cluster the errors of the model by individual to allow for within-cluster serial correlation but maintain the assumption that the number of publications per year across individuals is independent.

We use Maximum Likelihood Estimation to estimate two versions of the model. First, we estimate the equation using the JointHire indicator as our variable of interest. We then perform the same estimation except that we include two separate dummy variables for partner status—one indicating whether an individual was the primary hire and one indicating whether she was
the partner hire (within a couple). The log-likelihood function associated with the Poisson distributions is given by:

$$\ell = \sum_{i=1}^{N} \sum_{t=1}^{T} \left\{ -\exp(\mathbf{z}^\prime_i \mathbf{\beta}) + (\text{pubs}_{it}) \mathbf{z}^\prime_i \mathbf{\beta} - \ln(\text{pubs}_{it}) \right\}$$

(2.2)

where the variable $\text{pubs}_{it}$ is the count of publications by individual $i$ in year $t$ (including co-authored pieces). The product $\mathbf{z}^\prime_i \mathbf{\beta}$ is defined by (2.3) and (2.4) for our first and second specifications, respectively:

$$\mathbf{z}^\prime_i \mathbf{\beta} = \beta_0 + \beta_{\text{JointHire}} + Z_{it} \gamma + Y_i \delta$$

(2.3)

$$\mathbf{z}^\prime_i \mathbf{\beta} = \beta_0 + \alpha_{i \text{primary}} + \alpha_{i \text{partner}} + Z_{it} \gamma + Y_i \delta$$

(2.4)

The vector $\mathbf{z}_i$ contains time varying control variables including administrative status, rank indicator variables, and year indicators. $Y_i$ is a vector of time constant variables including sex, prior experience, field indicator variables, and indicators for an individual’s original hire year.

4 Results and Discussion

4.1 Productivity Results

Under an independent hiring policy, our model predicts that individuals hired as part of a couple are, on average, more productive than their single colleagues within the same institution (for all but the top institution type). In Table 1.4, we present our results examining how joint hires and non-joint hires compare in terms of publications per year at WSU. Our key finding is that holding other factors constant, joint hires have more publications per year, on average, than
their non-joint hire colleagues and this result is stronger when only the STEM fields are analyzed.

Since the Poisson model is a non-linear model, the initial estimates are not the marginal effects. To obtain the marginal effects for our binary variables, we use the finite-difference method which measures the change in the conditional mean of publications when the binary variable changes from 0 to 1. Among all disciplines, the expected number of publications per year predicted by our model for a joint hire is 3.067 publications per year while the prediction for the average non-joint hire is 2.505 publications per year.

The difference of 0.562 publications per year means that after six years (which is a typical tenure clock) we expect the average joint hire to have nearly 3.5 additional publications. In percent terms we divide the marginal effect of 0.562 by the average number of publications per year for all faculty of 2.58 and find that on average joint hires at WSU have approximately 22 percent more publications per year than the average WSU tenure-stream faculty member. Among only STEM disciplines, the expected number of publications per year predicted by our model for a joint hire is 4.115 and for a non-joint hire it is 3.185. The difference of 0.930 publications per year represents a difference of more than 5.5 publications after 6 years. In percent terms, joint hires in a STEM disciplines have on average 28 percent more publications per year than the average WSU tenure-stream faculty member.

When we look at primary hires and partner hires separately, we find that for all fields the average primary hire has just less than 0.9 additional publications per year relative to a single hire and in STEM fields a primary hire has more than 1.25 more publications per year relative to a single hire and the effect is statistically significant at the 5 percent level for each. At the same time, the average partner hire is less productive relative to an individual hire, with 0.769 fewer
publications per year among all fields and the effect is significant at the 10 percent level. When we look only in the STEM fields however, the negative effect is only about half as large at 0.467 and is not significant at conventional levels.

Our results are mostly consistent with the theoretical predictions of an independent hiring policy, which is that couple hires will be of higher quality, on average, than their individually hired colleagues (at all but the top institution type, and there they will be equal). The lower publication rate for partner hires is not consistent with the theoretical predictions of an independent hiring policy. If we assume that the less productive member of a couple is always the partner hire then under an average hiring policy there should be no difference in productivity. However, under an average hiring policy, the model gives an ambiguous prediction on whether a partner hire will be less productive compared to non-couple hires. Our empirical results suggest that WSU may not be strictly observing an independent approach to hiring. There may be some instances where it does take on a lower quality candidate in order to recruit someone else who is highly desirable. Such hiring may occur when couples are recruited into the same department and therefore the same department head is making the hiring decision.

Alternatively, the university may consider other aspects of a candidate as “high quality” aside from direct measures of productivity. For example consider the nationwide effort to increase females in the STEM disciplines. If the university has a goal to increase females in the STEM fields in addition to its goal of hiring the most qualified candidates possible, then it may view a female candidate as more desirable (or of higher quality) than a male candidate with equal levels of observable productivity. In the context or our model, we can consider the distribution of candidate productivity instead as a distribution of candidate quality where productivity and gender are two components of the quality distribution. If the university has these two objectives,
then we may observe primary hire females with productivity levels that are no different from other female colleagues. Additionally, if the university is engaging in “average hiring” in order to recruit the female candidate, we could also observe male partner hires with productivity levels below those of other male colleagues.\textsuperscript{15} We estimate our productivity equations for females and males only and the results are displayed in Table 1.5.

When a male is the primary hire his productivity is substantially greater than other males. The other member of the typical couple hire with a male primary candidate is a female partner candidate. Female partner candidates are not statistically different from other females and the coefficients are slightly positive. This suggests that the university is maintaining an independent approach when evaluating these couple types. The primary candidate has greater levels of productivity while the partner candidate is no different. However, when females are the primary hire the result changes. Among all fields, female primary hires are no different statistically from other females and the magnitude of the coefficient is close to zero. In STEM fields female primary hires are much more productive but the estimate is not statistically significant.\textsuperscript{16} However, the male partner hires are substantially less productive both among all fields and in the STEM only fields. They publish in excess of 1.5 articles fewer each year relative to other males. The result is statistically significant for all fields but not significant in the STEM only fields. These results suggest that the university may be engaging in a form of average hiring when trying to attract a female primary candidate. Even though female primary candidates are not necessarily more productive, their male partners are less productive. But in order to satisfy the

\textsuperscript{15} More than 95\% of couples hired at WSU were heterosexual.

\textsuperscript{16} The lack of statistical significance is likely due to the small sample size that is available when we examine only females in STEM fields who are primary hires.
objective of hiring female candidates, the university may be willing to accept a less than qualified male partner to do so.

4.2 Is it a marriage effect?

One concern about the validity of our findings of higher average productivity among joint hires is that the joint hire variable is simply capturing the well documented finding that married men are more productive than single men. One theory proposed by Nakosteen and Zimmer (1987) that seeks to explain this phenomenon is that there is selection in the marriage market: essentially, potential spouses recognize higher earning potential and choose their partner accordingly. Another popular theory originally proposed by Becker (1985) is that marriage makes men more productive through specialization and division of household labor. We do not seek to explain why married men are more productive in this paper. However, we argue that higher productivity among joint hires results from couples with mixed levels of productivity choosing to go to an institution where both can obtain employment. Thus, we need to rule out any confounding effect that marital status might have.

Marital status is not maintained in official university records. Therefore, to probe into this concern, we obtained survey data (from another study) that was randomly administered to a subsample of tenure-stream WSU faculty in 2009 which contains cross-sectional marital status information for the academic year 2008. We were able to match that information from the survey to our administrative data for 321 individuals who were employed at WSU in 2009. Table 1.6 contains the summary information.
Of those 321 individuals, 43 of them (13 percent) are joint hires which corresponds precisely to the 13 percent who are joint hires in our administrative dataset. This close correspondence supports the claim that the survey is representative of the larger population. Based on the survey data we find that a very large portion (83 percent) of tenure stream faculty at WSU in 2009 were married. In our specifications, then, the majority of the “control” group (those not hired as part of a couple) are married individuals whose partner does not work for WSU.

Using this much smaller sample of faculty, we first estimate the same productivity equations as before. This comes with the trade-off that statistical power will be reduced because of a smaller sample size. We then add a time-constant control variable for marital status as of 2008 and compare estimated coefficients between the two models to see whether there is a significant change in the couple hire variables. If the change is small then we believe that marital status will have an equally minor effect on the results from the full data set. For brevity, we report only the results for the JointHire, Primary, Partner, Female, and Married variables.

The first two columns of results reported in Table 1.7 replicate the prior estimation for publications using the smaller sample that we could match to the survey while the second two columns include the marital status indicator variable for this same group. These estimations are based on a sample size that is 43 percent smaller than the full administrative data. In this subsample, we find that the magnitudes for the effect of being part of a joint hire fall relative to those from the larger sample and lose statistical significance; however, they are consistent in terms of the signs of the effects. Furthermore, we perform a Wald test that the coefficient on JointHire differs between the larger and smaller samples and fail to reject it at conventional levels.
Marital status has a large and significant effect on publication rates for our subsample of tenure-stream faculty members, accounting for a difference of about three-fourths of a publication per year. This is consistent with the previously mentioned theories regarding the effect of marital status on productivity. In spite of the large effect of marriage, the magnitude of the marginal effect on the joint hire variable changes by just over one-tenth of a publication per year (from 0.378 to 0.268) when the marital indicator is added as a control variable. The coefficient on the Primary hire variable falls by a similar magnitude from from 0.651 to 0.543 publications per year. The similarity in the point estimates for the Joint Hire, Primary, and Partner variables between the two specifications provides some support for the notion that what we are capturing is not merely a marriage effect but rather something related to being a joint hire. Our theory explains this alternative effect based on selection in which highly productive individuals choose to go to lower-ranked universities because of a strong desire to work near or with their partner.

5 Summary and Conclusions

The presence of couples in the academic labor market affects the quality distribution of employees within a single institution. Due to the geographic distance between many universities, couples must often seek employment within the same institution. When couples are comprised of candidates with different employment options, one of the two may choose to accept an offer from a less prestigious institution in order to be near her partner. If members of couples are evaluated independently, which is consistent with Washington State University’s accommodation policy, all but the most elite universities can attract talent above their average by offering jobs to both partners of a couple. As a result, the expected level of productivity for the average joint hire individual in these institutions is higher than that of their colleagues. If
members of couples are evaluated by other means such as an average hiring policy then on average couple hires may not be much different from their colleagues.

We test whether couple hires are different in terms of productivity using data on tenure stream faculty at Washington State University. We estimate a productivity equation using the number of publications per year as the dependent variable. We find that overall, joint hires publish more than their colleagues. We also find evidence which suggests that the university may not strictly adhere to an independent hiring policy. It appears that when the primary candidate is a female, the university is willing to accept a male partner who is less productive than other male colleagues.

Our work provides insight for university administrators who may be considering policies to aid in the recruitment of couples. I find that all but the most elite universities stand to benefit when an independent hiring policy is used because they are able to attract high quality candidates without hiring candidates whom they otherwise would have refused. When an average policy is used, the only school to clearly benefit is the lowest ranked school while any benefit that may exist for middle ranked universities is almost, if not completely, offset because they are hiring lower quality faculty than they otherwise would.

There are other considerations that departments and universities should consider which have not addressed thus far. One consideration is that couples do not always stay couples. When couples divorce, one of them will likely look for employment at another institution especially if they are in the same department. The probability of obtaining an outside offer is highest for the most productive partner and unless there is a strong preference to stay at the current location, it is likely that the more productive of the two will leave. If a university uses an independent approach to hiring then the remaining partner should still be at least as productive as his
colleagues. But if an average policy was used then the university is left with a lower quality candidate whom they would not have hired otherwise.

Couple hiring is a difficult issue and there are still many questions that must be answered. Scheibinger et al. (2008) found that the proportion of new hires who are part of academic couples has increased from 3 percent in the 1970’s to 13 percent in the decade of the 2000’s in large part due to the increase in the female labor force participation rate. Currently, there is a strong political push to increase females in STEM fields which will likely cause the increasing trend to continue for some time. Our work is aimed to help university administrators, policy makers and couples understand how outcomes can be different for couples and use that information to make better decisions.
References


Appendix

A.1 Deriving the general solution for university thresholds when couples are evaluated independently

As shown in Equation (1.3), in a world comprised solely of single candidates, the university chooses its threshold to satisfy

\[ \int_{0}^{\tau_k} f(\theta) d\theta = \frac{k-1}{K}. \] (A.5)

And in a world comprised solely of couple candidates, the university chooses its threshold to satisfy

\[ \int_{0}^{\tau_k} f(x) d\theta_x \cdot \nonumber \int_{0}^{\tau_k} f(x) d\theta_y + 2 \cdot \int_{0}^{\tau_k} f(x) d\theta_x \cdot \int_{\tau_k}^{\infty} f(x) d\theta_y = \frac{k-1}{K} \] (A.6)

which can be rewritten as:

\[ \int_{0}^{\tau_k} f(x) d\theta_x \cdot \nonumber \int_{0}^{\tau_k} f(x) d\theta_y + 2 \cdot \int_{0}^{\tau_k} f(x) d\theta_x \cdot \left(1 - \int_{0}^{\tau_k} f(x) d\theta_y \right) = \frac{k-1}{K} \] (A.7)

When both single and couple candidates exist, the university chooses its threshold to satisfy a linear combination of these two densities as given by Equation (A.8).

\[ \alpha \left[ \int_{0}^{\tau_k} f(x) d\theta_x \cdot \int_{0}^{\tau_k} f(x) d\theta_y + 2 \left( \int_{0}^{\tau_k} f(x) d\theta_x \right) \left(1 - \int_{0}^{\tau_k} f(x) d\theta_y \right) \right] + (1-\alpha) \left[ \int_{0}^{\tau_k} f(x) d\theta \right] = \frac{k-1}{K} \] (A.8)

Each member of the couple has productivity that is drawn from the same distribution and the subscripts are merely for expositional convenience. Therefore to avoid cumbersome notation, we represent the integral from 0 to \( \tau_k \) over the general distribution, \( f(\theta) \), for any candidate type, whether single or part of a couple, as
\[ P \equiv \int_{0}^{\tau_k} f(\theta) d(\theta) \quad (A.9) \]

and form the combination. Then school \( k \)'s decision is to choose \( \tau_k \) such that the weighted probability of hiring a couple plus the weighted probability of hiring a single candidate is equal to \((k-1)/K\) as derived in Equation (A.10).

\[
\alpha \left[ (P)^2 + 2(P(1-P)) \right] + (1-\alpha)P = \frac{k-1}{K} \\
\alpha P^2 + 2\alpha P - 2\alpha P^2 + P - \alpha P = \frac{k-1}{K} \\
(1+\alpha)P - \alpha P^2 = \frac{k-1}{K} \\
(1+\alpha)\left(\int_{0}^{\tau_k} f(\theta) d(\theta)\right) - \alpha\left(\int_{0}^{\tau_k} f(\theta) d(\theta)\right)^2 = \frac{k-1}{K} \\
(1+\alpha)\int_{0}^{\tau_k} f(\theta) d\theta - \alpha\int_{0}^{\tau_k} f(\theta) d\theta \int_{0}^{\tau_k} f(\theta) d\theta = \frac{k-1}{K} \quad (A.10)
\]

If desired, the theory allows for different distributional assumptions among singles and couples, as well as for partners within couples. However doing so would prevent the preceding simplification of the equation.

### A.2 A comparison of expected productivities

#### A.2.1 A comparison of the expected levels of productivity of couples and singles.

We want to answer the question of whether the inequality in Equation (A.11) is true.

\[
\frac{\int_{\tau_k}^{\tau_{k+1}} f(\theta_1) d(\theta_1) \int_{\tau_k}^{\tau_f} f(\theta_2) d(\theta_2) + \int_{\tau_k}^{\tau_f} f(\theta_3) d(\theta_3) \int_{\tau_k}^{\tau_{k+1}} f(\theta_4) d(\theta_4)}{\int_{\tau_k}^{\tau_{k+1}} f(\theta_1) d(\theta_1) \int_{\tau_k}^{\tau_f} f(\theta_2) d(\theta_2) + \int_{\tau_k}^{\tau_f} f(\theta_3) d(\theta_3) \int_{\tau_k}^{\tau_{k+1}} f(\theta_4) d(\theta_4)} > \frac{\int_{\tau_k}^{\tau_{k+1}} f(\theta) d(\theta)}{\int_{\tau_k}^{\tau_{k+1}} f(\theta) d(\theta)} \quad (A.11)
\]
Since all productivities are drawn from the same distribution and the subscripts are simply there to aid in the presentation of the theory, we can remove the subscripts. Also, to simplify the notation further, let us also re-label the bounds as follows: let \( a = \tau_k \) and \( b = \tau_{k+1} \) such that \( 0 < a < b \). Then the inequality becomes

\[
\frac{\int_a^b \theta f(\theta) d(\theta) \int_a^\infty f(\theta) d(\theta) + \int_b^\infty \theta f(\theta) d(\theta) \int_a^b f(\theta) d(\theta)}{\int_a^b f(\theta) d(\theta) (\int_a^\infty f(\theta) d(\theta) + \int_b^\infty f(\theta) d(\theta))} > \int_a^b \theta f(\theta) d(\theta)
\]  

(A.12)

We proceed to simplify and rearrange this inequality until we can produce a form that clearly holds true.

\[
\frac{\int_a^b \theta f(\theta) d(\theta) \int_a^\infty f(\theta) d(\theta) + \int_b^\infty \theta f(\theta) d(\theta) \int_a^b f(\theta) d(\theta)}{\int_a^\infty f(\theta) d(\theta) + \int_b^\infty f(\theta) d(\theta)} > \int_a^b \theta f(\theta) d(\theta)
\]

(A.13)

\[
\int_a^\infty f(\theta) d(\theta) > \int_a^b \theta f(\theta) d(\theta) + \int_b^\infty \theta f(\theta) d(\theta)
\]

(A.14)

\[
\int_b^\infty \theta f(\theta) d(\theta) \int_a^\infty f(\theta) d(\theta) > \int_a^b \theta f(\theta) d(\theta) \int_a^\infty f(\theta) d(\theta)
\]

(A.15)

\[
\frac{\int_b^\infty \theta f(\theta) d(\theta)}{\int_b^\infty f(\theta) d(\theta)} > \frac{\int_a^\infty \theta f(\theta) d(\theta)}{\int_a^\infty f(\theta) d(\theta)}
\]

(A.16)

Equation (A.16) is clearly true. It states that the expected value of \( \theta \) over the re-weighted density region on the interval \( b \) to \( \infty \) is greater than the expected value of \( \theta \) over the re-weighted density region on the interval \( a \) to \( b \). Since \( 0 < a < b \), the inequality clearly holds. Hence the original inequality must also hold.
In the top school, however, the bounds on the couple side of the inequality are different. Here $\tau_{k+1}$ doesn’t exist and becomes $\infty$. So the inequality becomes

$$\int_{\tau_k}^{\infty} \theta f(\theta) d(\theta) \int_{\tau_k}^{\infty} f(\theta') d(\theta') + \int_{\tau_k}^{\infty} \theta f(\theta) d(\theta) \int_{\tau_k}^{\infty} f(\theta') d(\theta') > \int_{\tau_k}^{\infty} \theta f(\theta) d(\theta) \int_{\tau_k}^{\infty} f(\theta') d(\theta').$$

(A.17)

The integrals from $\infty$ to $\infty$ are zero and drop out of the inequality which leaves

$$\int_{\tau_k}^{\infty} \theta f(\theta) d(\theta) \int_{\tau_k}^{\infty} f(\theta') d(\theta') > \int_{\tau_k}^{\infty} \theta f(\theta) d(\theta) \int_{\tau_k}^{\infty} f(\theta') d(\theta').$$

(A.18)

And since the subscripts can be removed we are left with

$$\int_{\tau_k}^{\infty} \theta f(\theta) d(\theta) \int_{\tau_k}^{\infty} f(\theta') d(\theta') = \int_{\tau_k}^{\infty} \theta f(\theta) d(\theta) \int_{\tau_k}^{\infty} f(\theta') d(\theta').$$

(A.19)

which is clearly an equality.

A.2.2 A comparison of expected productivity of couples and singles given that the individual in the couple is either the higher or lower quality member of the couple.

Given that an individual is the higher quality member of a couple we compare her expected productivity to the expected productivity of a single candidate. This is done by determining the nature of the relationship between the two expected productivities.
\[
\frac{\int_{\tau_k}^{\infty} \theta f(\theta_x) d\theta \int_{\tau_k}^{\tau_{k+1}} f(\theta_y) d\theta_y}{\int_{\tau_k}^{\infty} f(\theta_x) d\theta \int_{\tau_k}^{\tau_{k+1}} f(\theta_y) d\theta_y} > \frac{\int_{\tau_k}^{\tau_{k+1}} \theta f(\theta) d\theta}{\int_{\tau_k}^{\tau_{k+1}} f(\theta) d\theta}
\]  

(A.20)

Again, under an independent hiring policy the subscripts are for notational convenience and can be dropped which leaves

\[
\frac{\int_{\tau_k}^{\infty} \theta f(\theta_x) d\theta \int_{\tau_k}^{\tau_{k+1}} f(\theta_y) d\theta_y}{\int_{\tau_k}^{\infty} f(\theta_x) d\theta \int_{\tau_k}^{\tau_{k+1}} f(\theta_y) d\theta_y} > \frac{\int_{\tau_k}^{\tau_{k+1}} \theta f(\theta) d\theta}{\int_{\tau_k}^{\tau_{k+1}} f(\theta) d\theta}
\]  

(A.21)

\[
\Rightarrow \frac{\int_{\tau_k}^{\infty} \theta f(\theta_x) d\theta \int_{\tau_k}^{\tau_{k+1}} f(\theta_y) d\theta_y}{\int_{\tau_k}^{\infty} f(\theta_x) d\theta \int_{\tau_k}^{\tau_{k+1}} f(\theta_y) d\theta_y} > \frac{\int_{\tau_k}^{\tau_{k+1}} \theta f(\theta) d\theta}{\int_{\tau_k}^{\tau_{k+1}} f(\theta) d\theta}
\]  

(A.22)

The lower bounds for both sides of the inequality in Equation (A.22) are equal, but the upper bounds on the left hand side extend to infinity while the bounds on the right hand side are capped at \( \tau_{k+1} \). For the highest ranked school the upper bound on the right hand side is \( \infty \). Thus for all but the top ranked school, the expected productivity of a couple candidate, given that she is the higher quality member of the couple is greater than a single candidate. In the top ranked school, the expected productivities are equal.

Given that an individual is the lower quality member of a couple, we compare her expected productivity to the expected productivity of a single candidate. This is done by determining the nature of the relationship between the two expected productivities.

\[
\frac{\int_{\tau_k}^{\tau_{k+1}} \theta f(\theta_x) d\theta \int_{\tau_k}^{\infty} f(\theta_y) d\theta_y}{\int_{\tau_k}^{\tau_{k+1}} f(\theta_x) d\theta \int_{\tau_k}^{\infty} f(\theta_y) d\theta_y} = \frac{\int_{\tau_k}^{\tau_{k+1}} \theta f(\theta) d\theta}{\int_{\tau_k}^{\tau_{k+1}} f(\theta) d\theta}
\]  

(A.23)

The subscripts can be dropped and Equation (A.23) reduces to a clear equality.
\[
\frac{\int_{r_k}^{r_{k+1}} \theta f(\theta) d\theta \int_{r_k}^{r_{k+1}} f(\theta) d\theta}{\int_{r_k}^{r_{k+1}} f(\theta) d\theta} = \int_{r_k}^{r_{k+1}} \theta f(\theta) d\theta
\] (A.24)

\[
\frac{\int_{r_k}^{r_{k+1}} \theta f(\theta) d\theta}{\int_{r_k}^{r_{k+1}} f(\theta) d\theta} = \int_{r_k}^{r_{k+1}} \theta f(\theta) d\theta
\] (A.25)

A.3 A numerical illustration

We use a numerical example to illustrate the model’s predictions. We arbitrarily assume that candidate productivity follows a gamma distribution, with shape and scale parameters set equal to 2, and that there are \( K = 5 \) schools. We first illustrate the solution for the minimum threshold values in a world where only single candidates exist. When only single candidates exist in the market the threshold values are as shown in Figure 1.4.

Figure 1.5 is a concrete illustration of what is shown in the right hand panel of Figure 1.2. The heavy solid lines represent the threshold values and the circular lines represent the contours of the joint gamma distribution. The bulk of the density is near the lower left corner and therefore thresholds \( \tau_2 \) and \( \tau_3 \) are closest together relative to the other thresholds.

The horizontal distance between the thresholds along both axes depends on the distributional assumption as well as the level of alpha. As the proportion of couples in the market
increases from zero to one, the threshold values fall *ceteris paribus*. In Figure 1.5 we plot how these threshold values change as $\alpha$ increases from zero to one.\textsuperscript{17}

Finally we calculate the expected productivity levels for the average single candidate and the average couple candidate within each of the $K$ schools. Table 1.8 gives the minimum threshold values, the expected level of productivity for the average single candidate, the expected level of productivity for the average couple candidate, and the percent difference in productivity for each of the 5 schools.

The results in the table clearly illustrate that given our assumptions about couple and university behavior, when couples exist in the marketplace the expected level of productivity for the average hires who are part of a couple will be greater than that of the average single hire within the same university. This difference is greatest in the lowest-tier universities and shrinks to zero as the prestige of the institution increases.

### A.4 An average hiring policy

#### A.4.1 Solving for the equilibrium threshold values and comparing expected productivity

Under an average policy, the university is still willing to hire a couple as long as the average level of productivity between the two is weakly greater than its threshold, otherwise it will not offer a job to the weaker of the two and the couple must go to a lower ranked school in

\textsuperscript{17} The implication is that the quality gap between lower-tier and higher-tier universities diminishes as the proportion of academic couples increases. It is beyond the scope of this work to explore this implication and we leave it to future research.
order to remain together. Under such a policy, the university is establishing two different thresholds, one that is constant for single candidates and another that varies depending on the relative quality of each member of an academic couple. If all universities utilize an average hiring policy, then each university must choose \( \tau_k \) to simultaneously solve:

\[
\alpha \left( \int_0^{c_k} \int_0^{\kappa - x} f(\theta, \theta') \, d\theta \, d\theta' \right) + (1 - \alpha) \left( \int_0^{c_k} f(\theta) \, d\theta \right) = \frac{k - 1}{K} \tag{A.26}
\]

and

\[
c_k = 2\tau_k. \tag{A.27}
\]

Equation (A.26) requires that the university choose threshold values such that the weighted area to the left of the couples’ threshold plus the weighted area to the left of the singles’ threshold is equal to \((K-1)/K\). Equation (A.27) establishes the link between the variable threshold for couples and the constant threshold for singles. The constant threshold for single candidate is \( \tau_k \). The variable threshold for candidate \( y \) given that he is partnered with candidate \( x \) is defined as

\[
\theta_y = c_k - \theta_x \tag{A.28}
\]

The intercept, \( c_k \) can be thought of as the lowest possible level of productivity for candidate \( y \) that school \( k \) would be willing to accept given that candidate \( x \) is the highest possible candidate school \( k \) could attract, subject to the constraint that the average of the two must be weakly greater than \( \tau_k \). The equal weighting of candidate productivity in the averaging process causes the one-to-one negative relationship between \( x \) and \( y \) and results in the intercept, \( c_k \), being exactly twice as large as the chosen threshold, \( \tau_k \), which yields Equation (A.27).
Equation (A.27) can be substituted into (A.26) and each university can solve for $\tau_k$.

Once the thresholds have been chosen, it is possible to make productivity comparisons of couple hires and single hires within the same institution. I do this by calculating expectations for each. The expected level of productivity for a single candidate hired by school $k$ is

$$E(\theta | \theta \in (\tau_k, \tau_{k+1})) = \frac{\int_{\tau_k}^{\tau_{k+1}} \theta f(\theta) d\theta}{\int_{\tau_k}^{\tau_{k+1}} f(\theta) d\theta}.$$  \hspace{1cm} (A.29)

The denominator in Equation (A.29) scales the distribution so that the integral of $f(\theta)$ from $\tau_k$ to $\tau_{k+1}$ integrates to one and a proper expectation can be calculated.

To calculate the expected level of productivity for a couple hired into school $k$ under an average hiring policy, I calculate the expected value to the left of the couple threshold for school $k+1$, and then subtract the expected value to the left of the couple threshold for school $k$. Mathematically it is given as

$$E\left(\theta, \left(\frac{\theta_x + \theta_y}{2}\right) \in (\tau_k, \tau_{k+1})\right) =$$

$$\frac{\int_{0}^{\tau_{k+1}} \int_{0}^{(\tau_{k+1} - x)} \left(\frac{\theta_x + \theta_y}{2}\right) f(\theta_x, \theta_y) d\theta_y d\theta_x - \int_{0}^{\tau_{k}} \int_{0}^{(\tau_{k+1} - x)} \left(\frac{\theta_x + \theta_y}{2}\right) f(\theta_x, \theta_y) d\theta_y d\theta_x}{\int_{0}^{\tau_{k+1}} \int_{0}^{(\tau_{k+1} - x)} f(\theta_x, \theta_y) d\theta_y d\theta_x - \int_{0}^{\tau_{k}} \int_{0}^{(\tau_{k} - x)} f(\theta_x, \theta_y) d\theta_y d\theta_x}.$$ \hspace{1cm} (A.30)

A direct analytical comparison of the expected productivity of couple and single candidates under a general distribution is not possible for each school. The comparison depends on the underlying distribution of candidate productivity and the rank of each school. However, we are able to compare expected productivity for the lowest and highest ranked schools. First, we must establish an equivalence relationship between the expected productivity of a single
candidate under a univariate density and the expected productivity of a single candidate under a bi-variate density. For the lowest ranked school we re-write Equation (A.29) as:

\[
E(\theta | \theta \in (0, \tau_2)) = \frac{\int_0^{\tau_2} \theta f(\theta) d\theta}{\int_0^{\tau_2} f(\theta) d\theta} = \frac{\int_0^{\tau_2} \int_0^{\tau_2} \frac{(\theta + \psi)}{2} f(\theta_x, \theta_y) d\theta_x d\theta_y}{\int_0^{\tau_2} \int_0^{\tau_2} f(\theta_x, \theta_y) d\theta_x d\theta_y}
\]  

(A.31)

where I have used the average of two independent and equal expected productivity values for single candidates and assumed that for single candidates

\[
f(\theta_x, \theta_y) = f(\theta) \cdot f(\theta).
\]  

(A.32)

For couple hires in the lowest ranked school, the second term in both the numerator and denominator of Equation (A.30) is zero and drops out of the equation, also we know that the intercept for the couple threshold is equal to twice the single threshold so that the expected productivity of a couple hire is:

\[
E(\theta | \left(\frac{\theta_x + \theta_y}{2}\right) \in (0, \tau_2)) = \frac{\int_0^{\tau_2} \int_0^{(\tau_2/2)} \frac{(\theta_x + \theta_y)}{2} f(\theta_x, \theta_y) d\theta_x d\theta_y}{\int_0^{\tau_2} \int_0^{(\tau_2/2)} f(\theta_x, \theta_y) d\theta_x d\theta_y}.
\]  

(A.33)

The only difference between Equations (A.31) and (A.33) is the boundaries on the integrals. Thus the proof that couple hires have higher expected productivity than do single hires in the lowest ranked school, we need only demonstrate that the expected productivity of couples incorporates more of the distribution than it does for single candidates.

For single hires, the boundaries encompass a square region with a base area defined by:

\[
(\tau_2 - 0) \cdot (\tau_2 - 0) = \tau_2^2.
\]  

(A.34)

For couple hires, the boundaries encompass a triangular region defined by:
\[ \frac{(2\tau - 0)(2\tau - 0)}{2} = 2\tau^2 \quad (A.35) \]

Since \( 2\tau^2 > \tau \), the expected productivity of couple hires in the lowest ranked school encompasses more of the distribution than does the expected productivity of single hires. The bounds for the expected productivity of single hires already include the lowest valued portion of the density. Since the bounds for the expected productivity of couples includes a larger portion of the density, it can only include portions where candidate productivity is higher. Including larger values in any averaging process increases the average. Thus in the lowest ranked school, expected productivity will be larger for couples than for singles.

By a similar argument, the use of an average hiring policy by the highest ranked school results in expected productivity that is lower for couples than for singles. Ignore that fact that the distribution increases continuously towards infinity and assume that one candidate has higher productivity relative to all of the other candidates. I denote this candidate’s productivity by \( \bar{\theta} \) and use it as an upper-bound for the distribution. Hence, the expected productivities for singles and couples can be expressed as:

\[
E\left(\theta \mid \theta \in (\tau_K, \bar{\theta})\right) = \frac{\int_{\tau_K}^{\bar{\theta}} \int_{\tau_K}^{\bar{\theta}} \left( \frac{\theta_x \theta_y}{2} \right) f(\theta_x, \theta_y) d\theta_x d\theta_y}{\int_{\tau_K}^{\bar{\theta}} \int_{\tau_K}^{\bar{\theta}} f(\theta_x, \theta_y) d\theta_x d\theta_y} \quad (A.36)
\]

\[
E\left(\theta \mid \left(\frac{\theta_x + \theta_y}{2}\right) \in (\tau_K, \bar{\theta})\right) = \frac{\int_{\frac{\theta_x + \theta_y}{2}}^{\bar{\theta}} \int_{\frac{\theta_x + \theta_y}{2}}^{\bar{\theta}} \left( \frac{\theta_x + \theta_y}{2} \right) f(\theta_x, \theta_y) d\theta_x d\theta_y}{\int_{\frac{\theta_x + \theta_y}{2}}^{\bar{\theta}} \int_{\frac{\theta_x + \theta_y}{2}}^{\bar{\theta}} f(\theta_x, \theta_y) d\theta_x d\theta_y} \quad (A.37)
\]
Again the only difference between the two expressions is the boundaries of integration. The base area of the portion of the density utilized in calculating the expected productivity for single candidates is the square region defined by:

\[(\bar{\theta} - \tau_K)(\bar{\theta} - \tau_K) = (\bar{\theta} - \tau_K)^2\]  \hspace{1cm}(A.38)

The base area of the portion of the density utilized in calculating the expected productivity for couple candidates is the triangular region defined by:

\[
\frac{2(\bar{\theta} - \tau_K)2(\bar{\theta} - \tau_K)}{2} = 2(\bar{\theta} - \tau_K)^2
\]  \hspace{1cm}(A.39)

Since \(2(\bar{\theta} - \tau_K)^2 > (\bar{\theta} - \tau_K)^2\), the portion of the density used in the calculation of the expected productivity for couples is larger than the portion used for singles. Since the boundaries for the single candidate calculation already include the highest values attainable under any distribution, the boundaries for the couple region must include lower valued portions of the distribution. Including smaller values in the averaging process will bring the average down. Thus, expected productivity in the highest ranked school will be lower for couples than for singles.

For universities between the lowest and highest ranked, there is an offsetting effect for couple hiring; they recruit candidates they otherwise would not have attracted and hire candidates in whom they otherwise would not have been interested. The rank of the school and the specific underlying distribution of candidate productivity determine which effect is strongest. However, regardless of which effect dominates, the magnitude of the difference will always be small. In Table 1.9 we present a numerical comparison of threshold values and expected productivities under four different distributional assumptions using both independent and average hiring.
A.4.2 Comparing expected levels of productivity between couples and singles given that a couple candidate is either the higher or lower quality member of the couple.

We compare the expected productivity of a couple candidate hired under an average policy by school \( k \), given that she is the higher quality partner in the couple, to the expected productivity of a single candidate. We use Figure 1.7 to help illustrate the explanation. Figure 1.7 represents a scenario with \( K = 5 \) universities and a joint gamma distribution whose contours are marked by the circular lines. The thick horizontal and vertical lines represent the thresholds for single candidates and the thick downward sloping lines represent the variable average threshold for couples. The area shaded using the standard grid pattern in represents the possible levels of productivity that the higher quality candidate could have and still be hired by school 3 under an average hiring policy. We know the lowest possible value for this candidate’s quality is the minimum threshold chosen by school 3. This is only achievable if her partner’s quality is also equal to the minimum. If the her quality were any lower then she could not have been hired by school 3. The highest level of quality achievable by her that would still allow her to be hired by school 3 is equal to twice the minimum threshold of school 4 minus \( \varepsilon \) (where \( \varepsilon \) is infinitesimally small). At this value, her partner could have a level of productivity equal to zero and their average would still fall in the range of quality that would allow school 3 to hire them. The generalized form the conditional expectation can be written as:

\[
\frac{\int_{\tau_k}^{2\tau_{k+1}} \theta f(\theta) d\theta}{\int_{\tau_k}^{2\tau_{k+1}} f(\theta) d\theta}
\] (A.40)
where \( \tau_{K+1} \) for the top school is equal to infinity. A simple comparison of the expected productivities of the higher quality partner in a couple and a single candidate clearly reveals that the higher quality partner has higher expected productivity.

\[
\int_{\tau_k}^{\tau_{K+1}} \theta f(\theta) d\theta \int_{\tau_k}^{\tau_{K+1}} f(\theta) d\theta > \int_{\tau_k}^{\tau_{K+1}} \theta f(\theta) d\theta \int_{\tau_k}^{\tau_{K+1}} f(\theta) d\theta \]  

(A.41)

We likewise compare the expected productivity of a couple candidate hired by school k given that she is the lower quality partner to the expected productivity of a single candidate. For concreteness, consider again the illustration in Figure 1.7. The possible range of productivity for a couple candidate hired into school 3 who is the lower quality partner is shaded with the diamond grid pattern. As are assuming that our candidate is always the lower quality partner, the highest possible value for her productivity is \( \varepsilon \) units below the minimum threshold established by school 4. In this situation, her partner’s productivity would be equal to her own and they would both be hired by school 3. Her productivity can also be as low as zero as long as her partner’s productivity is high enough to bring the average above the minimum threshold of school 3. The generalized conditional expectation is written as:

\[
\int_{0}^{\tau_{K+1}} \theta f(\theta) d\theta \int_{0}^{\tau_{K+1}} f(\theta) d\theta . \]  

(A.42)

A simple comparison of the expected productivities of the lower quality partner in a couple and a single candidate clearly reveals that under an average hiring policy, the lower quality partner has lower expected productivity.
\[
\frac{\int_0^{r_{k-1}} \theta f(\theta) d\theta}{\int_0^{r_{k-1}} f(\theta) d\theta} < \frac{\int_{r_k}^{r_{k+1}} \theta f(\theta) d\theta}{\int_{r_k}^{r_{k+1}} f(\theta) d\theta}.
\]

(A.43)

A.4.3 Identifying how the average expected productivity of a couple changes as university prestige increases.

A direct comparison of the endpoints reveals that in the lowest ranked university \( E(c) > E(s) \) and in the highest ranked university \( E(c) < E(s) \). How expected productivity compares for universities on the interior of the prestige rankings is ambiguous though it is possible to establish some properties of the expected value function over this range. A simple argument can be made to establish monotonicity. Let \( a < b < c \) represent threshold bounds for two adjacent universities. University one hires all single candidates with productivity between the bounds \( a \) and \( b \), and hires all couple candidates whose average productivity is between \( a \) and \( b \). University two hires single and couples candidates whose productivity or average productivity is between \( b \) and \( c \). Given that a couple has been hired by university one, the expected average productivity of the couple must necessarily be between \( a \) and \( b \). Similarly, the expected average rank of a couple hired by university two must necessarily be between \( b \) and \( c \). As a result the expected average productivity of a couple hired by a higher ranked university will be greater than the expected average rank of a couple hired by a lower ranked university which implies that the expected average productivity function is monotonically increasing. Knowing that the function is monotonic and that couples have higher, then lower productivity at each endpoint is enough to establish that there must exist at least point on the interior of the prestige rankings. But more can be done to identify how the expected productivity of couples behaves as prestige increases across the prestige distribution.
A well-known distributional result in probability theory is the probability integral transform (Savits 1994). Let the function \( f(x) \) represent the probability density function for the random variable \( x \) and let the random variable \( X = F(x) \) represent the cumulative distribution function of \( x \). If \( X \) is continuous then the function \( \tilde{X} = F(X) \) has a uniform distribution over the domain \((0,1)\). This result allows any continuous distribution to be converted into a uniform distribution. In the context of academic couples, \( f(\theta) \) is the probability density function of candidate productivity. Then \( \Theta = F(\theta) \) is the cumulative distribution of \( \theta \). For candidate \( i \) with productivity \( \theta_i \), \( F(\theta) \) acts as a function that ranks individuals according to their location in \( f(\theta) \). Since \( f(\theta) \) is continuous the probability that two individuals occupy the same location is zero thus the rank ordering is unique. We now define a new random variable, \( \tilde{\Theta} = F(\Theta) \), as the cumulative distribution of \( \Theta \). This new variable, which represents cumulative ranking is distributed \( U[0,1] \). This transformation is appealing because it greatly simplifies the calculation of the expected values. The difference is that we are now calculating expected rank within the productivity distribution as opposed to the expected level of productivity.

In transforming the distribution of productivity to the distribution of the rank of an individual in the productivity distribution there is no loss of generality for the single candidate case because there the order is preserved. When averaging over couples however the unit of measurement is important in that the order of individuals may not be preserved. As an example, if productivity is measured by the number of publications then the rank assigned to the average of two individual’s publications by \( F(\theta) \) may not be the same rank that is assigned if the two individuals are first individually ranked according to their publications and then the average of
the two rankings is done. However, productivity for an academic is a difficult concept to pin
down precisely. And in the context of this model, a candidate’s rank within the productivity
distribution is as natural a choice for observing how the presence of couples affects academic
labor market outcomes as the measure of productivity itself. Thus it is equally appealing to
consider the average rank of two individuals within the productivity distribution rather than the
average level of productivity.

We can now use $\Theta$ to calculate the average expected ranking with a uniform distribution
and can identify specific properties of how the expected ranking function behaves for singles and
couples. To simplify the notation we first define $x \equiv \Theta_x$, $y \equiv \Theta_y$, $a \equiv \tau_k$, $b \equiv \tau_{k+1}$. The expected
rank within the productivity distribution for a single candidate hired by university $k$, denoted by
$E_k(\Theta_S)$, is given as

$$E_k(\Theta_S) = \frac{\int_a^b x \, dx}{\int_a^b dx}$$

(A.44)

where $f(\Theta) = 1$ as a result of the uniform (0,1) distribution and is not explicitly written. The
lower bound of the integral for the lowest ranked university will be zero, $\tau_k = 0$, and the upper
bound of the integral for the highest ranked university will be one, $\tau_{k+1} = 1$.

The specification for the expected average ranking of a couple hired by university $k$, denoted by
$E_k(\Theta_C)$, depends on the prestige of the university. We use 5 different specifications
to calculate $E_k(\Theta_C)$. The rank of the university determines which equations are used. Equation
(A.45) corresponds to the lowest ranked university, $k = 1$, whose lower bound is zero, $2a = 0$, and
whose upper bound is the minimum threshold for couples established by the second lowest ranked university, $2b - x$.

The next three equations define $E_k(\hat{\Theta}_C)$ for universities in the interior of the prestige ranking of universities, $1 < k < K$. Equation (A.46) is for universities above the lowest ranked university as long as the intercept of that university’s upper bound is less than or equal to one, $2b < 1$. Equation (A.47) is for universities whose lower bound intercept is less than one, $0 < 2a < 1$, and whose upper bound intercept is greater than one, $1 < 2b < 2$. Equation (A.48) is for all universities where the intercepts of both the lower and upper bounds are greater than one, $1 < 2a < 2b < 2$. Equation (A.49) is used to determine $E_k(\hat{\Theta}_C)$ in the highest ranked university whose lower bound is $2a - x$ and whose upper bound is 1.

For the lowest ranked university, $k = 1$, the expected average ranking of a couple is given by

$$E_k(\hat{\Theta}_C) = \frac{\int_0^{2b} \int_0^{(2b-x)} \left( \frac{x + y}{2} \right) dy dx}{\int_0^{2b} \int_0^{(2b-x)} dy dx}. \quad (A.45)$$

For universities on the interior of the prestige rankings, $1 < k < K$, the expected average ranking of a couple hired by university $k$ is defined piecewise as follows:

If $0 < 2a < 2b \leq 1$ (where one is the upper boundary on the uniform $(0,1)$ distribution), then the expected average ranking of a couple hired by university $k$ is given by

$$E_k(\hat{\Theta}_C) = \frac{\int_0^{2b} \int_{(2a-x)}^{(2b-x)} \left( \frac{x + y}{2} \right) d\hat{\Theta}_y d\hat{\Theta}_x - \int_0^{2b} \int_{(2a-x)}^{(2b-x)} \left( \frac{x + y}{2} \right) d\hat{\Theta}_y d\hat{\Theta}_x}{\int_0^{2b} \int_{(2a-x)}^{(2b-x)} dy dx - \int_0^{2b} \int_{(2a-x)}^{(2b-x)} dy dx}. \quad (A.46)$$
If \( 0 < 2a < 1 < 2b < 2 \), then the expected average ranking of a couple hired by university \( k \) is given by

\[
E_k(\tilde{\Theta}_C) = \frac{\int_0^{2b} \int_{(2a-x)}^{(2b-x)} \left(\frac{x+y}{2}\right) dydx - \int_0^{(2b-1)} \int_{(2a-x)}^{(2b-x)} \left(\frac{x+y}{2}\right) dydx - \int_1^{1} \int_{(2a-x)}^{(2b-x)} \left(\frac{x+y}{2}\right) dydx - \int_0^{0} \int_{(2a-x)}^{(2b-x)} \left(\frac{x+y}{2}\right) dydx}{\int_0^{2b} \int_{(2a-x)}^{(2b-x)} dydx - \int_0^{(2b-1)} \int_{(2a-x)}^{(2b-x)} dydx - \int_1^{1} \int_{(2a-x)}^{(2b-x)} dydx - \int_0^{0} \int_{(2a-x)}^{(2b-x)} dydx}. \quad (A.47)
\]

If \( 1 \leq 2a < 2b < 2 \), then \( E_k(\tilde{\Theta}_C) \) is given by

\[
E_k(\tilde{\Theta}_C) = \frac{\int_1^{1} \int_{(2a-x)}^{(2b-x)} \left(\frac{x+y}{2}\right) dydx - \int_0^{(2b-1)} \int_{(2a-x)}^{(2b-x)} \left(\frac{x+y}{2}\right) dydx - \int_1^{1} \int_{(2a-x)}^{(2b-x)} \left(\frac{x+y}{2}\right) dydx - \int_0^{0} \int_{(2a-x)}^{(2b-x)} \left(\frac{x+y}{2}\right) dydx}{\int_1^{1} \int_{(2a-x)}^{(2b-x)} dydx - \int_0^{(2b-1)} \int_{(2a-x)}^{(2b-x)} dydx - \int_1^{1} \int_{(2a-x)}^{(2b-x)} dydx - \int_0^{0} \int_{(2a-x)}^{(2b-x)} dydx}. \quad (A.48)
\]

Finally, for the highest ranked university, \( k = K \), \( E_k(\tilde{\Theta}_C) \) is given by

\[
E_k(\tilde{\Theta}_C) = \frac{\int_1^{1} \int_{(2a-x)}^{(2b-x)} \left(\frac{x+y}{2}\right) dydx}{\int_1^{1} \int_{(2a-x)}^{(2b-x)} dydx}. \quad (A.49)
\]

In Equations (A.46) through (A.48), the first term of each includes triangular regions that are outside of the density function boundaries which necessitates the subtraction of those regions and hence the additional integration terms. These regions are pictured in Figure 1.1 for reference.

We evaluate Equations (A.44) through (A.49) and obtain equations which are strictly functions of the boundaries for each of the possible university types. Since the rank of the university determines the boundaries, we can differentiate the resulting equations to determine whether or not the functions are monotonic as the prestige of the university changes. If the first derivatives are positive, then the expected ranks for single and couple candidates are
monotonically increasing. A second derivative will reveal whether they are linear, concave, or convex.

The integrated expected rank function for a single candidate is

\[
\frac{a + b}{2} \text{ for } 0 \leq a < b \leq 1. 
\] (A.50)

Each of the partial derivatives of (A.50) with respect to \(a\) and \(b\) are one-half, respectively. The total effect of an increase in \(a\) and \(b\) is equal to the sum of the marginal effects. Thus a one unit increase in both the lower and upper bounds corresponds to a one unit increase in the expected rank of a single candidate. A positive first derivative ensures that the function is monotonically increasing. That the derivative is constant reveals that it is increasing at a constant rate as university prestige increases and result in zero valued second derivatives. Figure 1.4 graphically illustrates how the expected rank within the productivity distribution for a single candidate behaves as the prestige of the university increases.

For couple candidates the 5 functions for the average expected rank of a couple are given by Equations (A.51) through (A.55).

For \(0 = 2a < 2b < 1\),

\[
E(\tilde{\Theta}_c) = \frac{2}{3}b. 
\] (A.51)

For \(0 < 2a < 2b < 1\),

\[
E(\tilde{\Theta}_c) = \frac{2}{3} \cdot \frac{(a^2 + ba + b^2)}{(a + b)}. 
\] (A.52)

For \(0 < 2a < 1 < 2b < 2\),
\[
\frac{(b^2 + a^2)}{4b - 2b^2 - 1 - 2a^2} + \frac{(2b - 1)^3}{12} + \frac{(2b - 1)^2}{4} + b - \frac{1}{2} - b^2 (2b - 1) + \frac{2a^3}{3} + a^2 (1 - 2a)
\]  
(A.53)

For \(1 < 2a < 2b < 2\),

\[
\frac{b^2 (2 - 2a) - a^2 (2 - 2a)}{4b - 2b^2 - 4a + 2a^2} + \frac{(2b - 1)^3 - (2a - 1)^3}{12} + \frac{(2b - 1^2) - (2a - 1^2)}{4} + \frac{b - a}{2} - b^2 (2b - 2a)
\]  
(A.54)

For \(1 < 2a < 2b = 2\),

\[
\frac{2}{3}a + \frac{1}{3}
\]  
(A.55)

We compare the expected rank of a single candidate with the expected average rank of couple candidates given that they are all hired by the lowest ranked university. In the lowest ranked university, \(a = 0\) and therefore

\[
\frac{1}{2}b < \frac{2}{3}b \Rightarrow E(\tilde{\Theta}_s) < E(\tilde{\Theta}_c)
\]  
(A.56)

where \(E(\tilde{\Theta}_s)\) is the expected rank of a single candidate and \(E(\tilde{\Theta}_c)\) is the expected average rank of a couple and is analogous to the result obtained when we compared expected productivity rather than expected rank. We make a similar comparison in the highest ranked university. For the highest ranked university, \(b = 1\) and therefore

\[
\frac{a + 1}{2} > \frac{2a + 1}{3} \Rightarrow E(\tilde{\Theta}_s) > E(\tilde{\Theta}_c).
\]  
(A.57)

Thus, couples have higher average expected rank within the productivity distribution than singles at the lowest ranked university and couples have lower average expected rank than singles in the highest ranked university.
We have established that at the lowest ranked university, couples have higher average expected ranking and that at the highest ranked university they have lower average expected ranking than the rank of single candidates. The slope of the expected average rank function for couples is non-constant across the interior; it varies according to the threshold values that determine which candidates are hired by the respective university. These slopes can be obtained by differentiating Equations (A.52) through (A.54).

For (A.52) where $0 < a < b < 1$, the two partial derivatives are positive for an relevant combination of values for $a$ and $b$ which establishes that $E(\Theta_c)$ is monotonically increasing over this range. The second derivatives are also positive for relevant values of $a$ and $b$, hence $E_k(\Theta_c)$ is convex for universities in this range.

For a median school represented by Equation (A.53) where $0 < 2a < 1 < 2b < 2$ the the partial derivatives are positive, indicating that $E_k(\Theta_c)$ is monotonically increasing here as well. It is also interesting to note that as $2a \to 1$ from below and $1 \leftarrow 2b$ from above, the sum of the two partial derivatives is 1. This indicates that the slope of $E_k(\Theta_c)$ becomes equal to the slope of $E_k(\Theta_s)$ as the interval occupied by the median school shrinks. For wider intervals the slope is greater than 1. The second derivatives are still positive indicating that the function is still convex.

For schools above the median ranked school represented by Equation (A.54) where $1 \leq 2a < 2b < 2$, the first derivatives negative or positive depending on the values of $a$ and $b$ but the combined effect is always positive. Hence $E_k(\Theta_c)$ is monotonically increasing across schools ranked above the median. The partial second derivatives are also positive in some
intervals and negative in others but the combined effect is always negative. Therefore \( E_k(\tilde{\Theta}_c) \) is now concave for schools ranked above the median.

We have established that the function is monotonically increasing, that it is convex for universities below the median and concave for universities above the median. Therefore it must be true that there exists at least one point in the interior of the distribution where the expected rank for couples and singles is equal. It is in the median school where the switching point will exist. If the number of schools is even then in the lower half of schools, \( E_k(\tilde{\Theta}_s) < E_k(\tilde{\Theta}_c) \) and in the upper half of schools \( E_k(\tilde{\Theta}_c) < E_k(\tilde{\Theta}_s) \). If the number of schools is odd then in the median school the relative difference between couples and singles could be either positive, negative, or equal depending on the specific bounds, which are a function of the number of schools. But the switching point would occur within this median school.
Table 1.1 – Variable Names and Definitions

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>JointHire</td>
<td>= 1 if the individual was part of a jointly hired couple, 0 otherwise</td>
</tr>
<tr>
<td>Primary</td>
<td>=1 if the individual was first to receive the employment offer</td>
</tr>
<tr>
<td>Partner</td>
<td>=1 if the individual was not the primary hire</td>
</tr>
<tr>
<td>Admin</td>
<td>= 1 if the individual is an administrator, 0 otherwise</td>
</tr>
<tr>
<td>Female</td>
<td>= 1 if the individual is female, 0 otherwise</td>
</tr>
<tr>
<td>Pubs</td>
<td>Number of peer reviewed journal articles, book chapters, or books published</td>
</tr>
<tr>
<td>Prior</td>
<td>Number of years between highest degree and starting year at WSU</td>
</tr>
<tr>
<td>Rank</td>
<td>Indicators for Assistant, Associate, and Full Professor</td>
</tr>
<tr>
<td>Dept</td>
<td>Aggregated Field indicator variables</td>
</tr>
<tr>
<td>Year</td>
<td>Year of observation indicator variables</td>
</tr>
<tr>
<td>OHY</td>
<td>Original Hire Year indicator variables</td>
</tr>
</tbody>
</table>
Table 1.2 – Summary Statistics

<table>
<thead>
<tr>
<th></th>
<th>All Fields</th>
<th>STEM Fields</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Count</td>
<td>Percent</td>
</tr>
<tr>
<td>Number of Person/Year observations</td>
<td>2755</td>
<td></td>
</tr>
<tr>
<td>Number of Unique Individuals</td>
<td>682</td>
<td></td>
</tr>
<tr>
<td>Joint Hires</td>
<td>90</td>
<td>13%</td>
</tr>
<tr>
<td>Primary Hires</td>
<td>71</td>
<td>79%</td>
</tr>
<tr>
<td>Partner Hires</td>
<td>19</td>
<td>21%</td>
</tr>
<tr>
<td>Males</td>
<td>413</td>
<td>61%</td>
</tr>
<tr>
<td>Females</td>
<td>269</td>
<td>39%</td>
</tr>
<tr>
<td>Assistant Professors</td>
<td>461</td>
<td>68%</td>
</tr>
<tr>
<td>Associate Professors</td>
<td>127</td>
<td>19%</td>
</tr>
<tr>
<td>Full Professors</td>
<td>94</td>
<td>14%</td>
</tr>
<tr>
<td>Administrators hired</td>
<td>58</td>
<td>9%</td>
</tr>
<tr>
<td>Individuals with &lt;2 yrs prior experience</td>
<td>203</td>
<td>30%</td>
</tr>
<tr>
<td>Years of prior experience</td>
<td>6.65</td>
<td>7.19</td>
</tr>
<tr>
<td>Number of publications per year</td>
<td>2.58</td>
<td>3.41</td>
</tr>
</tbody>
</table>
### Table 1.3 – Mean Comparison of Publications by Joint Hire Status

<table>
<thead>
<tr>
<th></th>
<th>All Fields</th>
<th>STEM Fields</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Publications: Non Joint Hire</td>
<td>2.50</td>
<td>3.27</td>
</tr>
<tr>
<td>Mean Publications: Joint Hire</td>
<td>3.11</td>
<td>3.63</td>
</tr>
<tr>
<td>p-value for difference†</td>
<td>&lt;0.01</td>
<td>0.11</td>
</tr>
</tbody>
</table>

† A one-sided alternative was used.
Table 1.4 – Marginal Effects for Publications per Year, Poisson Model

<table>
<thead>
<tr>
<th>Parameter</th>
<th>All Fields</th>
<th>STEM Fields</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Model 1</td>
<td>Model 2</td>
</tr>
<tr>
<td>Joint Hire</td>
<td>0.562*</td>
<td>0.930*</td>
</tr>
<tr>
<td></td>
<td>(0.313)</td>
<td>(0.494)</td>
</tr>
<tr>
<td>Primary</td>
<td>0.885**</td>
<td>1.277**</td>
</tr>
<tr>
<td></td>
<td>(0.353)</td>
<td>(0.577)</td>
</tr>
<tr>
<td>Partner</td>
<td>-0.769*</td>
<td>-0.467</td>
</tr>
<tr>
<td></td>
<td>(0.405)</td>
<td>(0.661)</td>
</tr>
<tr>
<td>Admin</td>
<td>-1.458***</td>
<td>-1.492***</td>
</tr>
<tr>
<td></td>
<td>(0.290)</td>
<td>(0.283)</td>
</tr>
<tr>
<td>Female</td>
<td>-0.252</td>
<td>-0.247</td>
</tr>
<tr>
<td></td>
<td>(0.217)</td>
<td>(0.216)</td>
</tr>
<tr>
<td>Prior</td>
<td>0.006</td>
<td>0.009</td>
</tr>
<tr>
<td></td>
<td>(0.023)</td>
<td>(0.023)</td>
</tr>
<tr>
<td>Associate</td>
<td>0.670**</td>
<td>0.691**</td>
</tr>
<tr>
<td></td>
<td>(0.284)</td>
<td>(0.283)</td>
</tr>
<tr>
<td>Full Professor</td>
<td>0.884*</td>
<td>0.854*</td>
</tr>
<tr>
<td></td>
<td>(0.481)</td>
<td>(0.473)</td>
</tr>
<tr>
<td>Observations</td>
<td>2,755</td>
<td>2,755</td>
</tr>
<tr>
<td>Pseudo R²</td>
<td>0.0987</td>
<td>0.1027</td>
</tr>
</tbody>
</table>

Robust standard errors in parenthesis, clustered by individuals.

*** p<0.01, ** p<0.05, * p<0.1

Parameter estimates for Field of Study, Observation Year, and Year of Hire are not reported.
### Table 1.5 – Publications by Gender

<table>
<thead>
<tr>
<th></th>
<th>All Fields</th>
<th></th>
<th>STEM Fields</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Males</td>
<td>Females</td>
<td>Model 1</td>
<td>Model 2</td>
</tr>
<tr>
<td>JointHire</td>
<td>0.912**</td>
<td>-0.015</td>
<td>(0.444)</td>
<td>(0.396)</td>
</tr>
<tr>
<td>Primary</td>
<td>1.488***</td>
<td>-0.069</td>
<td>(0.473)</td>
<td>(0.463)</td>
</tr>
<tr>
<td>Partner</td>
<td>-1.667***</td>
<td>0.187</td>
<td>(0.359)</td>
<td>(0.577)</td>
</tr>
<tr>
<td>Admin</td>
<td>-1.403***</td>
<td>-1.468***</td>
<td>-2.055***</td>
<td>-2.053***</td>
</tr>
<tr>
<td>Prior</td>
<td>0.009</td>
<td>0.015</td>
<td>0.014</td>
<td>0.014</td>
</tr>
<tr>
<td>Associate</td>
<td>0.578</td>
<td>0.671*</td>
<td>0.584</td>
<td>0.589</td>
</tr>
<tr>
<td>Full Prof.</td>
<td>0.881</td>
<td>0.855</td>
<td>0.843</td>
<td>0.860</td>
</tr>
<tr>
<td>Obs.</td>
<td>1,651</td>
<td>1,651</td>
<td>1,104</td>
<td>1,104</td>
</tr>
<tr>
<td>Pseudo R²</td>
<td>0.1096</td>
<td>0.1216</td>
<td>0.1219</td>
<td>0.1221</td>
</tr>
</tbody>
</table>

Cluster Robust Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

†The delta method standard errors were unobtainable for males in STEM fields
**Table 1.6** – Summary Statistics for the Marital Status Data

<table>
<thead>
<tr>
<th>Group</th>
<th>Count</th>
<th>Percent of Total</th>
<th>of Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unique Individuals</td>
<td>21</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Married Individuals</td>
<td>65</td>
<td>83%</td>
<td>of Total</td>
</tr>
<tr>
<td>Joint Hires</td>
<td>3</td>
<td>13%</td>
<td>of Total</td>
</tr>
<tr>
<td>Primary Hires</td>
<td>4</td>
<td>79%</td>
<td>of Joint hires</td>
</tr>
<tr>
<td>Partner Hires</td>
<td>21%</td>
<td>of Joint hires</td>
<td></td>
</tr>
</tbody>
</table>
### Table 1.7 – Marginal Effects for Publications Using the Marital Data Subsample

<table>
<thead>
<tr>
<th>Variables</th>
<th>Model 1 Excluding Married Variable</th>
<th>Model 2 Excluding Married Variable</th>
<th>Model 1 Including Married Variable</th>
<th>Model 2 Including Married Variable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Joint Hire</td>
<td>0.378 (0.447)</td>
<td>0.268 (0.438)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary</td>
<td>0.651 (0.508)</td>
<td>0.543 (0.494)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Partner</td>
<td>-0.603 (0.693)</td>
<td>-0.715 (0.667)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>-0.333 (0.276)</td>
<td>-0.316 (0.275)</td>
<td>-0.293 (0.277)</td>
<td>-0.276 (0.275)</td>
</tr>
<tr>
<td>Married</td>
<td>0.722** (0.281)</td>
<td>0.734*** (0.280)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td>1,571</td>
<td>1,571</td>
<td>1,571</td>
<td>1,571</td>
</tr>
</tbody>
</table>

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

All other control variable coefficients are not reported.
Table 1.8 – Comparison of Expected Productivity, \( \Gamma(a = 2, b = 2) \), \( \alpha = 0.10 \), and \( K = 5 \)

Universities under an Independent Hiring Rule

<table>
<thead>
<tr>
<th>School</th>
<th>Minimum Thresholds</th>
<th>EV Single</th>
<th>EV Couple</th>
<th>Greater</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>0.97</td>
<td>2.64</td>
<td>172%</td>
</tr>
<tr>
<td>2</td>
<td>1.57</td>
<td>2.09</td>
<td>3.56</td>
<td>70%</td>
</tr>
<tr>
<td>3</td>
<td>2.62</td>
<td>3.22</td>
<td>4.57</td>
<td>42%</td>
</tr>
<tr>
<td>4</td>
<td>3.87</td>
<td>4.73</td>
<td>5.93</td>
<td>25%</td>
</tr>
<tr>
<td>5</td>
<td>5.77</td>
<td>8.28</td>
<td>8.28</td>
<td>0%</td>
</tr>
</tbody>
</table>
Table 1.9 – Comparison of Expected Productivities for Couples and Singles Using Independent and Average Evaluation Policies

<table>
<thead>
<tr>
<th>Distribution</th>
<th>School</th>
<th>Independent Evaluation</th>
<th>Average Evaluation</th>
<th>Shape of Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Minimum Thresholds</td>
<td>EV Single EV Couple</td>
<td>% greater</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EV Hire</td>
<td>Hire</td>
<td>% greater</td>
</tr>
<tr>
<td>Normal</td>
<td>1</td>
<td>-∞</td>
<td>8.557</td>
<td>9.352</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>9.103</td>
<td>9.411</td>
<td>9.930</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>9.685</td>
<td>9.940</td>
<td>10.338</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>10.191</td>
<td>10.473</td>
<td>10.771</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>10.782</td>
<td>11.353</td>
<td>11.353</td>
</tr>
<tr>
<td>Gamma</td>
<td>1</td>
<td>0</td>
<td>5.918</td>
<td>8.167</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>7.149</td>
<td>7.965</td>
<td>9.643</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>8.726</td>
<td>9.489</td>
<td>10.885</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>10.272</td>
<td>11.219</td>
<td>12.356</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>12.302</td>
<td>14.580</td>
<td>14.580</td>
</tr>
<tr>
<td>Gamma</td>
<td>1</td>
<td>0</td>
<td>0.970</td>
<td>2.640</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>1.570</td>
<td>2.090</td>
<td>3.560</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>2.620</td>
<td>3.220</td>
<td>4.570</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>3.870</td>
<td>4.730</td>
<td>5.930</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>5.770</td>
<td>8.280</td>
<td>8.280</td>
</tr>
<tr>
<td>Uniform</td>
<td>1</td>
<td>0</td>
<td>0.092</td>
<td>0.317</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>0.185</td>
<td>0.281</td>
<td>0.457</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>0.377</td>
<td>0.476</td>
<td>0.602</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>0.576</td>
<td>0.679</td>
<td>0.751</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>0.783</td>
<td>0.892</td>
<td>0.892</td>
</tr>
<tr>
<td><strong>Social Sciences</strong></td>
<td><strong>Math and Computer Sciences</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---------------------</td>
<td>-------------------------------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anthropology</td>
<td>Ati - Semi Conductors</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Center To Bridge The Digital Div</td>
<td>Department of Statistics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Community and Rural Sociology</td>
<td>Mathematics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Community Revitalization</td>
<td>Program In Statistics - Science</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comparative Ethnic Studies</td>
<td>Pure and Applied Mathematics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crit Culture/Gender/Race Studies</td>
<td>Science, Math and Engr Ed Center</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Economic Development Admin</td>
<td>WSU Vancouver School of Envs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Economics</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Educ Leadership and Couns Psy</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Human Development</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Philosophy</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Political Science</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Politics, Philosophy &amp; Pub Affrs</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Psychology</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rural Sociology</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>School of Economic Sciences</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>School of Elect Eng &amp; Comp Sci</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social &amp; Econ Sci Research Cntr</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sociology</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thomas S Foley Institute</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Women's Studies Department</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Women's Studies Program</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Health Sciences</strong></td>
<td><strong>Engineering</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Area Health Education Center</td>
<td>Biological Systems Engineering</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basic Medical Sci Prog (WWAMI)</td>
<td>Chemical Engineering</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biochemistry &amp; Biophysics</td>
<td>Chemical Engr &amp; Bioengr</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cancer Prevention Research Ctr</td>
<td>Civil and Environmental Engrng</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clinical Pharmacology</td>
<td>Composite Matls &amp; Eng Center</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>College of Nursing</td>
<td>Elec Engr &amp; Comp Scn, School of</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Health and Wellness Services</td>
<td>Engineering &amp; Arch, College of</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Health Policy &amp; Administration</td>
<td>School of Mech and Matls Eng</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Integrated Nutritional Sciences</td>
<td>Wood Materials &amp; Engineering Lab</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nursing Educ, Intercolg Ctr For</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nutrition &amp; Exercise Met/Pullman</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nutrition &amp; Exercise Met/Spokane</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pharmaceutical Sciences</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pharmacotherapy/Pullman</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pharmacotherapy/Spokane</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Biological and Physical Sciences</strong></td>
<td><strong>Biological and Physical Sciences</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chemistry</td>
<td>Chemistry</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>College of Sciences</td>
<td>College of Sciences</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electron Microscopy Center</td>
<td>Electro Microscopy Center</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Genetics and Cell Biology</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Geology</td>
<td>Genetics and Cell Biology</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Institute For Shock Physics</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Institute of Biological Chem</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Molecular Biosciences-Abelson</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Molecular Biosciences-Sci Hall</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nuclear Radiation Center</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physics</td>
<td>Nuclear Radiation Center</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physics and Astronomy</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Program In Biology</td>
<td>Physics and Astronomy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>School of Biological Sciences</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>School of Molecular Biosciences</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zoology</td>
<td>School of Molecular Biosciences</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Liberal Arts and Humanities</strong></td>
<td><strong>Liberal Arts and Humanities</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assessment Teaching &amp; Learning</td>
<td>Assessment Teaching &amp; Learning</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>College of Education</td>
<td>College of Education</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>College of Liberal Arts</td>
<td>College of Liberal Arts</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Pharmacy Practice
Pharmacy, College of
Program In Health Sci, WSU SPK
Speech and Hearing Sciences
WWAMI Medical Education Program
WWAMI Medical Sciences
WWAMI Spokane

**Agricultural, Environmental, Natural Resource, and Extension**
Ag Research Center Admin
Agr, Human & Nat Res Sci College
Agricultural & Resource Economic
Agricultural Economics
Agricultural Research Center
Agriculture & Home Econ, College
Agweathernet Program
Animal Sciences
Biological Systems Engineering
CAHE Academic Programs
CAHNRS Academic Programs
CAHNRS and WSU Extension
Center To Bridge The Digital Div
CEREO
Community and Rural Sociology
Community Revitalization
Composite Matls & Eng Center
Cooperative Extension
Cooperative Extension Agents
Crop and Soil Sciences
Ctr Environ Res, Ed & Outreach
Ctr For Prec & Auto Agric Sys
Ctr For Precision Agric Systems
Ctr For Sustaining Ag & Nat Res
Department of Horticulture
Entomology
Env Sci & Regional Planning Pgm
Ext Community Revitalization
Extension CES
Food & Environ Quality Lab
Food & Environmental Quality Lab
Food Science and Human Nutrition
Horticulture and Landscape Arch

Communication
Comparative American Cultures
Education, College of
English
Fine Arts
Foreign Languages & Cultures
Foreign Languages & Literatures
General Education
History
International Programs
IP Development Cooperation
IP/Int’L Students & Scholars
Murrow College of Communication
Music and Theatre Arts, School of
Program In Communication
School of Music
Teaching and Learning
Theatre and Dance
Theatre Program

**Veterinary Medicine**
Vet & Comp Anat, Pharmc, Physl
Vet Clin Sci
Vet Medicine, College of
Veterinary Medicine, College of
Veterinary Microbiology & Path
Veterinary Microbiology and Path
Wa Animal Disease Diag Lab
Wa Animal Disease Diagnostic Lab

**Other Fields**
Apparel, Merch, Design & Text
Apparel, Merch., and Int. Design
Architecture
Criminal Justice
Interior Design
Kinesiology and Leisure Studies
Libraries
Museum of Art
Plateau Ctr For Am Indian Stdy
Plateau Ctr For Am Indian Study
Sch of Design & Construction
School of Arch & Cst Mgmt
<table>
<thead>
<tr>
<th>Human Development</th>
<th>Administrative Fields</th>
</tr>
</thead>
<tbody>
<tr>
<td>Impact Center</td>
<td>Advancement &amp; External Affairs</td>
</tr>
<tr>
<td>International Marketing Prog For</td>
<td>Faculty Senate</td>
</tr>
<tr>
<td>Natural Resource Sciences</td>
<td>Graduate School</td>
</tr>
<tr>
<td>Paul G. Allen SG AH</td>
<td>Office of Undergraduate Education</td>
</tr>
<tr>
<td>Pesticide Information Center</td>
<td>Office of Equity and Diversity</td>
</tr>
<tr>
<td>Plant Pathology</td>
<td>Office of Research</td>
</tr>
<tr>
<td>Rural Sociology</td>
<td>Ombudsmen, University</td>
</tr>
<tr>
<td>Sch of Earth &amp; Environmental Sci</td>
<td>President, office of</td>
</tr>
<tr>
<td>Sch of The Environment-CAHNRS</td>
<td>Professional Development Pgm</td>
</tr>
<tr>
<td>School For Global Animal Health</td>
<td>Professional Development Program</td>
</tr>
<tr>
<td>School of Economic Sciences</td>
<td>Provost &amp; Executive Vice Pres</td>
</tr>
<tr>
<td>School of Food Science</td>
<td>Provost and Academic Vice Pres</td>
</tr>
<tr>
<td>School of The Environment</td>
<td>Provost, office of</td>
</tr>
<tr>
<td>Vet Clin Sci</td>
<td>University College</td>
</tr>
<tr>
<td>Viticulture and Enology</td>
<td>University Development</td>
</tr>
<tr>
<td>Wa St Pest Mgmt Res Serv Ctr</td>
<td>University Honors College</td>
</tr>
<tr>
<td>Water Research Center</td>
<td>University Relations</td>
</tr>
<tr>
<td>Western Center Rme</td>
<td>Vice Pres - Equity and Diversity</td>
</tr>
<tr>
<td>Wood Materials &amp; Engineering Lab</td>
<td>Vice President - Student Affairs</td>
</tr>
<tr>
<td>WSU - Tri-Cities</td>
<td>VP For Administration</td>
</tr>
<tr>
<td>WSU - Vancouver</td>
<td>VP Student Aff, Equ &amp; Div</td>
</tr>
<tr>
<td>WSU County Extension</td>
<td></td>
</tr>
<tr>
<td>WSU Creamery</td>
<td></td>
</tr>
<tr>
<td>WSU Extension</td>
<td></td>
</tr>
<tr>
<td>WSU Mount Vernon NW Rec</td>
<td></td>
</tr>
<tr>
<td>WSU Mt Vernon Res &amp; Ext Center</td>
<td></td>
</tr>
<tr>
<td>WSU Prosser IAREC</td>
<td></td>
</tr>
<tr>
<td>WSU Puyallup Res &amp; Ext Center</td>
<td></td>
</tr>
<tr>
<td>WSU Vancouver Res &amp; Ext Unit</td>
<td></td>
</tr>
<tr>
<td>WSU Wenatchee TFREC</td>
<td></td>
</tr>
<tr>
<td><strong>Table 1.11</strong> – List of STEM Departments at WSU by College</td>
<td></td>
</tr>
<tr>
<td>-----------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td><strong>College of Sciences</strong></td>
<td><strong>College of Agricultural, Human, and Natural Resource Sciences</strong></td>
</tr>
<tr>
<td>School of Biological Sciences</td>
<td>Animal Sciences</td>
</tr>
<tr>
<td>Chemistry</td>
<td>Institute of Biological Chemistry</td>
</tr>
<tr>
<td>School of Earth and Environmental Sciences</td>
<td>Biological Systems Engineering</td>
</tr>
<tr>
<td>Mathematics</td>
<td>Crop and Soil Sciences</td>
</tr>
<tr>
<td>Physics and Astronomy</td>
<td>School of Economic Sciences</td>
</tr>
<tr>
<td>Statistics</td>
<td>Entomology</td>
</tr>
<tr>
<td><strong>College of Engineering and Architecture</strong></td>
<td>School of Food Science</td>
</tr>
<tr>
<td>Chemical Engineering and Bioengineering</td>
<td>Horticulture and Landscape Architecture</td>
</tr>
<tr>
<td>Civil and Environmental Engineering</td>
<td>Natural Resource Sciences</td>
</tr>
<tr>
<td>Electrical Engineering and Computer Science</td>
<td>Plant Pathology</td>
</tr>
<tr>
<td>Engineering and Computer Science</td>
<td><strong>College of Veterinary Medicine</strong></td>
</tr>
<tr>
<td>Mechanical and Materials Engineering</td>
<td>School for Global Animal Health</td>
</tr>
<tr>
<td></td>
<td>School of Molecular Biosciences</td>
</tr>
<tr>
<td><strong>College of Liberal Arts</strong></td>
<td>Veterinary Microbiology and Pathology</td>
</tr>
<tr>
<td>Anthropology</td>
<td>Veterinary and Comp. Anatomy, and</td>
</tr>
<tr>
<td>Psychology</td>
<td>Pharmacology, and Physiology</td>
</tr>
<tr>
<td>Sociology</td>
<td></td>
</tr>
</tbody>
</table>
Figure 1.1 – Desired Solution for the Highest Ranked School

\[ g(\theta) = \frac{1}{K} \]

\[ = \frac{K-1}{K} \]
Figure 1.2 – Potential Couple Types
Figure 1.3 – Equilibrium Threshold Values Under an Average Hiring Policy
Figure 1.4 – A Comparison of the Expected Average Rank of Couples and the Expected Rank of Singles as a function of University Prestige.
Figure 1.5 – Equilibrium Threshold Values with \( \theta_i \sim \Gamma[a = 2, b = 2] \), \( \alpha = 0 \), and \( K = 5 \).
Figure 1.6 – Equilibrium Threshold Values with $\theta_i \sim \Gamma[a = 2, b = 2]$, $\alpha = 0.10$, and $K = 5$. 
Figure 1.7 – Change in Threshold Values for $\alpha \in [0,1]$, $\theta \sim \Gamma[a = 2, b = 2]$, and $K = 5$ Universities.
Figure 1.8 – Expected Productivity Given the Candidate is the Higher/Lower Quality Partner
Figure 1.9 – Regions of integration when calculating the expected average rank of a couple within the productivity distribution.
CHAPTER 2: WHAT’S THE PRICE OF BEING AN ACADEMIC PARTNER?

Abstract

I add to the literature on the cause of observed negative returns to seniority for academic faculty by constructing a direct test of the monopsony theory proposed by Ransom (1993). I identify a group of faculty, dual career academic couples for whom the university is aware of high mobility costs. I extend Ransom’s monopsony model and obtain predictions that academic couples will have longer durations of employment and slower salary growth relative to their colleagues. If universities exercise monopsony power over individuals with high mobility costs, then empirical tests that compare employment duration and salary growth of academic couples with their colleagues will detect it. I test these predictions using administrative data from Washington State University. I use a hazard model to measure employment duration and I find that academic couples are less likely to leave relative to a comparable colleague. I also compare salary growth. Consistent with previous studies, I find negative returns to seniority for academic faculty in general, and I find that academic couples are penalized more for each year of seniority relative to their colleagues.
1 Introduction

A decades-long debate is ongoing regarding the cause of the often observed negative returns to seniority for academic faculty. One theory proposed by Ransom (1993) is that mobility costs are prohibitively high due to the large distances between many universities. These mobility costs create a wedge between an individual’s current market wage and the wage he is willing to accept from his current institution. Ransom provides strong empirical evidence in support of his theory and later studies by Brown and Woodbury (1998); Barbezat and Donihue (1998); and Bratsberg, Ragan, and Warren (2003) provide additional supporting evidence to varying degrees. A second theory is that “raiding” of highly productive faculty is the cause. Highly productive faculty are recruited away from their current institution resulting in higher seniority for those with lower productivity. Thus the negative returns to seniority are driven by lower productivity rather than monopsony power. Evidence in favor of the raiding hypothesis has been found by Moore, Newman, and Turnbull (1998) and Monks and Robinson (2001).

More recently Bratsberg, Ragan, and Warren (2003), put the raiding hypothesis to test using a 30 year panel of economics faculty from five large mid-level research universities in the Midwest. They find strong evidence against the raiding hypothesis and with no other plausible alternatives, conclude that universities act as monopsonists.¹ Their findings are not direct proof of the monopsonist theory, only proof against the raiding hypothesis. To date, no research has been able to directly test the monopsonist theory because mobility costs have always been unobserved.

¹ Hilmer and Hilmer (2011) find that the labor market for top-level universities is different from other academic labor markets and therefore the results from this paper and previous studies should not be generalized to top-level universities.
Academic couples are an ideal group for testing this theory because universities have more information about the job prospects of academic couples compared to other dual career households. With academic couples, the university can directly observe one piece of what affects a faculty member’s mobility costs, namely the combined knowledge of who is part of an academic couple and the low probability of obtaining two offers for both partners at the same outside institution. If universities behave as monopsonists, then knowledge of higher mobility costs for academic couples should enable them to exercise greater monopsony power over academic couples relative to other faculty members.

I first extend the theoretical model presented by Ransom by allowing the university to have knowledge concerning the probable job prospects of an academic couple. For academic couples, the probability that they stay with their current institution is affected not only by unobserved (to the university) mobility costs, but also by both the observed probability of obtaining two outside offers from the same university, and by potential below market wages for a partner. By allowing the university to observe some information about the mobility costs of academic couples, the model predicts that the wage offers made to academic couples each year will be lower than the wages offered to their colleagues and that academic couples will have higher levels of institutional seniority.

I use panel data for new tenure-track hires at Washington State University from 1999 to 2012 that includes information regarding which faculty members are part of academic couples. I compare newly hired academic couples to their newly hired colleagues and include control variables for year of observation, year of hire, sex (female), prior career experience, academic rank, field of specialization, and quantity of publications per year. I compare employment, initial salaries, and the effect of seniority on salary in subsequent years of employment. I find that
academic couples have longer durations of employment and that universities penalize academic couples more for each additional year of seniority relative to their colleagues.

2 Theory

2.1 The probability of staying at one’s current institution

Following Ransom, I assume that every agent in the economy is employed and earning a wage from their current institution. Each year, the university makes a wage offer to individuals, \( w_i' \). Faculty members incur costs to move to another job denoted by \( m \), and as Ransom suggests, these costs may include monetary as well as psychic costs associated with leaving friends and family, etc. All non-pecuniary characteristics are assumed to be constant across universities. Each year, individuals receive wage offers from other universities. It is reasonable to assume that these wage offers are equal to each individual’s market wage rate. The probability that an individual accepts the offer from his current institution, \( p \), is a function of that wage offer, \( w_i' \) the discounted costs of moving, \( \delta m \), and the individual’s market wage rate, \( w_i^{\text{mkt}} \). Ransom suggests a plausible structure for \( p \) given by:

\[
p_i \left( w_i' + \delta m - w_i^{\text{mkt}} \right)
\]

(2.1)

In this model, \( p \) is continuous, non-negative and monotonically increasing. For an individual who is part of an academic couple, the structure for \( p \) is slightly different. If he wants to move, he faces some level of uncertainty about whether he will be able to secure a position for
his partner in the same outside university.¹ The following search behavior for academic couples seems plausible. Both members search but one member of the couple first receives an offer, equal to his market wage, \(w^\text{mkt}_i\). That individual must then try to negotiate a position for his partner.² He may or may not be successful. I denote the probability of finding a position for the partner by \(q\) and the probability of finding no position by \((1-q)\). For simplicity, I assume that if a position for the partner cannot be found, then the outside offer will be refused and the individual will stay where he is. Thus a plausible structure for \(p\) for an individual who is part of an academic couple is:

\[
p_i \left( w^o_i + \delta m - \left[ q \cdot w^\text{mkt}_i + (1-q) w^o_i \right] \right)
\]

(2.2)

In either case, \(p\) increases as the wage offer from the current institution increases or as mobility costs increase, and \(p\) decreases as the outside wage offer increases.

A ceteris paribus comparison of the arguments of \(p\) in Equation (2.3), reveals that \(q\) causes \(p\) for an individual who is part of an academic couple to be different relative to an identical colleague.

\[
w^o_i + \delta m - \left[ q \cdot w^\text{mkt}_i + (1-q) w^o_i \right] \leq w^o_i + \delta m - w^\text{mkt}_i
\]

\[\Rightarrow q \left( w^o_i - w^\text{mkt}_i \right) \leq w^o_i - w^\text{mkt}_i
\]

(2.3)

If \(q = 1\) then there is no difference in the probability of accepting the wage offer. However if \(q < 1\), then \(p_c\) with respect to the outside market wage is larger than \(p_s\), as shown in panel \(a\) of

---

¹ By the same assumption that universities are far enough apart to warrant moving costs, universities are also far enough apart to prevent each member of a couple to work at different institutions but still maintain the same residence.

² It is rare for a university to have two simultaneous openings that match the specialized fields of both partners.
Figure 2.1. This difference shifts $p$ with respect to the wage offer up for couples. Given that couples have a higher $p$ than singles, the university can offer lower wages to academic couples relative to singles and achieve the same probability that the individual will accept the wage offer shown in panel $b$ of Figure 2.1.

The difference in expected outside wages acts as an exogenous shift of the probability of staying as a function of the wage offer. As long as a university can identify who is part of a couple and who is not, it will be able to offer those academics lower wages each year relative to their colleagues. Additionally, Ransom showed that expected seniority increases with $p$ and since $q$ creates higher values of $p$ for academic couples, we should observe higher levels of seniority.

The exogenous shift of $p$ that is caused by $q$ is enough to provide the predictions that if universities behave as monopsonists, then the negative effect of seniority on academics in general should be larger for academic couples and academic couples should have longer durations of employment on average.

This however, is not the entire story for academic couples. The model to this point has assumed that the wage of each partner is completely independent, but at some point in the negotiation process for a new position, a member of an academic couple must reveal his academic couple status. This knowledge will allow the university to exert greater monopsony power by suppressing initial wages for couples and will strengthen the university’s ability to penalize in terms of lower subsequent wage offers.

Consider the search behavior previously described. An individual does not reveal his status as a member of an academic couple until after an initial market wage offer has been
made. Once the individual reveals that a position must be secured for his partner before he will accept the offer, the university must then find a suitable position (if one can be found) and then choose a wage to offer the partner. Figure 2.2 diagrams the payoffs associated with each decision.

With probability $q$, the couple chooses among the following three payoff options.

1) Accept offers received from a single outside university with payoff $(w_i^m + w_j^m - \delta m)$ where $w_j^m$ is a non-market wage paid to partner $j$ and $\delta m$ is the discounted mobility costs of moving to a new location.

2) Accept offers from separate universities with payoff $(w_i^m + w_j^m - d_{i,j} - \delta m)$, where $d_{i,j}$ represents the disutility from living apart.\(^2\)

3) Accept offers from their current institution with payoff $(w_i^o + w_j^o)$.\(^3\)

With probability $(1-q)$, the couple chooses among three alternative payoff options.

1) Accept a single offer and move together with payoff $(w_i^m + 0 - \delta m)$.

---

1 This assumption about couple’s search behavior seems most consistent with junior faculty who are first entering the market. “Power Couples” who have already demonstrated high productivity may already have sufficient bargaining power and will advertise themselves as a couple from the start.

2 The disutility from living apart includes all tangible costs of maintaining separate residences, as well as psychic costs associated with separation.

3 One other option exists if the couple cannot secure a position for the partner in the same institution. One partner may move and the other partner may stay at the current institution. Since moving costs are already incurred by the couple when sending one partner to another university, additional moving costs for the second candidate are likely negligible and the disutility from living apart would already exist. Therefore, I assume for simplicity that two market wage offers in different locations dominate one market wage offer in a different location and one offer from the current university.
2) Accept offers from separate universities with payoff $\left( w_i^{mkt} + w_j^{mkt} - d_{i,j} - \delta m \right)$.

3) Accept offers from their current institution with payoff $\left( w_i^o + w_j^o \right)$.

In addition to the effect that $q$ has on $p$ for academic couples, the potential below market wage that may be offered to the partner also affects $p$. The structure for $p$ for an academic couple may now be written as:

$$p\left(\left( w_i^o + w_j^o \right) + \delta m - EPM \right) \tag{2.4}$$

where $EPM$ is the expected payoff from moving and is defined as:

$$EPM = q \max\left\{ \left( w_i^{mkt} + w_j^{mkt} \right), \left( w_i^{mkt} + w_j^{mkt} - d_{i,j} \right) \right\} \left( 1-q \right) \max\left\{ \left( w_i^{mkt} + 0 \right), \left( w_i^{mkt} + w_j^{mkt} - d_{i,j} \right) \right\} \tag{2.5}$$

When making a pair of wage offers to both members of an academic couple, the university is uncertain about the couple’s mobility costs other than its knowledge of who is part of an academic couple, which increases $p$. The university is also uncertain about the value the couple places on staying together captured by $d_{i,j}$, which affects the couple’s willingness to accept a lower wage offer for the partner and will be demonstrated later. Should a couple leave the university, then the university must pay to replace them. Thus, the university’s objective function is to choose a pair of wages to offer a couple that will minimize the expected cost of those wage offers given by Equation (2.6).

$$\min_{\left( w_i^o + w_j^o \right)} EC\left( w_i^o + w_j^o \right) = \min_{\left( w_i^o + w_j^o \right)} p \cdot \left( w_i^o + w_j^o \right) + (1-p) \cdot R \tag{2.6}$$

where $R$ is the expected replacement cost. Now, in addition to the effect of $q$ on a couple’s decision to accept the university’s wage offer, a second factor affects the optimal wages offered to couples. It is possible for the university to replace a couple with another couple, and as a
result, it may avoid paying full market wage to the partner candidate. Alternatively, it may replace the two that leave with two non-couple candidates, in which case it needs to pay a full market wage to each. Let $\alpha$ represent the proportion of couples in the candidate pool. Then the expected cost of replacement for the university is:

$$R = \alpha \left[ q \cdot (w_{i,mkt} + w_{i,m}) + (1-q) \cdot (w_{i,mkt} + w_{i,m}) \right] + \left( 1-\alpha \right) \cdot (w_{i,mkt} + w_{i,mkt}).$$

With probability $q$, the partner in the potential couple will be a match for the open position and the university can make wage offers $(w_{i,mkt} + w_{i,m})$. With probability $(1-q)$ the partner will not match and the university will need to make two market wage offers. If $w_{i,m} < w_{i,mkt}$, then the replacement costs for the university are reduced. Therefore, $R$ reduces to either part of Equation (2.8) depending on the value of $w_{i,m}$.

$$R = \begin{cases} 
\left( w_{i,mkt} + w_{i,mkt} \right) - \alpha q \left( w_{i,mkt} - w_{i,m} \right) & \text{if } w_{i,m} < w_{i,mkt} \\
\left( w_{i,mkt} + w_{i,mkt} \right) & \text{if } w_{i,m} = w_{i,mkt} 
\end{cases}$$

If $w_{i,m} = w_{i,mkt}$, then the pair of wage offers that minimizes the expected employment cost, $(w_{i,o} + w_{j,o})^*$, is implicitly defined by the first order condition in Equation (2.9)

$$\left( (w_{i,o} + w_{j,o})^* - (w_{i,mkt} + w_{j,mkt}) \right) p^* + p = 0.$$

Since $p$ and $p^*$ are both positive, $(w_{i,o} + w_{j,o})^*$ must be less than $(w_{i,mkt} + w_{j,mkt})$ and Equation (2.9) appears to be a simple two candidate version of Ransom’s single agent model other than the effect of $q$ shifting $p$ for couples. Thus if the university is unable to pay lower wages to at least
one member of the academic couple, then the outcome for academic couples will only be
different to the degree that \( q \) affects \( p \).

If couples are willing to accept lower wages in order to find employment in the same
institution so that \( w_j^{nm} < w_j^{mkt} \), then \( \alpha q \left( w_j^{mkt} - w_j^{nm} \right) \) is positive and \( R \) is less than the case where
\( w_j^{nm} = w_j^{mkt} \). Then the pair of wage offers that minimizes the expected employment cost is
implicitly defined by the first order condition in Equation (2.10):

\[
\left( (w_i^o + w_j^o)^* - (w_i^{mkt} + w_j^{mkt}) + \alpha q \left( w_j^{mkt} - w_j^{nm} \right) \right) p' + p = 0. \quad (2.10)
\]

Under Equation (2.10), the cost minimizing pair of wage offers, \( (w_i^o + w_j^o)^* \), must be less
than the market wage by larger amount equal to \( \alpha q \left( w_j^{mkt} - w_j^{nm} \right) \) compared to what is required in
when the partner candidate (candidate \( j \)) is paid full market wage in order for the equality to still
hold true. The term \( \alpha q \left( w_j^{mkt} - w_j^{nm} \right) \) is the discounted difference between the market wage of
candidate \( j \) and the wage that candidate \( j \) is willing to accept in order to work in the same
university as candidate \( i \). The size of this wage difference depends on the alternative payoffs
available to a couple which I will discuss in the next section. The discount factor, \( \alpha q \), is the
product of the proportion of couples in the candidate pool and the probability that a match for
both partners exists within the same university. Thus if, \( w_j^{nm} < w_j^{mkt} \), then subsequent wages
offered to members of academic couples will be suppressed even further relative to other
academics in addition to the effects of \( q \).

The sufficient condition for cost minimization is:
\[
2p^+\left(\left(w_i^p + w_j^p\right)^* - \left(w_i^mkt + w_j^mkt\right) + \alpha q\left(w_j^mkt - w_j^nm\right)\right)p^i = 0
\]  
(2.11)

The comparative static result that shows how the wage offers change with \( m \) is found by taking the total differential of (2.10) using the structure of \( p \) given in (2.12).

\[
\frac{d\left(w_i^p + w_j^p\right)^*}{dm} = -\delta \left[ \frac{p^i\left(\left(w_i^p + w_j^p\right)^* - \left(w_i^mkt + w_j^mkt\right) + \alpha q\left(w_j^mkt - w_j^nm\right)\right) + p^i\left(\right)}{p^i\left(\left(w_i^p + w_j^p\right)^* - \left(w_i^mkt + w_j^mkt\right) + \alpha q\left(w_j^mkt - w_j^nm\right)\right) + 2p^i\left(\right)} \right] < 0
\]  
(2.12)

As is true for the single candidate case, those couples who find it more costly to move are offered lower wages each year relative to the market wage.

### 2.2 Are academic couples willing to accept a below-market wage?

The preceding results beg the question, how much are couples willing to give up in wages in order to remain together? The answer is a function of the available payoffs of the alternative options. An academic couple’s expected payoff from moving (EPM) is given in Equation (2.5).

Assuming that a position exists for the spouse, \( q = 1 \), a couple’s viable alternative is to choose the greater of: 1) accepting wage offers from separate institutions and incurring moving costs plus the disutility from living apart, or 2) staying where they are. Therefore, the condition under which a couple will accept the pair of wages \( \left(w_i^mkt + w_j^nm\right) \), is:

\[
\left(w_i^mkt + w_j^nm\right) - \delta m \geq \max \left\{ \left(w_i^p + w_j^p\right), \left(w_i^mkt + w_j^mkt - d_{i,j} - \delta m\right) \right\}.
\]  
(2.13)
This effect of this condition on the magnitude of \((w_j^{mkt} - w_j^{mm})\) depends on which alternative payoff is higher for a couple. I first compare the two payoffs from the right hand side of (2.13). A couple’s best alternative is to stay where they are when the increase in wages from living apart is less than or equal to the disutility from living apart plus the discounted moving costs expressed as

\[
(w_i^{mkt} + w_j^{mkt}) - (w_i^{o} + w_j^{o}) \leq d_{i,j} + \delta m. \tag{2.14}
\]

If the larger payoff for a couple is to accept wage offers in different locations, then a comparison of the payoff associated with the joint wage offer and the payoff associated with two market wage offers in separate locations reveals that the wage penalty for the partner that the couple is willing to accept can be as large as the disutility they would incur from living apart.

\[
(w_j^{mkt} + w_j^{mm} - \delta m) \geq (w_i^{mkt} + w_j^{mkt} - \delta m - d_{i,j})
\]

\[
\Rightarrow (w_j^{mkt} - w_j^{mm}) \leq d_{i,j}. \tag{2.16}
\]

Instead, the larger payoff for a couple might be to remain where they are. Then a comparison of the two alternative payoffs reveals that as long as the increase in wage for the primary candidate is at least large enough to cover the moving costs of the couple (which is the necessary condition to recruit the candidate in the first place), the outside university can offer a wage to the partner that is at least as low as, or lower than his wage offer from the current institution.

\[
(w_j^{mkt} + w_j^{mm} - \delta m) > (w_i^{o} + w_j^{o}) \tag{2.17}
\]
In either case, $w_{jm}^{mkt} < w_{jm}^{mkt}$. Thus, moving costs and a couple’s disutility from living apart result in lower initial wage offers for a partner relative to what his market wage would be if he were a single candidate. The potential for receiving a lower initial wage offer from an outside university also negatively affects subsequent wage offers made to the couple at their current university as previously shown in (2.10).

A simple addition to Ransom’s model that incorporates the inferior job prospects faced by members of academic couples sets up an empirical test for whether universities actually engage in monopsony behavior. In addition, couples’ willingness to accept a lower initial wage offer adds an additional empirical test and serves to increase the difference between the subsequent wage offers of academics who are part of an academic couple and those who are not.

3 Data

Washington State University began keeping detailed records on new hires who were recruited through its partner accommodation program in 1999. This program allows the university administration to provide temporary bridge funding to the department who is willing to hire the partner of a desired job candidate, provided he is qualified. Records kept on
individuals who took advantage of this funding allow me to identify individuals hired as part of an academic couple.¹

My data consists of a panel of individual observations for those newly hired between 1999 and 2012 into tenure stream positions. I am able to observe the first year that an individual appears in the data as well as whether or not the individual is observed in subsequent years. The last year in which an individual is observed in the data is marked as the year of departure. I have additional information on annual salary, sex, academic rank, administrative status, the number of publications per year, whether an individual obtained a grant in a given year, years of prior experience, and department affiliation. Table 2.1 provides a list of variables and their descriptions. Table 2.2 provides information about different departments at WSU have been aggregated into broader fields of research.

Most of the variables contain information for all years in the data set. However, information about publications per year and grant receipt each year is only available for the College of Agriculture, Human and Natural Resource Sciences (CAHNRS) in 2005 and 2006. Beginning in 2007, publication information is also available for faculty at the WSU-Vancouver campus. In 2008, publication information is available for all faculty excluding those in the business school. The decision to include or not include productivity information will affect my analysis because of missing observations in earlier years. Those for whom I have productivity information are those who were hired from 1999 – 2012 who were still in the data in 2005, 2007, or 2008 depending on the college. If I use only observations for which I have productivity

¹ It is possible that some couples were able to find two positions without utilizing administrative funds to do so. These individuals are not identified as couples in my data.
information and if academic couples are less likely to leave, then they will be over-represented and estimates for Couple hire employment duration will be biased upwards.

I report summary statistics for all observations as well as only those for which I have productivity data in Table 2.3. As expected, a larger proportion of couple hires left WSU when all observations are included. Using all data, 25 percent of couple hires left WSU compared to 40 percent of non-couple hires. When I use only observations for which I have publication information, 19 percent of couple hires left WSU compared to 58 percent of non-couple hires. It might be easy to conclude based on a comparison of means, that there are no substantial differences in salary or employment duration between couple hires and their colleagues. However, after controlling for other confounding factors, careful analysis reveals that couple hires have longer durations of employment and that the negative effect of seniority on wages is larger for individuals who are part of academic couples than for those who are not.

4 Methods

The implications of the theory presented in Section 1 are that academic couples should have longer durations of employment relative to their colleagues and that their wages should be lower for additional years of seniority. I employ two different empirical techniques to investigate these implications.

First, I analyze differences in the length of employment using a duration model. I use a non-parametric Cox proportional hazards model which is specified in Equation (4.1). The non-parametric Cox model is a common choice for modeling durations of events because of its robustness; it makes no assumptions about the underlying distribution. The trade-off is that there
can be a loss of efficiency compared to a parametric model if the assumed distribution closely approximates the actual data generating process. To account for the likely correlation of employment duration between members of academic couples, I cluster the standard errors by couples. This clustering strategy is a robust technique that does not make assumptions about the nature of the correlation process; it is sufficient to know that subjects might be correlated (Cleves et al. 2010, 198–199). The data is also right censored, meaning I do not observe departure for many individuals because the data collection period ends before those individuals actually leave. I account for this while structuring the data prior to estimation.

\[ h_j(t) = h_0(t) \exp \left( x_j \beta \right) \]  

(4.1)

In Equation (4.1), the term \( h_j(t) \) is the probability that individual \( j \) will leave the university after \( t \) years of employment. It is interpreted as the hazard rate of individual \( j \). The term \( h_0(t) \) is the baseline hazard or the probability of leaving after \( t \) years of employment when all covariates are zero. The vector \( x_j \) contains all of the covariates that can modify the baseline hazard rate for individual \( j \), including the indicator variables, \( \text{CoupleHire}, \text{Female}, \text{Admin} \), and a continuous variable, \( \text{Prior} \). I also include three additional sets of indicator variables representing academic rank, year of hire, and field of specialization in the vector \( x_j \). The academic rank indicator variables include levels for assistant, associate, and full professor. I use assistant professor as the reference category. I model the year of hire variable as a set of indicator variables rather than a continuous variable because I do not know \textit{a priori} whether cohorts hired in a particular year are more or less likely to stay longer than those hired in any other year. Also by including year of hire as a set of indicator variables, I control for any heterogeneity that may be present among the different cohorts. Field of specialization includes the categories listed in
Table 2.3. I use Engineering as the reference category. \( \beta \) is the vector of coefficients to be estimated for each covariate. Time is measured as years of employment at WSU so that in the first year of employment \( t = 1 \) for each individual irrespective of the calendar year in which the individual was hired.

The estimated coefficients cannot be directly interpreted. Their sign and statistical significance can be ascertained, but the coefficient must be exponentiated in order to understand the relative effect. Exponentiating an estimated coefficient yields the marginal relative effect of a one unit increase in that covariate and is the ratio of the modified hazard rate relative to the baseline hazard rate. Equation (4.1) can be rewritten to illustrate this interpretation and is shown in Equation (4.2). Thus, for a 1 unit change in a covariate \( x \), \( \exp (\beta x) \) is the proportional relationship between the hazard rate modified by \( x \) and the baseline hazard rate.

\[
\frac{h_j(t)}{h_0(t)} = \exp (x_j \beta).
\]

(4.2)

To analyze differences in initial salaries and in salary growth, I estimate two wage equations. First, I analyze a subset of the data which includes only the first year of an individual’s employment to test for differences in initial salary between couple hires and their colleagues. I use ordinary least squares to estimate the semi-elasticity models in Equations (4.3) and (4.4). The theory in Section 1 suggests strong correlation between the salaries of individuals hired as part of a couple. I account for this correlation by clustering the standard errors of those who form a couple. Each cluster contains one observation if the candidate is either not part of a Couple hire or if his partner was hired into a non-tenure track position and therefore not in the
data set, or two observations if both members of the couple were hired into tenure-track positions.

\[
\ln(sal)_{ic} = \alpha_0 + \alpha_1 CoupleHire_{ic} + \mathbf{x}_{ic} \cdot \alpha_x
\]  

(4.3)

\[
\ln(sal)_{ic} = \beta_0 + \beta_1 primary_{ic} + \beta_2 partner_{ic} + \mathbf{x}_{ic} \cdot \beta_x
\]  

(4.4)

The subscript \(i\) denotes the individual and the subscript \(c\) denotes the couple. The vector \(\mathbf{x}_{ic}\) in Equations (4.3) and (4.4) contains variables for sex, academic rank, years of prior experience, a set of indicator variables representing fields of study, and a set of indicators for year of hire. It also includes a variable for the mean of each individual’s future publications per year at WSU as a proxy for expected productivity.

Second, I use all available observations of new hires from 1999 - 2012 and estimate both a pooled OLS model using a two-way clustering scheme presented by in Cameron, Gelbach, and Miller (2006), and a fixed effects model with robust standard errors. In the two-way clustering model, I cluster the standard errors of an individual over time to allow for serial correlation, and also by couples to allow for correlation between the salaries of those hired as part of a couple. I maintain the assumption that the errors are independent outside of these clusters. In the fixed effects model, I cluster the standard errors by couples. A comparison of the magnitudes of the coefficients of estimates present in both models will provide information about how much individual heterogeneity or omitted variables bias is influencing the results.

I follow the previous literature and include variables for Seniority, which represents the number of years since a faculty member was hired, Experience, which represents total years since a faculty member received his highest degree, and the square of both Seniority and
Experience. I also include interaction terms between Seniority and CoupleHire and Seniority^2 and CoupleHire which will provide the test of the monopsony theory. The equation estimated is:

$$\ln(sal)_{itc} = \alpha_0 + \alpha_1 CH_{itc} + \alpha_2 Sen + \alpha_2 Sen^2 + \alpha_4 Sen \times CH + \alpha_5 Sen^2 \times CH + w_{itc} \alpha_w$$ (4.5)

where CH stands for couple hire and Sen is an abbreviation for Seniority. The subscript \( t \) represents calendar year and the subscripts \( i \) and \( c \) are as previously described. The vector \( w_{itc} \) contains variables for sex (female), administrative status, academic rank, experience, experience^2, a set of indicators for fields of study, a set of indicators for year of observation to control for secular influences related to a given year, and a set of indicators for year of hire to account for heterogeneity across cohorts. The theory in Section 1 predicts that universities can suppress wage growth for academic couples relative to their colleagues. If the coefficients, \( \alpha_4 \) or \( \alpha_5 \) are negative and significant or at least jointly significant, then there is evidence in favor of the monopsony theory.

I also estimate these equations a second time and include some variables representing productivity. Woolstenhulme et al. (2012) develop a model of the academic labor market which allows for couple hiring. The model predicts that on average, couple hires are more productive than their colleagues and they find empirical evidence supporting this prediction. It is reasonable to assume that productivity will affect an academic’s salary; therefore, excluding productivity creates an omitted variable bias. In the absence of productivity measures, the estimated effect of seniority on salary for couples would be biased toward zero; I expect a negative effect for seniority, but higher productivity for couples may have a countervailing effect.

However, I have productivity measures only for later years of observation, so including only observations with productivity information creates a bias towards those who are more likely
to remain at WSU. It is possible that those who are more productive could have left the university quickly because of better offers in which case only those with lower productivity and potentially lower salaries remain in the data. Or, those with high productivity remained while those with low productivity left because they did not believe they would be granted tenure. I estimate both specifications to compare the outcomes in the presence of the two potential biases. If the estimates are very similar then the biases are likely not affecting the results much.

5 Results

I present the results of the employment duration analysis in Table 2.4. The first column contains the estimates for the coefficients and the second column contains the hazard ratio which is the exponentiated value of each coefficient. As predicted by the theory in Section 1, the coefficient on the CoupleHire variable shown in the first column of results in Table 2.4 is negative and statistically significant at the 5 percent level, meaning couple hires are less likely to leave relative to their colleagues. The hazard ratio reported in the second column of results in Table 2.4 provides the magnitude of the difference. The probability that a couple hire leaves in a particular year is just 61 percent of the probability that a non-couple hire will leave WSU on average. Figure 2.2 is a graphical illustration of the estimated differences in the probability of leaving for couple hires and non-couple hires as a function of years of employment.

A comparison of initial salaries presented in Table 2.5 also provides evidence in support of the predictions of the model. When accommodated couple hires are identified by whether each was the primary or the partner candidate, I find that salaries for partner hires are about 5 percent less than salaries of non-couple hires, but the result is not significant at traditional levels.
The lack of significance is likely due to the small number of partner hires in the tenure track data set.

Many partner hires were offered non-tenure track positions and their salary information is not available in the data. Support staff and Non-tenure track faculty are lower paid positions relative to tenure track positions. I conducted a web search to identify the job titles of the partners hired into non-tenure track positions. Out of 58 partner hires in non-tenure track positions, 50 (86 percent) had titles for a non-tenure track faculty position or an administrative support staff position and just 8 had titles in an administrative leadership position. A partner hire’s willingness to accept a lower initial salary is largely reflected by the large proportion of non-tenure track faculty positions accepted by partner hires. Table 2.6 summarizes the titles for these three types of positions.

I also find that salaries for primary hires are about 5 percent more than the salaries of their colleagues and the result is significant at the 10 percent level. The theory in Section 1 does not explain this finding. As previously mentioned, Woolstenhulme, et al. (2012) develop a theory which predicts that academic couple hires will be more productive relative to their peers and provide empirical evidence in support of this theory. If the primary hire in the couple is generally the more productive of the two, then higher productivity expectations for the primary hire are likely the cause of higher initial salaries. I have attempted to control for this possibility by using the average number of future annual publications as a proxy for expected productivity. Its effect is significant but small. However, the variable is not a perfect proxy; it does not capture the quality of publications. I believe the higher pay for primary hires is a reflection of higher expected productivity and that my proxy variable has failed to account fully for this effect.
Table 2.7 contains the results from the estimations for whether seniority has a differential affect on salary for couple hires. When the model is estimated with the two-way clustering scheme, I find that couple hires are penalized between two and three percent per year for each year of seniority depending on whether I include the productivity observations and is evidence in support of the monopsony theory. The effect of seniority by itself is also negative but not statistically significant. When I estimate the fixed effects model, the results change substantially. The coefficients on the interaction terms are nearly zero and not significant at conventional levels and the linear effect for seniority is positive and significant when the productivity variables are included.

While the fixed effects estimator is generally considered to be superior to the other estimators, it may not be true in this case. If the unobserved time constant individual effects are strong proxies for whether or not an individual is part of an academic couple, then the fixed effects method throws the baby out with the bathwater; it controls away the effect I am trying to estimate. On the other hand, the differences among the estimated coefficients between the two models may also suggest that there is a large omitted variables bias likely related to measures of productivity that I am currently unable to capture in my model.

Additionally, my data contains information only on new hires between 1999 and 2012. Many couple hires were recruited in later years during which time salary increases were frozen university-wide as a result of the financial crisis of 2007-2008. Since all salary increases were suspended over a period of time when couple hiring was increasing, the differential effects of seniority on salary for couple hires may be biased toward zero.

It may also be true that the university is careful to not pay lower salaries to couples or disproportionately penalize them for additional years of seniority because of laws prohibiting
discrimination due to marital status. This is tricky. Most academic couples are married; but in the negotiation process for their positions, they must reveal their marital status which could put the university in an awkward situation. On the one hand, the university knows that it can offer lower wages, on the other hand it may consciously choose to not do so in order to stay on the safe side of the law though offering lower wages to couple hires is not direct evidence of discrimination. In many cases, temporary positions are created and limited funds may prevent the university from paying a full market wage so that the lower wage is the best they can do. Further research with larger amounts of data from multiple institutions including more comprehensive productivity data will be necessary to properly test the monopsony theory in the manner presented in this paper.

6 Conclusions

I have constructed a test for the monopsony theory of why we observe negative returns to seniority for many academic faculty members. Academic couples have higher mobility costs relative to their colleagues in the form of observably inferior job prospects. Lower job prospects result in longer durations of employment and therefore, if the monopsony theory is true, then we should observe that academic couples are penalized more for each additional year of seniority. I find empirical evidence that academic couples have longer durations of employment. When I test for differential returns to seniority using an interaction term, I find inconclusive results. The two-way cluster robust model suggests a penalty of between two and three percent for each additional year of seniority but when I estimate a fixed effects model the difference falls to nearly zero. This evidence is derived from faculty employed by a single institution. A similar empirical
examination using a larger set of data from multiple universities is needed in order to adequately use this approach for testing the monopsony theory.

Aside from testing the validity of the monopsony theory, this paper has produced results which are useful for university administrators and job seekers who are part of academic couples. I have found clear evidence that couple hires remain at their current institution for longer periods of time relative to their colleagues. Job searches are costly to universities therefore academic couples represent an opportunity for universities to reduce turnover costs.

References


Appendix

A.1 Derivation of the comparative static result for how the wage offer to a single candidate changes with moving costs.

The equation fully displayed is:

\[ p'(w_i^o - \delta m + w_i^m)w_i^o - p'(w_i^o - \delta m + w_i^m)w_i^m + p(w_i^o - \delta m + w_i^m) = 0 \]  \hspace{1cm} (A.1)

Take the total derivative with respect to the wage offer and the moving costs.

\[ dw_i^o \frac{p''(\cdot)w_i^o}{w_i^m} + dw_i^o p'(\cdot) + dm\delta p''(\cdot)w_i^o - dw_i^o p''(\cdot)w_i^m
\]

\[ -dm\delta p''(\cdot)w_i^m + dw_i^o p'(\cdot) + dm\delta p'(\cdot) = 0 \]  \hspace{1cm} (A.2)

Collect like terms

\[ dw_i^o \left[ p''(\cdot)(w_i^o - w_i^m) + 2p'(\cdot) \right] + dm\delta \left[ p''(\cdot)(w_i^o - w_i^m) + p'(\cdot) \right] = 0 \]  \hspace{1cm} (A.3)

Isolate the expression for \( dw_i^o / dm \).

\[ \frac{dw_i^o}{dm} = -\delta \left[ \frac{p''(\cdot)(w_i^o - w_i^m) + p'(\cdot)}{p''(\cdot)(w_i^o - w_i^m) + 2p'(\cdot)} \right] \]  \hspace{1cm} (A.4)

A.2 Derivation of the comparative static result for how the wage offer to a couple candidate changes with moving costs.

The function \( p(\cdot) \) is expressed as:

\[ p\left((w_i^o + w_j^o) + \delta m - q(w_i^m + w_j^m) - (1-q)\max\left\{(w_i^m + w_j^m - d_{i,j}), (w_i^m + 0)\right\}\right) \]  \hspace{1cm} (A.5)

Equation (2.10) is:

\[ (w_i^o + w_j^o) p'(\cdot) - (w_i^m + w_j^m) p'(\cdot) + \alpha q(w_i^m - w_j^m) p'(\cdot) + p(\cdot) = 0 \]  \hspace{1cm} (A.6)
Take the total derivative of Equation (2.10) with respect to the pair of wage offers and the moving costs.

\[
d\left(w_i^o + w_j^o\right)^* p^\prime(\cdot)\left(w_i^o + w_j^o\right)^* + d\left(w_i^o + w_j^o\right)^* + dm\delta p^\prime(\cdot)\left(w_i^o + w_j^o\right)^*
\]

\[
-d\left(w_i^o + w_j^o\right)^* p^\prime(\cdot)\left(w_i^{\text{mkt}} + w_j^{\text{mkt}}\right) - dm\delta p^\prime(\cdot)\left(w_i^{\text{mkt}} + w_j^{\text{mkt}}\right)
\]

\[
+d\left(w_i^o + w_j^o\right)^* p^\prime(\cdot)\alpha q\left(w_j^{\text{mkt}} - w_j^{\text{nm}}\right) + dm\delta p^\prime(\cdot)\alpha q\left(w_j^{\text{mkt}} - w_j^{\text{nm}}\right)
\]

\[
+d\left(w_i^o + w_j^o\right)^* p^\prime(\cdot) + dm\delta p^\prime(\cdot) = 0
\]

(A.7)

Collect like terms.

\[
d\left(w_i^o + w_j^o\right)^* \left(p^\prime(\cdot)\left(\left(w_i^o + w_j^o\right)^* - \left(w_i^{\text{mkt}} + w_j^{\text{mkt}}\right) + \alpha q\left(w_j^{\text{mkt}} - w_j^{\text{nm}}\right)\right) + 2p^\prime(\cdot)\right)
\]

\[
+ dm\delta \left(p^\prime(\cdot)\left(\left(w_i^o + w_j^o\right)^* - \left(w_i^{\text{mkt}} + w_j^{\text{mkt}}\right) + \alpha q\left(w_j^{\text{mkt}} - w_j^{\text{nm}}\right)\right) + p^\prime(\cdot)\right) = 0
\]

(A.8)

Isolate the expression for \(d\left(w_i^o + w_j^o\right)^*/dm\).

\[
\frac{d\left(w_i^o + w_j^o\right)^*}{dm} = -\delta \left(p^\prime(\cdot)\left(\left(w_i^o + w_j^o\right)^* - \left(w_i^{\text{mkt}} + w_j^{\text{mkt}}\right) + \alpha q\left(w_j^{\text{mkt}} - w_j^{\text{nm}}\right)\right) + p^\prime(\cdot)\right) < 0
\]

(A.9)

A.3 Derivation of the comparative static result for how the wage offer changes with changes in the gap between the market wage and the non-market wage of the partner

The function \(p(\cdot)\) is expressed as:

\[
p^\prime\left(w_i^o + w_j^o\right) + \delta m - q\left(w_i^{\text{mkt}} + w_j^{\text{nm}}\right) - \left(1 - q\right) \max\left\{\left(w_i^{\text{mkt}} + w_j^{\text{nm}} - d_{ij}\right),\left(w_i^{\text{mkt}} + 0\right)\right\}
\]

(A.10)

Equation (2.10) is:

\[
\left(w_i^o + w_j^o\right)^* p^\prime(\cdot) - \left(w_i^{\text{mkt}} + w_j^{\text{mkt}}\right) p^\prime(\cdot) + \alpha q\left(w_j^{\text{mkt}} - w_j^{\text{nm}}\right) p^\prime(\cdot) + p(\cdot) = 0
\]

(A.11)
Take the total derivative of Equation (2.10) with respect to the pair of wage offers and the difference between the market wage and the non-market wage.

\[
\left[ d \left( w_i^o + w_j^o \right)^* p' (\cdot) + \left( w_i^o + w_j^o \right)^* p'' (\cdot) d \left( w_i^o + w_j^o \right)^* \right] \\
+ aq \left( w_i^o + w_j^o \right)^* p'' (\cdot) d \left( w_{j_{\text{mk}}} - w_{j_{\text{nm}}} \right) \\
- d \left( w_i^o + w_j^o \right)^* p'' (\cdot) \left( w_{j_{\text{mk}}} + w_{j_{\text{mk}}} \right) \\
- d \left( w_{j_{\text{mk}}} - w_{j_{\text{nm}}} \right) aq p'' (\cdot) \left( w_{j_{\text{mk}}} + w_{j_{\text{mk}}} \right) \\
+ d \left( w_i^o + w_j^o \right)^* p'' (\cdot) \alpha q \left( w_{j_{\text{mk}}} - w_{j_{\text{nm}}} \right) \\
+ \left[ aqd \left( w_{j_{\text{mk}}} - w_{j_{\text{nm}}} \right) p' (\cdot) + \left( \alpha q \right)^2 \left( w_{j_{\text{mk}}} - w_{j_{\text{nm}}} \right) d \left( w_{j_{\text{mk}}} - w_{j_{\text{nm}}} \right) p'' (\cdot) \right] \\
+ d \left( w_i^o + w_j^o \right)^* p' (\cdot) + aqd \left( w_{j_{\text{mk}}} - w_{j_{\text{nm}}} \right) p' (\cdot) = 0
\]  
(A.12)

Collect like terms

\[
d \left( w_i^o + w_j^o \right)^* \left( p'' (\cdot) \left( w_i^o + w_j^o \right)^* - \left( w_{j_{\text{mk}}} + w_{j_{\text{mk}}} \right) + \alpha q \left( w_{j_{\text{mk}}} - w_{j_{\text{nm}}} \right) \right) + 2 p' (\cdot) \\
+ aqd \left( w_{j_{\text{mk}}} - w_{j_{\text{nm}}} \right) \left( p'' (\cdot) \left( w_i^o + w_j^o \right)^* - \left( w_{j_{\text{mk}}} + w_{j_{\text{mk}}} \right) + \alpha q \left( w_{j_{\text{mk}}} - w_{j_{\text{nm}}} \right) \right) + 2 p' (\cdot) = 0
\]  
(A.13)

Isolate the expression for \( d \left( w_i^o + w_j^o \right)^* / d \left( w_{j_{\text{mk}}} - w_{j_{\text{nm}}} \right) \).

\[
\frac{d \left( w_i^o + w_j^o \right)^*}{d \left( w_{j_{\text{mk}}} - w_{j_{\text{nm}}} \right)} = -aq \frac{p'' (\cdot) \left( w_i^o + w_j^o \right)^* - \left( w_{j_{\text{mk}}} + w_{j_{\text{mk}}} \right) + \alpha q \left( w_{j_{\text{mk}}} - w_{j_{\text{nm}}} \right) + 2 p' (\cdot)}{p'' (\cdot) \left( w_i^o + w_j^o \right)^* - \left( w_{j_{\text{mk}}} + w_{j_{\text{mk}}} \right) + \alpha q \left( w_{j_{\text{mk}}} - w_{j_{\text{nm}}} \right) + 2 p' (\cdot)}
\]  
(A.14)

\[
= -aq < 0
\]

107
Table 2.1 – Variable Names and Definitions

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CoupleHire</td>
<td>= 1 if the individual was part of a jointly hired couple, 0 otherwise</td>
</tr>
<tr>
<td>Admin</td>
<td>= 1 if the individual is an administrator, 0 otherwise</td>
</tr>
<tr>
<td>Female</td>
<td>= 1 if the individual is female, 0 otherwise</td>
</tr>
<tr>
<td>Grantee</td>
<td>= 1 if the individual obtained at least one grant in a given year, 0 otherwise</td>
</tr>
<tr>
<td>Pubs</td>
<td>Number of peer reviewed journal articles, book chapters, or books</td>
</tr>
<tr>
<td>Prior</td>
<td>Number of years between highest degree and starting year at WSU</td>
</tr>
<tr>
<td>lnosal</td>
<td>The natural logarithm of annual salary</td>
</tr>
<tr>
<td>Rank</td>
<td>Indicators for Assistant, Associate, and Full Professor</td>
</tr>
<tr>
<td>Dept</td>
<td>Aggregated Field indicator variables</td>
</tr>
<tr>
<td>Year</td>
<td>Year of observation indicator variables</td>
</tr>
<tr>
<td>OHY</td>
<td>Original Hire Year indicator variables</td>
</tr>
</tbody>
</table>
### Table 2.2 – Summary Statistics for Aggregated Fields of Research

<table>
<thead>
<tr>
<th>Aggregated Disciplines</th>
<th>All Data</th>
<th></th>
<th>STEM Data</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Count</td>
<td>Percent</td>
<td>Count</td>
<td>Percent</td>
</tr>
<tr>
<td>Engineering</td>
<td>64</td>
<td>7%</td>
<td>29</td>
<td>9%</td>
</tr>
<tr>
<td>Agricultural, Environmental,</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Natural Resource, Extension</td>
<td>160</td>
<td>18%</td>
<td>71</td>
<td>21%</td>
</tr>
<tr>
<td>Biological and Physical Sciences</td>
<td>80</td>
<td>9%</td>
<td>28</td>
<td>8%</td>
</tr>
<tr>
<td>Health Sciences</td>
<td>82</td>
<td>9%</td>
<td>29</td>
<td>9%</td>
</tr>
<tr>
<td>Liberal Arts and Humanities</td>
<td>162</td>
<td>18%</td>
<td>55</td>
<td>16%</td>
</tr>
<tr>
<td>Math and Computer Sciences</td>
<td>32</td>
<td>4%</td>
<td>20</td>
<td>6%</td>
</tr>
<tr>
<td>Social Sciences</td>
<td>191</td>
<td>21%</td>
<td>72</td>
<td>21%</td>
</tr>
<tr>
<td>Veterinary Medicine</td>
<td>55</td>
<td>6%</td>
<td>16</td>
<td>5%</td>
</tr>
<tr>
<td>Other Field</td>
<td>72</td>
<td>8%</td>
<td>20</td>
<td>6%</td>
</tr>
</tbody>
</table>
Table 2.3 – Summary Statistics for New Hires, 1999-2011

<table>
<thead>
<tr>
<th></th>
<th>All Data</th>
<th>Productivity Data</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Count</td>
<td>Percent</td>
</tr>
<tr>
<td>Number of Person/Year Obs.</td>
<td>5072</td>
<td></td>
</tr>
<tr>
<td>Number of Unique New Hires</td>
<td>898</td>
<td></td>
</tr>
<tr>
<td>Couple Hires</td>
<td>114</td>
<td>13%</td>
</tr>
<tr>
<td>Primary Hires</td>
<td>86</td>
<td>75%</td>
</tr>
<tr>
<td>Partner Hires¹</td>
<td>28</td>
<td>25%</td>
</tr>
<tr>
<td>Males</td>
<td>549</td>
<td>61%</td>
</tr>
<tr>
<td>Females</td>
<td>349</td>
<td>39%</td>
</tr>
<tr>
<td>Assistant Professors</td>
<td>713</td>
<td>79%</td>
</tr>
<tr>
<td>Associate Professors</td>
<td>83</td>
<td>9%</td>
</tr>
<tr>
<td>Full Professors</td>
<td>102</td>
<td>11%</td>
</tr>
<tr>
<td>Administrators hired</td>
<td>98</td>
<td>11%</td>
</tr>
<tr>
<td>Mean Annual Salary</td>
<td>77,792</td>
<td>72,905</td>
</tr>
<tr>
<td>Mean Years of Seniority</td>
<td>4.61</td>
<td>4.71</td>
</tr>
<tr>
<td>Individuals who left</td>
<td>28 (25%)</td>
<td>311 (40%)</td>
</tr>
</tbody>
</table>

¹ The imbalance between primary hires and partner hires is a result of many partner hires accepting non-tenure track positions. The dataset contains only tenure-track faculty.
Table 2.4 – Results of the Analysis of Employment Duration

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>Estimated Coefficient</th>
<th>Hazard Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>CoupleHire</td>
<td>-0.494** (0.224)</td>
<td>0.610**</td>
</tr>
<tr>
<td>Female</td>
<td>-0.068 (0.111)</td>
<td>0.934</td>
</tr>
<tr>
<td>Admin</td>
<td>-0.242 (0.245)</td>
<td>0.785</td>
</tr>
<tr>
<td>Prior</td>
<td>0.013 (0.010)</td>
<td>1.013</td>
</tr>
<tr>
<td>Associate</td>
<td>-0.861*** (0.200)</td>
<td>0.423***</td>
</tr>
<tr>
<td>Full Professor</td>
<td>-0.455* (0.266)</td>
<td>0.635*</td>
</tr>
</tbody>
</table>

Observations  5072  5,072
Individuals  898  898

Clustered Robust Standard errors in parenthesis
Coefficients for Fields of Research and Years of Hire variables not reported

*** p<0.01, ** p<0.05, * p<0.1
### Table 2.5 – Results for Initial Salary

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>Spec 1</th>
<th>Spec 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>CoupleHire</td>
<td>0.038</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.026)</td>
<td></td>
</tr>
<tr>
<td>Primary</td>
<td>0.053*</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.028)</td>
<td></td>
</tr>
<tr>
<td>Partner</td>
<td></td>
<td><strong>-0.048</strong></td>
</tr>
<tr>
<td></td>
<td>(0.038)</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>-0.057***</td>
<td>-0.058***</td>
</tr>
<tr>
<td></td>
<td>(0.019)</td>
<td>(0.019)</td>
</tr>
<tr>
<td>Avg Pubs/year</td>
<td>0.006*</td>
<td>0.006</td>
</tr>
<tr>
<td></td>
<td>(0.004)</td>
<td>(0.004)</td>
</tr>
<tr>
<td>Associate</td>
<td>0.254***</td>
<td>0.258***</td>
</tr>
<tr>
<td></td>
<td>(0.029)</td>
<td>(0.029)</td>
</tr>
<tr>
<td>Professor</td>
<td>0.663***</td>
<td>0.660***</td>
</tr>
<tr>
<td></td>
<td>(0.056)</td>
<td>(0.056)</td>
</tr>
<tr>
<td>Prior</td>
<td>0.004*</td>
<td>0.004*</td>
</tr>
<tr>
<td></td>
<td>(0.002)</td>
<td>(0.002)</td>
</tr>
<tr>
<td>Observations</td>
<td>747</td>
<td>747</td>
</tr>
<tr>
<td>R^2</td>
<td>0.695</td>
<td>0.696</td>
</tr>
</tbody>
</table>

Robust standard errors in parentheses

Coefficients for Fields of Research and Years of Hire variables not reported

*** p<0.01, ** p<0.05, * p<0.1
### Table 2.6 – Job Titles for Non-Tenure Track Partner Hires

<table>
<thead>
<tr>
<th>Non-TT Faculty</th>
<th>count</th>
<th>Admin. Support Staff</th>
<th>count</th>
<th>Admin. Leadership</th>
<th>count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinical Assistant Prof.</td>
<td>8</td>
<td>Coordinator</td>
<td>8</td>
<td>Assistant Director</td>
<td>3</td>
</tr>
<tr>
<td>Research Associate</td>
<td>7</td>
<td>Analyst</td>
<td>3</td>
<td>Director</td>
<td>2</td>
</tr>
<tr>
<td>Assistant Research Prof.</td>
<td>4</td>
<td>Administrative Profess’l</td>
<td>1</td>
<td>Associate Director</td>
<td>1</td>
</tr>
<tr>
<td>Instructor</td>
<td>4</td>
<td>Advisor</td>
<td>1</td>
<td>PR Director</td>
<td>1</td>
</tr>
<tr>
<td>Adjunct Faculty</td>
<td>3</td>
<td>Assistant</td>
<td>1</td>
<td>Staff Director</td>
<td>1</td>
</tr>
<tr>
<td>Instructional Supervisor</td>
<td>1</td>
<td>Graphic Designer</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lecturer</td>
<td>1</td>
<td>Instruct’l Media Spec.</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scientific Assistant</td>
<td>1</td>
<td>Network Administrator</td>
<td>1</td>
<td>Professional Worker</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Project Associate</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Proposal Manager</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Webmaster</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>29</strong></td>
<td><strong>21</strong></td>
<td></td>
<td></td>
<td><strong>8</strong></td>
</tr>
</tbody>
</table>
### Table 2.7 – Results of ln(Annual Salary) Comparison

<table>
<thead>
<tr>
<th>Variable</th>
<th>Two-way Clustering</th>
<th>Fixed Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All Obs</td>
<td>Prod Obs</td>
</tr>
<tr>
<td>CoupleHire</td>
<td>0.070***</td>
<td>0.104**</td>
</tr>
<tr>
<td></td>
<td>(0.026)</td>
<td>(0.048)</td>
</tr>
<tr>
<td>Seniority</td>
<td>-0.006</td>
<td>-0.011</td>
</tr>
<tr>
<td></td>
<td>(0.004)</td>
<td>(0.007)</td>
</tr>
<tr>
<td>Seniority²</td>
<td>-0.001***</td>
<td>-0.001</td>
</tr>
<tr>
<td></td>
<td>(0.000)</td>
<td>(0.001)</td>
</tr>
<tr>
<td>CoupleHire×Seniority</td>
<td>-0.018**</td>
<td>-0.033**</td>
</tr>
<tr>
<td></td>
<td>(0.008)</td>
<td>(0.015)</td>
</tr>
<tr>
<td>CoupleHire×Seniority²</td>
<td>0.001</td>
<td>0.002</td>
</tr>
<tr>
<td></td>
<td>(0.001)</td>
<td>(0.001)</td>
</tr>
<tr>
<td>Experience</td>
<td>-0.001</td>
<td>-0.001</td>
</tr>
<tr>
<td></td>
<td>(0.003)</td>
<td>(0.004)</td>
</tr>
<tr>
<td>Experience²</td>
<td>0.000*</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>(0.000)</td>
<td>(0.000)</td>
</tr>
<tr>
<td>Female</td>
<td>-0.055***</td>
<td>-0.052***</td>
</tr>
<tr>
<td></td>
<td>(0.014)</td>
<td>(0.015)</td>
</tr>
<tr>
<td>Admin</td>
<td>0.156***</td>
<td>0.218***</td>
</tr>
<tr>
<td></td>
<td>(0.029)</td>
<td>(0.046)</td>
</tr>
<tr>
<td>Associate</td>
<td>0.191***</td>
<td>0.209***</td>
</tr>
<tr>
<td></td>
<td>(0.014)</td>
<td>(0.016)</td>
</tr>
<tr>
<td>Full Professor</td>
<td>0.567***</td>
<td>0.567***</td>
</tr>
<tr>
<td></td>
<td>(0.030)</td>
<td>(0.034)</td>
</tr>
<tr>
<td>Publications</td>
<td>0.004*</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.002)</td>
<td></td>
</tr>
<tr>
<td>Grants</td>
<td>0.055***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.012)</td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td>5072</td>
<td>2755</td>
</tr>
<tr>
<td>R²</td>
<td>0.714</td>
<td>0.696</td>
</tr>
<tr>
<td>Number of Unique Ind.</td>
<td>898</td>
<td>682</td>
</tr>
</tbody>
</table>

Two-Way Cluster Robust Standard Errors in parentheses for the clustering model
Robust Standard Errors in parentheses for the Fixed Effects Model
Indicator variables for field of research, year of observation, and year of hire not reported
*** p<0.01, ** p<0.05, * p<0.1
Figure 2.2.1 – How $q$ Affects the Wage Offered to Couples
Figure 2.2.2 – Decision Tree for an Academic Couple
Figure 2.2.3 – Smoothed Estimates of the Probability of Leaving
CHAPTER 3: ARE ALL COUPLE HIRES CREATED EQUAL?

DIFFERENCES BETWEEN WITHIN AND CROSS-DEPARTMENTAL COUPLE HIRING.

Abstract

I have previously modeled the university as a single decision maker when evaluating couple candidates. While both members of some couples specialize in the same field and can be hired into a single department, other couples specialize in different fields and the hiring decision is made by multiple individuals. It is likely that couples hired into separate departments experience outcomes similar to those predicted by an independent evaluation policy. On the other hand it is at least more likely that couples hired into the same department experience outcomes similar to those predicted by an average hiring policy. I test for differences in the number of publications per year, employment duration, and salaries using data on new couple hires at Washington State University between 1999 and 2011. I find no statistical evidence that differences exist.
1 Introduction

A common dilemma in the academic labor market involves the decision of how to handle potential candidates who are part of an academic couple where both partners work in academia. The root problem associated with hiring an academic couple is that a position may not be available for the partner of a desired candidate or even if one is available the candidate may not be the best fit. To overcome the first challenge, many universities are adopting official accommodation polices to reduce the timing friction by temporarily allocating central administrative funds to partially cover the cost of the partner hire’s salary until a permanent faculty line opens up. Still, the question remains of how well the partner candidate fits with the new department.

In previous work (Woolstenhulme et al. 2012; Woolstenhulme 2013) I analyze how labor market outcomes are different for academic couples relative to other academics. In Woolstenhulme et al. 2012, my coauthors and I demonstrate why academic couples may have higher levels of productivity compared to their colleagues. We consider two different hiring rules for couples. The first rule requires that each candidate be evaluated for a position based upon her own merits independent of her partner and we refer to it as an independent policy. The second hiring rule allows the university to consider the average productivity of both partners together, and we refer to it as an average hiring policy. We find that the type of hiring policy chosen by the university results in very different outcomes in terms of the quality of candidates that a university can ultimately hire.

In Woolstenhulme (2013), I consider how universities can exploit knowledge about which employees are part of academic couples by offering lower salaries to such couples. Academic couples face tougher job prospects compared to other academics because they must
find two positions, not only in the same region, but often in the same institution. The lower probability of leaving caused by poorer job prospects gives the university the ability to offer lower annual wage increases relative to other academics.

In both papers, I model the university as a single decision maker, however, academic couples often have different areas of specialization and the decision to hire the couple can rest with multiple department heads and deans. While there is certainly room for “collusion” among several department heads, it is likely that couples who are hired into the same department (where there is essentially one decision maker) experience different outcomes than those who are hired into separate departments (where hiring and wage decisions involve multiple department heads, budgets, etc).

The process for hiring couples, at least at the junior level, usually involves a national search for specific position. The university chooses its desired candidate and makes an offer. At that point, the candidate reveals that a partner is also involved and in order to accept the offer from the university, a second position must also be found. The partner’s area of specialization determines whether a position can be found internally or if another department must be involved in the decision. If a separate department is brought in, then time constraints imposed by an unforeseen “opportunity hire” render a national search unlikely. Perhaps the partner hire would not be the department’s first choice if a national search is conducted and the partner’s quality may come into question. It does not make sense for one department to accept a candidate whom they otherwise would not hire (someone whose productivity is lower than the rest of the department) in order to allow a separate department to attract an all-star. Such behavior does not serve the interest of the receiving department and if forced upon a particular department (through peer pressure or administrative pressure), the partner hire may become the victim of social
stigmas. Therefore it is more likely that couples hired into separate departments experience outcomes more closely aligned with an independent approach to hiring.

In the alternative scenario, both members of the couple specialize within the same discipline and seek employment within the same department. The hiring decision, and subsequent wage decisions, for both members of the couple are made by the same department head. It may be that this particular department really wants to recruit a top female (as is common in STEM fields), but in order to do so, it must also find a position for her partner. The prospect of hiring a female may cause the department head to relax the standards a little and hire the partner even though he would not have otherwise. Additionally, in subsequent wage decisions, such as merit increases and matching wages to ward off outside offers, it is more likely that a single department head can suppress wage growth for both partners than would be possible across departments.

In this paper, I empirically compare productivity and salary for academic couples hired into the same department with academic couples hired into separate departments. It is reasonable to believe that the hiring rule used to recruit couples into different departments most closely resembles an independent policy. Couples hired into the same department may have also been evaluated under an independent hiring policy, but at least the opportunity to use an average hiring policy is much greater.

In terms of productivity, the independent hiring rule predicts that neither partner should perform any worse than their peers and that at least one of them should perform much better. With an average hiring rule the model predicts that one member of the couple will perform better and one member of the couple will perform worse. But the model does not allow productivity to change over a candidate’s career or allow interaction effects for couples. For academics in
different fields, one partner’s success may come at the expense of the other because household responsibilities result in competing demands for each partner’s time. In contrast, couples who are in the same field of research can collaborate on the same project so that if household demands require the time of one partner, the other can continue the same project and productivity is not lost and can potentially be enhanced. These couples have more time to talk about research together and co-author papers in a way that traditional colleagues or couples in different departments cannot. The collaboration effect may be enough to offset any lower productivity that might occur by utilizing an average hiring policy. Therefore, it’s not clear \textit{a priori} whether couples in the same department will perform worse or better compared to couples hired into separate departments.

2 Data

Washington State University has maintained records on which individuals took advantage of the partner accommodation funds available to help accommodate a qualified partner of a desired candidate since 1999. Using this information I have identified each member of an academic couple and designated them as either the primary or partner candidate in a couple.\footnote{Some couples may have found two positions without utilizing the policy. These couples are not captured in my data.}

A primary candidate is the individual who was first recruited by the university. A partner candidate is an individual whose salary was temporarily supplemented using administrative funds until a permanent faculty line opened. Some of the candidates who utilized the accommodation policy were not hired into tenure stream positions and instead accepted non-
tenure track faculty positions or administrative support staff positions. Thus, there is a difference between the number of primary hires and the number of partner hires in the tenure stream data that I use where the number of partner hires is much smaller than the number of primary hires. I match this information with administrative data on tenure stream faculty which includes information about each individual’s year of hire, salary, field of research, job title, academic rank, and other variables.

I also obtained information about faculty members’ productivity using a self-reporting data base available to all faculty. Faculty members report all productive activity including publications, grants, university service, and other elements into this data base. It is used in merit pay increases as well as tenure and rank advancement decisions and is cross validated by department heads for accuracy. However, this information is only available for a few departments beginning in 2005, others are added in 2007, and in 2008 the information is available for all departments except the business school. Table 3.1 contains the variables that I use in my analysis and Table 3.2 contains summary information about the data.

3 Methods

I use a set of dummy variables which represent tenure stream couples hired into the same department (base), and tenure stream couples hired into different departments or couples with a non-tenure stream partner. I compare both annual publications and annual salary using multiple specifications of the same general model. As a benchmark specification I use pooled OLS and cluster the standard errors by individual to account for serial correlation of the observations of a single individual over time. However, the standard errors of this specification are likely biased
because it maintains the assumption that the standard errors are independent across individuals. As I demonstrate in Woolstenhulme (2013), the individual salaries for academic couples are likely correlated therefore I adjust the error matrix using a multi-way clustering method developed by Cameron, Gelbach, and Miller (2006). With this method I am able to obtain standard errors that are robust both to correlation of a single individual’s error over time, as well as correlation of the error across individuals who are part of an academic couple. The coefficient estimates of these two models are identical. The difference is in the standard errors. I also estimate a population averaged model, a random effects model, and a fixed effects model.

The first four models all rely on the same identification assumption, that any unobserved effect remaining in the error term is uncorrelated with all explanatory variables. I attempt to satisfy this assumption by including a set of dummy variables for each year of observation to account for unobserved secular influences that may differ across years. I also include a set of field indicator variables to account for differences in salary and publication among the different disciplines, Variables for academic rank, past experience, and years of seniority are included as well. I include seniority as a continuous variable in the salary regression to be consistent with prior literature. In the publications regression in lieu of seniority, I instead include a full set of indicator variables representing the year an individual was hired to allow for greater flexibility for differences in hiring cohorts. While the fixed effects model is generally considered to be a more convincing tool for estimating the ceteris paribus effects, I am only able to use the fixed effects specification in the salary model and not in the productivity model. This is because the key variables of interest in the productivity model are time constant.
I also test for differences in the probability of leaving WSU using the Cox proportional hazard model (Cleves et al. 2010). This model is a semi-parametric model which does not rely on underlying distributional assumptions and is considered generally robust.

4 Results

I report the results of the salary comparison in Table 3.3. The estimates are consistent across the first four specifications. Couples hired into different departments are paid about 6.4 to 7.5 percent more than couples hired into the same department but the estimate is not significant at traditional levels. An estimate from the fixed effects specification is not available for this variable because it is time constant. While the evidence that salaries are different for couples hired into the same department compared to couples hired into different department is weak, the direction of the effect agrees with the idea that there may be greater opportunity for a department head to pay lower salaries if both members of the couple are under his jurisdiction. He will likely have much greater information about the outside job prospects of both partners compared to couples who are in different fields of research and may be able to exploit that information. There is no evidence that the effect of additional years of seniority is different between any couple type as the magnitudes are very close to zero.

In Table 3.4 I report the results of the publications comparison. The evidence is inconclusive about whether there is a difference in annual publications in the pooled OLS models the effect is negative but the magnitude is not very large in absolute value. With the population averaged model and the random effects model the effect is positive and equal to about a half a publication per year. However the effect is not significant in any specification.
In Table 3.5, I report the results of the employment duration comparison. Once again there is no statistical evidence that differences exist. The magnitude of the hazard ratio however is quite large. But its size is not the result of any substantive difference between the two groups. Both types of couples have extremely low estimated probabilities of leaving WSU. Figure 3.1 provides a visual comparison of the estimated probability of leaving for each type of couple. Notice that the scale on the vertical axis is miniscule. Both couple types are estimated to have nearly a zero probability of leaving which is lower than anticipated but it is likely because a supermajority of the sample are new assistant professors and the data set only extends beyond the tenure decision for a very small segment of those. The solid line represents couples hired into different departments and is clearly higher than the other lines which represents couples hired into the same department.

5 Discussion and Conclusions

I am unable to find any substantial differences between academic couples hired into the same department and academic couples hired into different departments. However, my inability to find a difference is not conclusive evidence that there is no difference. My data consists of a very small sample from a single institution and is comprised mostly of new junior faculty. Additionally, previous research has shown that quantity of publications is a poor predictor of salary (Moore, Newman, and Turnbull 1998; Ragan Jr, Warren, and Bratsberg 1999; Bratsberg, Ragan, and Warren 2010) and that the quality of publications is a more important contributor to salary. Larger data sets with more observations and additional information about productivity are needed to fully test for differences in salary and productivity.
In light of the results from the first two chapters and the lack of difference between two
different types of couples that is presented in this chapter, university administrators should be
better informed about how couple hiring can affect their institutions. Independent evaluation
policies are transparent and at the same time are more likely to result in improved recruitment
outcomes than an average policy. Additionally academic couples stay longer at an institution
which can help reduce turnover costs but universities should be cautious in how they make pay
decisions for couples. Though I find weak empiricical evidence that couple hires are be penalized
to a greater degree for each additional year of seniority, I have theoretically demonstrated that
universities certainly have the opportunity to exploit the low probability of leaving by paying
lower wages. If strong evidence can be found that couples are penalized more, universities may
face legal challenges.

My findings support the argument that couple hiring can be advantageous to universities
if it is done appropriately. There is still much work to be done in this area however data
availability is the limiting factor. Universities who are engaging in couple hiring should keep
detailed records of the practice that will enable future research to further disentangle all of the
effects that couple hiring can have for both the university and the couple.
References


Table 3.1 – Variable Names and Descriptions

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SameDept</td>
<td>= 1 if the individual was hired into the same department as her partner</td>
</tr>
<tr>
<td>DiffDept</td>
<td>= 1 if the individual was hired into a different department than her partner</td>
</tr>
<tr>
<td>NonTTpartner</td>
<td>= 1 if the individual has a non-tenure track partner</td>
</tr>
<tr>
<td>Admin</td>
<td>= 1 if the individual is an administrator, 0 otherwise</td>
</tr>
<tr>
<td>Female</td>
<td>= 1 if the individual is female, 0 otherwise</td>
</tr>
<tr>
<td>Pubs</td>
<td>Number of peer reviewed journal articles, book chapters, or books published (annual)</td>
</tr>
<tr>
<td>Seniority</td>
<td>Number of years since first hired by WSU</td>
</tr>
<tr>
<td>Prior</td>
<td>Number of years between highest degree and starting year at WSU</td>
</tr>
<tr>
<td>Rank</td>
<td>Indicators for Assistant, Associate, and Full Professor</td>
</tr>
<tr>
<td>Dept</td>
<td>Aggregated Field indicator variables</td>
</tr>
<tr>
<td>Year</td>
<td>Year of observation indicator variables</td>
</tr>
<tr>
<td>OHY</td>
<td>Original Hire Year indicator variables</td>
</tr>
</tbody>
</table>
Table 3.2 – Summary Statistics for those with publication data.

<table>
<thead>
<tr>
<th></th>
<th>Count</th>
<th>of group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Person/year obs.</td>
<td>374</td>
<td></td>
</tr>
<tr>
<td>Total Individuals</td>
<td>90</td>
<td></td>
</tr>
<tr>
<td>Same Dept</td>
<td>31</td>
<td>34%</td>
</tr>
<tr>
<td>Diff Dept†</td>
<td>7</td>
<td>8%</td>
</tr>
<tr>
<td>NonTT partner</td>
<td>52</td>
<td>58%</td>
</tr>
<tr>
<td>Admin</td>
<td>11</td>
<td>12%</td>
</tr>
<tr>
<td>Female</td>
<td>36</td>
<td>40%</td>
</tr>
<tr>
<td>Male</td>
<td>54</td>
<td>60%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>mean</th>
<th>std. dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pubs</td>
<td>2.54</td>
<td>3.52</td>
</tr>
<tr>
<td>Seniority</td>
<td>1.39</td>
<td>0.98</td>
</tr>
<tr>
<td>Prior</td>
<td>7.18</td>
<td>7.38</td>
</tr>
</tbody>
</table>

†The odd number of couples results from some individuals not publishing.
Table 3.3 – Results From the Salary Analysis

<table>
<thead>
<tr>
<th>Variable</th>
<th>Pooled OLS Cluster by Individual</th>
<th>Pooled OLS Two-way Cluster by Ind. and Couple</th>
<th>Population Averaged Model</th>
<th>Random Effects Model</th>
<th>Fixed Effects Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>DiffDept</td>
<td>0.064</td>
<td>0.064</td>
<td>0.064</td>
<td>0.075</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.072)</td>
<td>(0.080)</td>
<td>(0.054)</td>
<td>(0.059)</td>
<td></td>
</tr>
<tr>
<td>Seniority</td>
<td>-0.029***</td>
<td>-0.029***</td>
<td>-0.030***</td>
<td>-0.029***</td>
<td>0.024***</td>
</tr>
<tr>
<td></td>
<td>(0.009)</td>
<td>(0.010)</td>
<td>(0.007)</td>
<td>(0.010)</td>
<td>(0.004)</td>
</tr>
<tr>
<td>DiffDept×Sen</td>
<td>-0.003</td>
<td>-0.003</td>
<td>0.003</td>
<td>0.003</td>
<td>0.003</td>
</tr>
<tr>
<td></td>
<td>(0.011)</td>
<td>(0.012)</td>
<td>(0.005)</td>
<td>(0.004)</td>
<td>(0.004)</td>
</tr>
<tr>
<td>Female</td>
<td>0.007</td>
<td>0.007</td>
<td>-0.019</td>
<td>-0.037</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.031)</td>
<td>(0.029)</td>
<td>(0.039)</td>
<td>(0.052)</td>
<td></td>
</tr>
<tr>
<td>Associate</td>
<td>0.187***</td>
<td>0.187***</td>
<td>0.141***</td>
<td>0.112***</td>
<td>0.096***</td>
</tr>
<tr>
<td></td>
<td>(0.037)</td>
<td>(0.038)</td>
<td>(0.021)</td>
<td>(0.016)</td>
<td>(0.015)</td>
</tr>
<tr>
<td>Full Professor</td>
<td>0.756***</td>
<td>0.756***</td>
<td>0.546***</td>
<td>0.338***</td>
<td>0.222***</td>
</tr>
<tr>
<td></td>
<td>(0.053)</td>
<td>(0.054)</td>
<td>(0.075)</td>
<td>(0.059)</td>
<td>(0.052)</td>
</tr>
<tr>
<td>Publications</td>
<td>0.008**</td>
<td>0.008*</td>
<td>0.002</td>
<td>0.000</td>
<td>-0.000</td>
</tr>
<tr>
<td></td>
<td>(0.004)</td>
<td>(0.004)</td>
<td>(0.002)</td>
<td>(0.001)</td>
<td>(0.001)</td>
</tr>
<tr>
<td>Observations</td>
<td>374</td>
<td>374</td>
<td>374</td>
<td>374</td>
<td>374</td>
</tr>
<tr>
<td>R²</td>
<td>0.820</td>
<td>0.820</td>
<td>N/A</td>
<td>0.615</td>
<td>0.644</td>
</tr>
<tr>
<td>Unique Individuals</td>
<td>90</td>
<td>90</td>
<td>90</td>
<td>90</td>
<td>90</td>
</tr>
</tbody>
</table>

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Year of hire, original hire year, and field effects not reported
**Table 3.4** – Results from the Publications Analysis

<table>
<thead>
<tr>
<th>Variable</th>
<th>Pooled OLS Cluster by Individual</th>
<th>Pooled OLS Two-way Cluster by Ind. and Couple</th>
<th>Population Averaged Model</th>
<th>Random Effects Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diff. Dept.</td>
<td>-0.148</td>
<td>-0.148</td>
<td>0.414</td>
<td>0.458</td>
</tr>
<tr>
<td></td>
<td>(0.864)</td>
<td>(0.691)</td>
<td>(0.766)</td>
<td>(0.791)</td>
</tr>
<tr>
<td>Female</td>
<td>-0.861</td>
<td>-0.861</td>
<td>-0.904</td>
<td>-0.896</td>
</tr>
<tr>
<td></td>
<td>(0.673)</td>
<td>(0.757)</td>
<td>(0.565)</td>
<td>(0.584)</td>
</tr>
<tr>
<td>Associate</td>
<td>0.637</td>
<td>0.637</td>
<td>0.298</td>
<td>0.251</td>
</tr>
<tr>
<td></td>
<td>(0.759)</td>
<td>(0.746)</td>
<td>(0.518)</td>
<td>(0.550)</td>
</tr>
<tr>
<td>Full Professor</td>
<td>1.022</td>
<td>1.022</td>
<td>0.247</td>
<td>0.109</td>
</tr>
<tr>
<td></td>
<td>(1.275)</td>
<td>(1.016)</td>
<td>(0.785)</td>
<td>(0.734)</td>
</tr>
<tr>
<td>Observations</td>
<td>374</td>
<td>374</td>
<td>374</td>
<td>374</td>
</tr>
<tr>
<td>R²</td>
<td>0.228</td>
<td>0.228</td>
<td>N/A</td>
<td>0.202</td>
</tr>
<tr>
<td>Number of Ind.</td>
<td>90</td>
<td>90</td>
<td>90</td>
<td>90</td>
</tr>
</tbody>
</table>

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Year of hire, original hire year, and field effects not reported
Table 3.5 – Results From the Analysis of Employment Duration

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>Coeff. Est.</th>
<th>Haz. Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diff. Dept.</td>
<td>2.606</td>
<td>13.546</td>
</tr>
<tr>
<td></td>
<td>(1.843)</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>-1.062</td>
<td>0.346</td>
</tr>
<tr>
<td></td>
<td>(1.528)</td>
<td></td>
</tr>
<tr>
<td>Publications</td>
<td>-0.606</td>
<td>0.546</td>
</tr>
<tr>
<td></td>
<td>(0.403)</td>
<td></td>
</tr>
<tr>
<td>Associate</td>
<td>-1.272</td>
<td>0.280</td>
</tr>
<tr>
<td></td>
<td>(0.833)</td>
<td></td>
</tr>
<tr>
<td>Full Professor</td>
<td>-1.661</td>
<td>0.190</td>
</tr>
<tr>
<td></td>
<td>(1.874)</td>
<td></td>
</tr>
<tr>
<td>Administrator</td>
<td>0.742</td>
<td>2.100</td>
</tr>
<tr>
<td></td>
<td>(0.831)</td>
<td></td>
</tr>
<tr>
<td>Prior Experience</td>
<td>0.016</td>
<td>1.016</td>
</tr>
<tr>
<td></td>
<td>(0.121)</td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td>374</td>
<td>374</td>
</tr>
</tbody>
</table>

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1
Figure 3.1 – A Comparison of the Probability of Leaving

![Graph showing the probability of leaving WSU after t years. The graph compares the probability for students in the same department and those in different departments over 8 years at WSU. The probability increases steadily with years.](image-url)