Solving the Two-Body Problem: An Evaluation of University Partner Accommodation Policies

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October 19, 2011

Abstract

Universities and academic couples frequently face the dilemma of finding two jobs at the same institution for two job candidates who form an academic couple. Universities are increasingly adopting official partner accommodation policies to address this issue during the hiring process. Little is known about the effect these policies have on recruitment, retention, and productivity. We seek to understand how specific types of policies – such as the one in place at Washington State University – affect the university's ability to recruit and retain highly productive candidates. We develop a theoretical model that predicts that when couples have a strong desire to work near each other, and universities evaluate members of couples independently one of another, couple hires will comprise some of an institutions highest quality faculty. We test our prediction using employment data from WSU. Using salary and promotion as indirect measures of productivity, we find that new assistant professors hired under the accommodation policy are 30% more likely than their peers to gain tenure. We also find that individual's hired via accommodation have 4.6% higher salaries than their peers on average. Thus, partner accommodation policies may be instrumental in the recruitment of top academic candidates.

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1 Introduction

Much discussion is taking place in academia regarding a growing trend to define official partner accommodation policies. These policies are being written to guide the decision university administrators are frequently faced with of whether or not to hire the partner of a desired job candidate when that partner is also a qualified academic. According to a 2008 study conducted by the Michelle R. Clayman Institute for Gender Research at Stanford University, academic couples currently comprise 36% of the American Professoriate. Also, the proportion of academics that are hired as part of a couple has been steadily increasing – from roughly 3% per year in the 1970's to 13% in the 2000's (Scheibinger, Henderson, & Gilmartin, 2008). As a result of the larger representation of couples in academia, joint searches for employment are increasing and Blossfeld and Drobnic (2001) argue that for many couples, the decision to accept or retain an academic position can be contingent on the ability of a spouse to find suitable employment. Thus, couple hiring represents an increasingly important issue for university administrators.

Though there are many ways in which a partner may be accommodated, we focus on the case where the partner is considered for a tenure/tenure track position. One commonly cited concern when a partner is hired is the stigma of "less good" that may be attached because he or she was not hired through the traditional method (Scheibinger, et al., 2008). But little is actually known about the real effect these policies have on faculty recruitment, retention, and productivity. We seek to understand how this specific type of policy – which is similar to the one in place at Washington State University – affects the university's ability to recruit and retain highly productive candidates[1]. Our hypothesis is that at a place like WSU, where temporary funding is available for the partners of first hires, partner accommodation allows the university to hire some higher quality candidates for whom this particular university would not have otherwise been their first choice.

There are two key observations of couple behavior that help us model our theory. First, many couples prioritize staying (or even working) together over other career considerations. Second, in couples of "mixed quality," one member of the couple may be willing to forgo her best available job to remain with her partner (Helppie & Murray-Close, 2010; Scheibinger, et al., 2008). Additionally, we assume that there is heterogeneity in the level of quality of individuals within couples. For example, one individual may be able to attract an offer from a very prestigious school whereas the other may not. Given these assumptions about the preferences and quality of academic couples, we predict that when universities evaluate members of couples independently one of another, couple hires will comprise some of an institution's highest quality faculty members.

We empirically evaluate this model using data on WSU faculty. To our knowledge such an empirical analysis of the effectiveness of accommodation policies has yet to be done. We use probability of achieving tenure and salary as two indirect measures of productivity. Our preliminary findings indicate

[1] There are also diversity considerations; Scheibinger, et al. (2008) state that 74% of the partner hires in their study are women. If it is generally true that the majority of partner hires are female, then understanding the effects of partner hiring will also have important implications for the recruitment and retention of female faculty specifically.

that those who were hired as part of a couple are somewhat more likely to gain tenure at WSU and have on average 4.6% higher salaries than those who were not hired as part of a couple.[2]

2 Theoretical Model

Set-up

We build our theoretical model on dissertation work done by Li (2009). Li builds a job-matching model for dual-career academic couples and universities and focuses on the distribution of faculty quality over geographic region. Our work instead focuses on the quality distribution of couple and non-couple faculty hires within a university, which he does not do.

We assume that each of three different schools has exogenously given initial levels of quality or prestige, L, M, and H, where L represents the lowest of the three qualities, M represents the middle of the three qualities, and H represents the highest of the three qualities. There are measure one job candidates each with individual quality denoted by θ_i and candidate quality is uniformly distributed along the unit interval, $\theta_i \sim u[0,1]$.[3] The total number of job candidates equals the total number of job openings. The three schools each have 1/3 of those job vacancies to fill. Each school maximizes the quality of its faculty by hiring the most qualified candidates it can subject to the constraint that it must fill all of its positions.

Following Li (2009), we assume all job candidates have productivity equal to their own level of quality and gain additional productivity ε_k, based on the quality of the school that employs them. Candidates derive utility from productivity according to the utility function

$$u\left(\theta_i, \varepsilon_j\right) = \theta_i + \varepsilon_k, \ i \in [0,1], \ k \in \{L, M, H\} \tag{2.1}$$

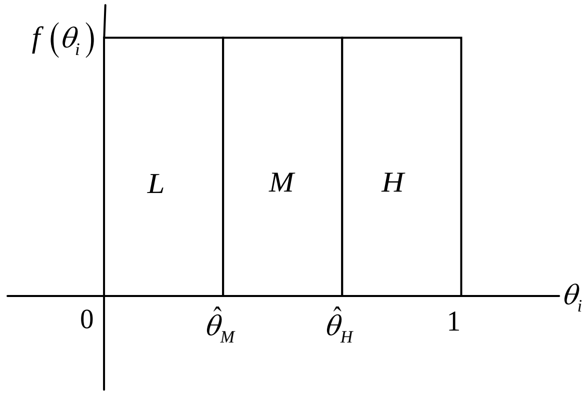
where $\varepsilon_L < \varepsilon_M < \varepsilon_H$, i indexes the individual, and k indexes the school.

The case with no couples

Suppose initially there are only non-couple candidates in the market. In equilibrium each school will set a cutoff quality level, $\hat{\theta}_k$, $k \in \{L, M, H\}$, and hire all candidates whose quality falls above that minimum threshold level (see Li, 2009). The distribution is shown in Figure 1.

[2] We recognize that neither tenure nor wages is a direct measure of productivity. We are working to augment our analysis by obtaining direct productivity measures including publications and citations.
[3] An individual with a quality level of zero still holds a PhD and is still qualified to be hired as a professor.

Figure 1: Uniform PDF of the quality of non-couple academic job candidates



Candidates are hired by the high-quality school if their individual quality is greater than the minimum threshold set by the high-quality school, $\theta_i > \hat{\theta}_H$. Thus, the probability that a non-couple candidate will be employed by the high-quality school, P_H^N, is

$$P_H^N \equiv 1 - \hat{\theta}_H. \tag{2.2}$$

Candidates are hired by the medium-quality school if their individual quality level falls above the minimum threshold set by the medium-quality school, but below the minimum threshold of the high-quality school, $\hat{\theta}_M < \theta_i < \hat{\theta}_H$. Thus, the probability that a non-couple candidate will be employed by the medium-quality school, P_M^S, is

$$P_M^N \equiv \hat{\theta}_H - \hat{\theta}_M. \tag{2.3}$$

Finally, candidates are hired by the low-quality school if their individual quality level falls above the minimum threshold set by the low-quality school but below the minimum threshold set by the medium-quality school. However, because it must fill all its positions, the low-quality school will set its minimum threshold level equal to zero. Hence, candidates hired by the low-quality school satisfy $0 < \theta_i < \hat{\theta}_M$, so the probability that a non-couple candidate will be employed by the low-quality school, P_L^N, is

$$P_L^N \equiv \hat{\theta}_M. \tag{2.4}$$

Each school has an equal number of openings, and the constraint requires that all schools fill their open positions. Thus,

$$\left(\hat{\theta}_M\right) = \left(\hat{\theta}_H - \hat{\theta}_M\right) = \left(1 - \hat{\theta}_H\right) = \frac{1}{3}, \tag{2.5}$$

such that the equilibrium minimum thresholds established by the medium- and high-quality schools are

$$\hat{\theta}_M = \frac{1}{3} \text{ and } \hat{\theta}_H = \frac{2}{3}. \tag{2.6}$$

Academic couples and an independent hiring policy

The official policy of Washington State University regarding partner accommodation states:

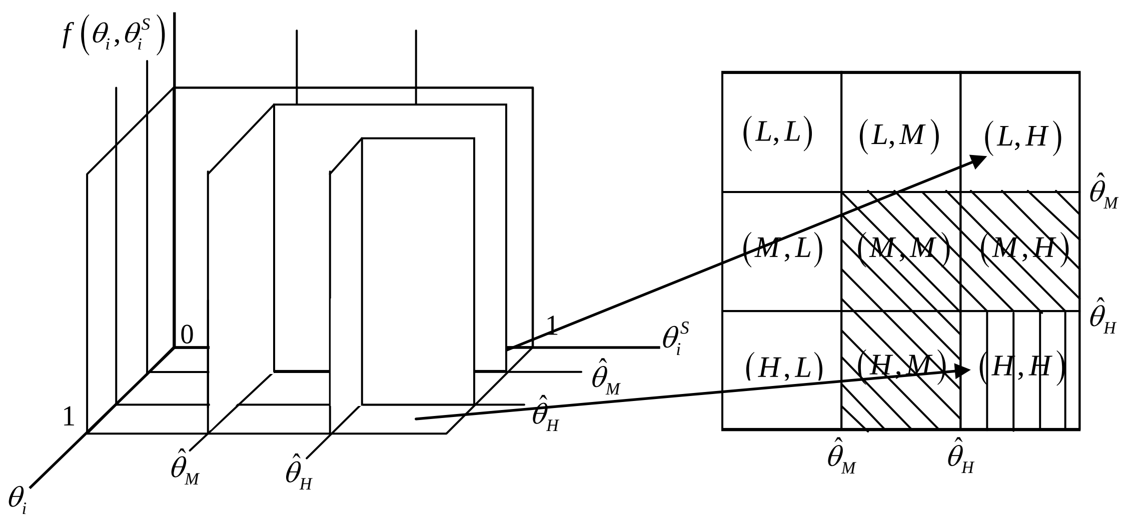
> *"In order to recruit or retain an employee, it is sometimes feasible for the University to find satisfactory employment for a partner or spouse.* ***[This] is a nonmandated program*** *... to assist units in recruiting and retaining employees.* ***No unit is required to participate in this program****" (emphasis added).*

It is clear from the policy and supported by interviews with administrative personnel that WSU is careful to not force any department into accepting a candidate they would not otherwise hire. The stated policy implies that each member of a couple is evaluated according to his/her individual merits; therefore, we develop our theory based on this form of partner accommodation. We consider an alternative hiring policy where couples are evaluated based on their combined average productivity in Section 2 of the Appendix.

We assume that a fraction α 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 couple is independent of the quality level of each person[4] and that couples' preferences are such that they will only accept jobs if each member of the couple receives an offer from the same school.

Suppose that $\alpha > 0$ and that the universities use the same minimum threshold to evaluate both non-couple and couple candidates. This implies that to be hired by school *k*, each individual within a couple must meet the minimum standard such that $\theta_i, \theta_i^S > \hat{\theta}_k$ where θ_i^S represents the spouse of individual *i*. The joint uniform distribution of quality for two candidates who form a couple, $f\left(\theta_i, \theta_i^S\right)$, is depicted in Figure 2.

Figure 2: Joint-Uniform Distribution of Quality of Academic Couples, Independent Hiring Policy



[4] In later footnotes we discuss the implications of relaxing this assumption.

As seen in Figure 2, hiring couples is least likely for the high-quality university, as each member must have $\theta_i > \hat{\theta}_H$. Since the proportion of *individuals* that are of high enough quality to work at the high-quality school is $1-\hat{\theta}_H$, the probability that a high-quality school can hire a couple, P_H^C, under an independent hiring policy is

$$P_H^C \equiv \left(1-\hat{\theta}_H\right)^2, \tag{2.7}$$

which is represented by the vertically shaded portion in Figure 2.

A medium-quality school, however, is able to hire couples where both members are in the medium-quality range, (M,M), as well as couples who are mixed between the high- and medium-quality ranges, (H,M) and (M,H). Thus, the probability that a medium-quality school is able to hire a couple, P_M^C, is

$$P_M^C \equiv \left(\hat{\theta}_H - \hat{\theta}_M\right)^2 + 2\cdot\left(\hat{\theta}_H - \hat{\theta}_M\right)\left(1-\hat{\theta}_H\right). \tag{2.8}$$

This is given by the diagonally shaded portion of Figure 2.

A low-quality school has five different types of couples that will meet its hiring criteria. Those where both members of the couple are in the low-quality range, (L,L), those couples who are mixed between the low and medium-quality ranges, (M,L) and (L,M), and those who are mixed between the high and low-quality ranges, (H,L) and (L,H). Thus the probability that a low-quality school is able to hire a couple, P_L^C, is

$$P_L^C \equiv \left(\hat{\theta}_M\right)^2 + 2\left(\hat{\theta}_M\right)\cdot\left(\hat{\theta}_H - \hat{\theta}_M\right) + 2\left(\hat{\theta}_M\right)\cdot\left(1-\hat{\theta}_H\right), \tag{2.9}$$

which is represented by the un-shaded portion of Figure 2.

Again the constraints require that all positions are filled, that the number of positions available at each school is equal, and that couples must work at the same institution. These constraints imply the following equality:

$$(1-\alpha)P_L^N + \alpha P_L^C = (1-\alpha)P_M^N + \alpha P_M^C = (1-\alpha)P_H^N + \alpha P_H^C = 1/3. \tag{2.10}$$

Equation (2.10) states that the weighted sum of the proportions of non-couples and couples who are hired by the low-quality school must be equal to the same weighted sum at the medium-quality school, which in turn must be equal to the same weighted sum at the high-quality school. Also, each school has an equal number of open positions for the measure one quantity of job candidates and so these weighted sums must each equal 1/3.

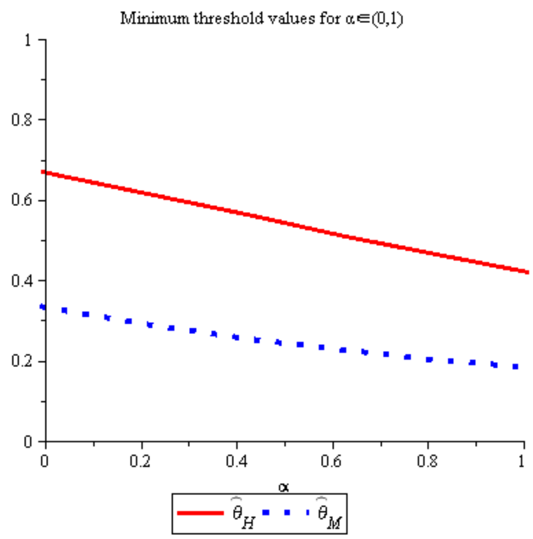
We solve the equalities in equation (2.10) for the equilibrium levels of $\hat{\theta}_M$ and $\hat{\theta}_H$ in terms of α. The specific derivation is in Section 1 of the Appendix. For any $\alpha > 0$ the solution is

$$\hat{\theta}_H = \frac{3+3\alpha-\sqrt{9-6\alpha+9\alpha^2}}{6\alpha} \tag{2.11}$$

$$\hat{\theta}_M = \frac{3+3\alpha-\sqrt{9+6\alpha+9\alpha^2}}{6\alpha}. \tag{2.12}$$

Figure 3 shows the equilibrium values that $\hat{\theta}_M$ and $\hat{\theta}_H$ take as α ranges from 0 to 1.

Figure 3: Minimum Threshold levels for $\alpha \in (0,1)$



It is clear from the figure that as more couples enter the labor market, the minimum threshold levels of quality set by both the medium- and high-quality schools decrease.

Expected quality of an individual in a couple

We now compare the average quality of non-couple hires and couple hires within a university given that all universities evaluate members of a couple independently one of another. These averages depend on the cutoff values $\hat{\theta}_H$ (for high-quality institutions) and $\hat{\theta}_M$ (for medium-quality institutions), which in turn depend on the proportion of academic couples, α, in the market. Since faculty quality is uniformly distributed on the $[0,1]$ interval, the quality of non-couple hires in the high-quality institution is uniformly distributed on the $[\hat{\theta}_H, 1]$ interval. Thus, the expected quality of a non-couple hire in a high-quality institution is

$$E(\theta_i \mid \theta_i \geq \hat{\theta}_H) = \int_{\hat{\theta}_H}^{1} \frac{1}{1-\hat{\theta}_H} x dx = \frac{1+\hat{\theta}_H}{2}. \tag{2.13}$$

Similarly, the expected quality of a non-couple hire in the medium-quality institution is $\frac{\hat{\theta}_M + \hat{\theta}_H}{2}$, and the expected quality of a non-couple hire in a lower-quality institution is $\frac{\hat{\theta}_M}{2}$.

We now turn to the expected quality of one who came to the university as part of a couple hire. Given our assumption that couples form independently of individual quality, the quality of individuals in a couple at the high-quality institution is uniformly distributed on the $[\hat{\theta}_H, 1]$ interval. Thus, the expected quality of such individuals is given by

$$E(\theta_i \mid \theta_i \geq \hat{\theta}_H, \theta_i^S \geq \hat{\theta}_H) = \frac{1+\hat{\theta}_H}{2}. \tag{2.14}$$

Members of couples in medium-quality institutions are comprised of high-quality individuals (θ_i at or above $\hat{\theta}_H$) with a medium-quality spouse (θ_i^S between $\hat{\theta}_M$ and $\hat{\theta}_H$), and medium-quality individuals with a spouse whose quality falls somewhere between $\hat{\theta}_M$ and 1. The expected quality of the first type is $\frac{1+\hat{\theta}_H}{2}$ while that of the second type is $\frac{\hat{\theta}_M + \hat{\theta}_H}{2}$. To determine the expected quality of *all* members of couples in medium-quality institutions, we must re-weight the probability of being in each category so that the total probability of being in a medium-quality institution is 1. The expected quality of members of couples in medium-quality schools is then

$$\begin{aligned} &E(\theta_i \mid \theta_i \geq \hat{\theta}_H,\ \hat{\theta}_M \leq \theta_i^S < \hat{\theta}_H \ \ or \ \ \hat{\theta}_M \leq \theta_i < \hat{\theta}_H,\ \hat{\theta}_M \leq \theta_i^S \leq 1) \\ &\quad = \frac{\hat{\theta}_H - \hat{\theta}_M}{1-2\hat{\theta}_M + \hat{\theta}_H} \cdot \frac{1+\hat{\theta}_H}{2} + \frac{1-\hat{\theta}_M}{1-2\hat{\theta}_M + \hat{\theta}_H} \cdot \frac{\hat{\theta}_H + \hat{\theta}_M}{2}. \end{aligned} \tag{2.15}$$

By a similar argument, the expected quality of members of couples in low-quality schools is

$$\begin{aligned} &E(\theta_i \mid \theta_i \geq \hat{\theta}_M, 0 \leq \theta_i^S < \hat{\theta}_M \ \ or \ \ \theta_i < \hat{\theta}_M, 0 \leq \theta_i^S \leq 1) \\ &\quad = \frac{\hat{\theta}_M}{1+\hat{\theta}_M} \cdot \frac{1+\hat{\theta}_M}{2} + \frac{1}{1+\hat{\theta}_M} \cdot \frac{\hat{\theta}_M}{2}. \end{aligned} \tag{2.16}$$

Given these results, it is apparent that when all institutions evaluate partners independently one of another, the average quality of couples is the same as that of singles in high-quality institutions while the average quality of couples is strictly greater than that of singles in both medium- and low-quality institutions.

The driving force behind these results is the presence of mixed quality of couples who wish to stay together.[5] Higher quality members of couples choose to go to lower quality schools than they would have as non-couple candidates in order to be near their partners.[6]

3 Empirical Analysis

We examine the implication that faculty quality differs by partner status in mid-tier universities using data from Washington State University.

Data

Washington State University's partner accommodation policy first became official in June 2003. However, informal use of the policy was prevalent before this time and records were kept on accommodated couples as far back as the 1990's but is most complete beginning in 1999. Thus our data consists of current tenure/tenure track faculty observations for the years 1999-2010. Among other variables, our data set identifies who was hired as part of an accommodation as well as whether or not they were the primary hire of the couple.

Summary Statistics

Tables 1, 2, and 3 summarize the data we use for our empirical models.

Table 1: Summary Statistics: New Assistant Professors Hired 1999 - 2002 inclusive

	Count	Ever Tenured	Accommodated Individuals	Percent Tenured	Percent Accommodated
First Year Observations	236	122	30	52%	13%
Males	140	70	21	50%	15%
Females	96	52	9	54%	9%

We first explore whether being hired under the accommodation policy has an effect on the probability of achieving tenure by analyzing only assistant professors who were newly hired between the years 1999 and 2002 inclusive. In this cross section, 13% of the new hires received an accommodation (15% of males and 9% of females, respectively). We define and indicator variable for tenure that takes a value of 1 if an individual was granted tenure at WSU by 2010 (and 0 otherwise). We consider any person who left before achieving tenure or who was still employed but had not been granted tenure to be non-tenured. About half of the new assistant professors hired between 1999 and 2002 achieved tenure with a slightly greater percentage of females being granted tenure than males.

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[5] The degree to which the results of the model will be weakened or strengthened depend on the degree of similarity in which academic couples form as well as how strong the preference of a couple is to work in the same location. It could be argued that individuals tend to partner with those who are of very similar quality level. If this is the case and there are more couples where both members are of equal quality then the effects will not be as large. However if "opposites attract," then the effects will be enhanced. And if fewer couples choose to work in the same location and instead commute to see each other then the effects will be weakened as well.

[6] This result is not an artifact of using three schools. More and more schools may be added to the analysis and the result will be that the expected quality of a member of a couple hire will be strictly greater than that of a non-couple hire in all but the highest quality school.

Second, we use person/year observations for both new hires since 1999 as well as for all employees in the data set to analyze the effect that being hired as part of an accommodated couple has on an individual's salary. Table 2 contains a summary of those hired since 1999 and Table 3 contains a summary of all employees in the data set.

Table 2: Summary Statistics, Hired Since 1999

	Count	Accommodated Individuals	Percent Accommodated
Number of Person/Year Observations	4033	543	13%
Males	2441	328	13%
Females	1592	215	14%
Assistant Professors	2550	321	13%
Associate Professor	975	135	14%
Professors	508	87	17%
	Mean	Std. Dev	
Years of experience	10.4	7.39	
Years of seniority	4.2	2.65	

The number of observations of unique individuals is 807 with 491 males and 316 females.

There are 109 unique individuals who are dual hires with 65 males and 44 females.

Of those hired since 1999, 13% have been hired under this policy. When the percentages of female and male hires are compared, 14% of females and 13% of males were part of a couple hire. Once again, more accommodations were approved for assistant professors (321) relative to both associates (135) and full professors (87). However the percentage of accommodations for professor hires (17%) was greater than the percentage of those for associate (14%) and assistant professors (13%).

Table 3: Summary Statistics, All observations

	Count	Accommodated Individual Obs.	Percent Accommodated
Number of Person/Year Observations	14045	787	6%
Males	9494	474	5%
Females	4551	313	7%
Assistant Professors	3405	366	11%
Associate Professor	4710	234	5%
Professors	5930	187	3%
	Mean	Std. Dev	
Years of experience	19.2	10.72	
Years of seniority	15.0	10.82	

The number of observations of unique individuals is 2018 with 1339 males and 679 females.

There are 134 unique individuals who are dual-hires with 79 males and 55 females.

Finally, in Table 3 we summarize all faculty members in our data. Overall, 7% of the faculty in our data were hired as part of an accommodated couple. A slightly larger percentage of female hires were

accommodated than were males. And, a greater number of lower ranked recruits were hired as part of an accommodated couple than were higher ranked recruits.[7]

Methods

We indirectly test whether couple hires are more productive than their non-couple counterparts by looking at promotion and salary differences. We first look only at the tenure decision of newly hired assistant professors to determine whether being part of an accommodated couple is correlated with a higher probability of achieving tenure. We restrict our data to include only those assistant professors who were hired between the years 1999 and 2002 inclusive. We chose 2002 to allow sufficient time for a tenure promotion to show up in our data. We use our tenure variable as the dependent variable in a standard probit model with robust standard errors to test whether being part of a couple has an effect on tenure achievement as given in equation (3.1):

$$tenure_i = \alpha + \beta \cdot couple_i + \boldsymbol{X}_i \delta + \varepsilon_i . \tag{3.1}$$

In this equation $couple_i$ represents whether individual i was hired as part of a couple and $\boldsymbol{X}_i$ is a vector containing controls for individual i's experience, sex, year hired, and academic department. We define experience as the years since an individual received his/her highest degree.

We study salary from two angles. We are interested in testing whether there are salary differences for couples early in their careers and then we want to know whether that changes over time.[8] We first look to see whether there is a difference in the pay of couple hires and non-couple hires. We restrict the data to those who have been hired since 1999 and treat each person/year entry as a separate observation but cluster the standard errors by individual to account for correlation of the same individual's error term across multiple years. We run two specifications of a standard OLS regression which are given in equations (3.2) and (3.3) below:

$$\ln(salary)_{it} = \alpha + \beta \cdot couple_i + \boldsymbol{X}_{it} \delta + \varepsilon_{it} \tag{3.2}$$

$$\ln(salary)_{it} = \alpha + \beta \cdot couple_i + \gamma \cdot primary_i + \boldsymbol{X}_{it} \delta + \varepsilon_{it} . \tag{3.3}$$

[7] We see an interesting pattern regarding female recruitment. In both those hired since 1999 as well as the full data, the number of males hired into faculty positions as part of an accommodated couple was greater than that of females. But, relative to the total number of male and female recruits, proportionally more females were hired into faculty positions as part of accommodated couples than were males. It may be that WSU's accommodation policy has been effective in recruiting a greater proportion of female faculty.

[8] Our salary analysis is similar to two previous studies. Ransom (1993) finds negative returns to seniority for the academic profession relative to other professions. He suggests that one reason for this could be a higher mobility cost of relocating for some individuals, particularly those with a spouse and/or children. However, he is not able to test this with his data because the higher cost of moving due to a partner would be confounded by the wage premium that married men receive. Ragan and Khan (2007) test Ransom's theory with faculty data from Kansas State University. They look at those academics whose partner works for the same institution and find evidence that wage growth is negatively affected when one's partner also works at the same university. Neither of these studies directly considers accommodated couples nor do they consider the effects of using an accommodation policy on the quality of a university's faculty.

The dependent variable in these equations is the log of annual salary for individual i in year t. $couple_i$ represents an individual who was hired as a couple hire, $primary_i$ represents whether that individual was the primary hire of the couple, and $\boldsymbol{X}_i$ is a vector of control variables including variables for administrator status, sex, academic rank, and academic department, as well as experience and seniority. We define seniority as the number of years a person has been continuously employed at WSU. For our final model, we repeat this analysis but expand the data to include all available observations.

Results

Couples are more likely to achieve tenure

Table 4 contains the results on tenure promotion. We find that an assistant professor who is part of a couple hire is 15.6 percentage points more likely to achieve tenure than his/her non-couple counterpart (at the mean of all variables). The coefficient is just shy of being statistically significant at standard levels,[9] but its economic significance is large. Since only 52% of all assistant professors were granted tenure, this translates to a 30% greater probability of receiving tenure for new assistant professors hired as part of a couple.

We do recognize though that both supply and demand factors affect our tenure variable. Couples may differ in their propensity to stay in the same location (see Ransom, 1993), which could be driving this effect. On the other, hand our theory predicts that on average couples will have higher levels of productivity or quality; thus this effect could be a reflection of the predicted higher productivity of couples. It is likely that we are observing a combination of these effects and hope to disentangle them in future work by including direct measures of productivity in the analysis.

Table 4: Tenure acheivment for new assistant professors hired during 1999-2002

	Probit	Marginal effects
couple	0.434	0.156†
	(0.280)	(0.099)
experience	0.015	0.005
	(0.020)	(0.007)
female	0.340*	0.122*
	(0.188)	(0.067)
constant	-0.542	
	(0.412)	
Observations	236	236
No. of Ind. in a couple	30	30

*** p<0.01, ** p<0.05, * p<0.10, † p<0.121

Year effects not reported. Field effects not reported

Robust standard errors in parentheses.

[9] The p-value is 0.121.

The effects of accommodation on salaries

Table 5 contains the wage results for both faculty hired since 1999 (columns 1 and 2) as well as all faculty (columns 3 and 4). In column 1, we find that for recently hired faculty there is little difference in salary between couple-hires and non-couple hires. In contrast, when we look at the entire sample in column 3, we find a strong positive effect on salary for couple hires.

We also are interested in determining whether there is a difference between the salaries of primary hires and their partners. For more recent hires, when we include only the couple variable (column 1) we find almost no effect, but after adding in the primary hire dummy (column 2), the results begin to tell a better story. By adding this variable we remove the effect of the primary hire from the couple variable, which allows us to interpret the couple variable as the effect for a secondary hire. New secondary hires receive on average an 11.3% wage penalty, but the primary hire receives about 11.7% more than his/her partner and thus earns approximately the same as single faculty members. Once we consider the salaries of all employees (not just those hired in the last 10 years) we find that couples

Table 5: Log of Annual Salary for Recently hired and All Faculty Members

	Hired Since 1999		All Faculty	
	model 1a	model 1b	model 2a	model 2b
couple	-0.021	-0.113**	0.046***	-0.006
	(0.019)	(0.046)	(0.016)	(0.039)
primary_hire		0.117**		0.066
		(0.049)		(0.042)
admin	0.280***	0.277***	0.333***	0.332***
	(0.052)	(0.052)	(0.019)	(0.019)
female	-0.021	-0.02	-0.025**	-0.025**
	(0.013)	(0.013)	(0.011)	(0.011)
experience	0.007***	0.007***	0.001	0.001
	(0.001)	(0.001)	(0.001)	(0.001)
seniority	-0.002	-0.002	-0.009***	-0.009***
	(0.002)	(0.002)	(0.001)	(0.001)
associate professor	0.184***	0.186***	0.190***	0.190***
	(0.012)	(0.012)	(0.012)	(0.012)
professor	0.504***	0.499***	0.477***	0.476***
	(0.031)	(0.031)	(0.019)	(0.019)
Observations	4,033	4,033	14,045	14,045
No. of Ind. in a couple	107	107	134	134

Robust standard errors in parentheses. Field effects not reported

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

receive 4.6% higher salaries on average. Furthermore, when we add the primary hire dummy (column 4), we find that secondary hires are paid about the same as other faculty but primary hires enjoy a 6.6% salary premium (though the estimate is not statistically significant at conventional levels). In future work we intend to explore whether these salary differences over couple-hire status can be explained by direct productivity measures.

4 Conclusions

Our results indicate that universities have much to gain from offering accommodation to a partner so long as that partner is qualified for their position they take. For WSU, not only does the evidence refute the common stigma of “less good” that may come with being a “secondary hire” but it supports the implication that the opposite may be true; couples hired via accommodation are likely to be some of an institution’s best faculty. Additionally, a higher probability of tenure translates into lower turnover costs and as was mentioned in footnote 1, if females represent a large percent of partner hires, then offering accommodation could be a powerful tool in recruiting and retaining female faculty.

As a robustness check to our results we are currently working to gather additional data from other institutions that are similar in stature to WSU. We will then look at how couple-hire status is correlated with direct research productivity measures such as the number and quality of academic publications.

Appendix:

1 Solving for the equilibrium levels of $\hat{\theta}_M$ and $\hat{\theta}_H$ under an independent hiring policy.

We begin by separating equation (2.10) into the three equalities given in equations (A.1.1), (A.1.2), and (A.1.3).

$$(1-\alpha)P_L^S + \alpha P_L^C = 1/3 \tag{A.1.1}$$

$$(1-\alpha)P_M^S + \alpha P_M^C = 1/3 \tag{A.1.2}$$

$$(1-\alpha)P_H^S + \alpha P_H^C = 1/3 \tag{A.1.3}$$

We have 3 equations and only 2 unknowns, $\hat{\theta}_H$ and $\hat{\theta}_M$, so one equation is redundant.

We use (A.1.1) to solve for $\hat{\theta}_M$ in terms of α.

$$\begin{aligned}
&(1-\alpha)P_L^S + \alpha P_L^C = 1/3 \\
&\Rightarrow (1-\alpha)\hat{\theta}_M + \alpha\left(\hat{\theta}_M{}^2 + 2\left(\hat{\theta}_M\right)\cdot\left(\hat{\theta}_H - \hat{\theta}_M\right) + 2\left(\hat{\theta}_M\right)\cdot\left(1-\hat{\theta}_H\right)\right) = 1/3 \\
&\Rightarrow \hat{\theta}_M - \alpha\hat{\theta}_M + \alpha\hat{\theta}_M{}^2 + 2\alpha\hat{\theta}_M\hat{\theta}_H - 2\alpha\hat{\theta}_M{}^2 + 2\alpha\hat{\theta}_M - 2\alpha\hat{\theta}_M\hat{\theta}_H = 1/3 \\
&\Rightarrow \hat{\theta}_M{}^2(-\alpha) + \hat{\theta}_M(1+\alpha) - 1/3 = 0
\end{aligned}$$

Using the quadratic formula we solve for $\hat{\theta}_M$.

$$\frac{-(1+\alpha) \pm \sqrt{(1+\alpha)^2 - 4(-\alpha)(-1/3)}}{2(-\alpha)} = \frac{-(1+\alpha) \pm \sqrt{1+(2/3)\alpha+\alpha^2}}{2(-\alpha)}$$

$$= \frac{3+3\alpha+\sqrt{9+6\alpha+9\alpha^2}}{6\alpha} \tag{A.1.4}$$

or

$$\frac{3+3\alpha-\sqrt{9+6\alpha+9\alpha^2}}{6\alpha} \tag{A.1.5}$$

The solution in equation (A.1.4) lies outside the relevant range and is not interpretable. Therefore the optimal level for $\hat{\theta}_M$ for any value of $\alpha \in (0,1]$ is given by equation (A.1.5).

We use (A.1.3) to solve for $\hat{\theta}_H$ in terms of α.

$$\begin{gathered}(1-\alpha)P_L^S+\alpha P_L^C=1/3\\ \Rightarrow(1-\alpha)\left(1-\hat{\theta}_H\right)+\alpha\left(1-\hat{\theta}_H\right)^2=1/3\\ \Rightarrow\left(1-\alpha-\hat{\theta}_H+\alpha\hat{\theta}_H\right)+\left(\alpha-2\alpha\hat{\theta}_H+\alpha\hat{\theta}_H{}^2\right)=1/3\\ \Rightarrow\alpha\hat{\theta}_H{}^2-\hat{\theta}_H(1+\alpha)+2/3=0\end{gathered}$$

Using the quadratic formula we solve for $\hat{\theta}_H$.

$$\frac{(1+\alpha)\pm\sqrt{(1+\alpha)^2-4\alpha(2/3)}}{2\alpha}=\frac{(1+\alpha)\pm\sqrt{1-(2/3)\alpha+\alpha^2}}{2\alpha}$$

$$=\frac{3+3\alpha+\sqrt{9-6\alpha+9\alpha^2}}{6\alpha} \tag{A.1.6}$$

or

$$\frac{3+3\alpha-\sqrt{9-6\alpha+9\alpha^2}}{6\alpha} \tag{A.1.7}$$

Again the solution in equation (A.1.6) lies outside the relevant range and is not interpretable. Therefore the optimal level for $\hat{\theta}_H$ for any value of $\alpha\in(0,1]$ is given by equation (A.1.7).

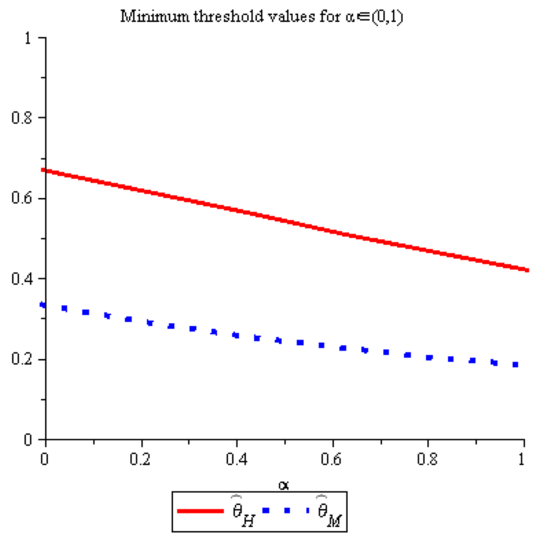
Equilibrium values for the minimum threshold levels of quality as α ranges from 0 to 1.

Table 6 contains numerical values for $\hat{\theta}_H$ and $\hat{\theta}_M$ which correspond to a range of values for α. Figure 4 is repeated from the main body of the paper and is a graphical representation of Table 6 showing the equilibrium values that both $\hat{\theta}_H$ and $\hat{\theta}_M$ take as α ranges from 0 to 1.

Table 6: Threshold levels for increasing levels of α (Individual Merit Policy)

α	$\hat{\theta}_H$	$\hat{\theta}_M$	$\hat{\theta}_H-\hat{\theta}_M$
0.0	0.667	0.333	0.333
0.1	0.644	0.312	0.332
0.2	0.620	0.292	0.328
0.3	0.594	0.274	0.321
0.4	0.569	0.257	0.312
0.5	0.543	0.242	0.301
0.6	0.517	0.228	0.289
0.7	0.492	0.215	0.277
0.8	0.468	0.204	0.264
0.9	0.444	0.193	0.251
1.0	0.423	0.184	0.239

Figure 4



It is clear from both Table 6 and Figure 4 that as the proportion of couple job candidates increases, the threshold values set by both the high and medium-quality schools decrease. It is possible that rather than consider each candidate on their own individual merits that a school or department may consider the average quality of the couple jointly. We consider this type of policy in Section 2 of the Appendix. The implications of such a policy are similar to the independent policy described above.

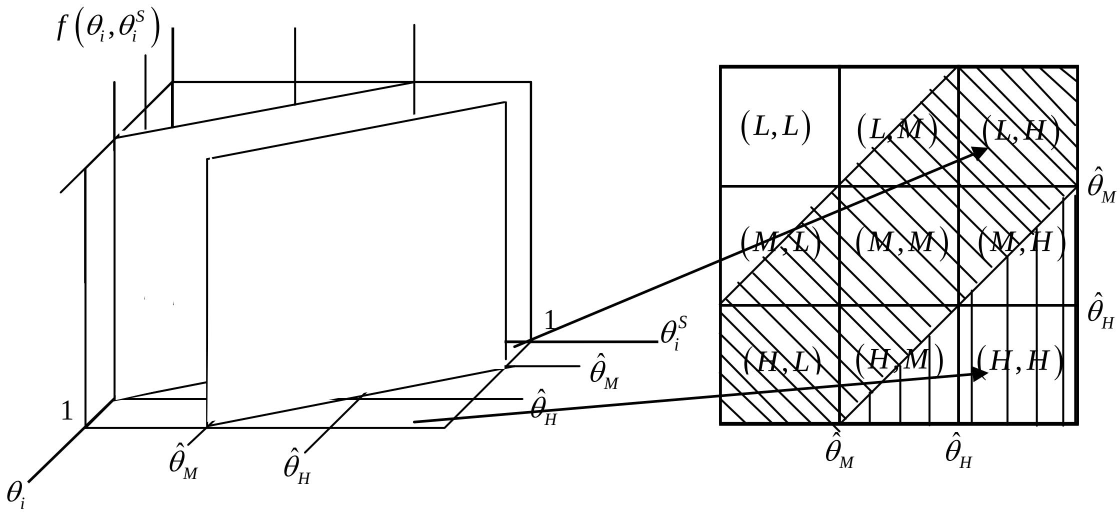
2 Academic couples and an average quality policy

Suppose that all universities consider couple candidates jointly and hire based on the average quality of the couple such that

$$\frac{\theta_i + \theta_i^S}{2} \geq \hat{\theta}_k, \;\; i \in (0,1), \; k \in \{M, H\}$$

where i indexes an individual, the superscript *S* denotes the spouse of individual *i*, and $\hat{\theta}_k$ is the minimum threshold level set by school *k*. Figure 5 illustrates the joint distribution under this assumption. There is one notable difference to the distribution under an average policy compared to an independent policy; it is now the medium-quality school rather than the low-quality school that has the greatest potential for couples to be included within its range of quality.

Figure 5: Joint Uniform Distribution of Couples, Average Quality Hiring Policy



Under an average hiring policy the probability that a high-quality school will be able to hire a couple is represented by the vertically shaded region of Figure 5. In order to define the probability of a couple being in this region we need to define the endpoints of the line. To do so, consider the extreme case where an individual's spouse has quality equal to one. Then we want to know the lowest quality level this individual could have and still be hired by the high-quality institution. Mathematically we solve

$$\frac{(x+1)}{2} = \hat{\theta}_H \tag{A.2.1}$$

for x and obtain the solution $x = 2\hat{\theta}_H - 1.$ Therefore under an average policy the probability that the high-quality university is able to hire a couple, P_H^C, is given by

$$P_H^C \equiv \frac{1}{2}\left(1-\left(2\hat{\theta}_H - 1\right)\right)\cdot\left(1-\left(2\hat{\theta}_H - 1\right)\right) = \frac{1}{2}\left(2 - 2\hat{\theta}_H\right)^2 \tag{A.2.2}$$

and is represented by the vertically shaded portion of Figure 5.

A similar calculation applies to the low-quality school. We find the point at which the average quality line for the medium-quality school intersects the axis by assuming that one member of the couple is has quality level equal to 1 and calculate the lowest level of quality the other could have and still be hired by the medium-quality institution. The solution is $x = 2\hat{\theta}_M$ and hence the probability that the low-quality university is able to hire a couple, P_L^C, is given by

$$P_L^C \equiv \frac{1}{2}\left(2\hat{\theta}_M\right)^2 \tag{A.2.3}$$

which is represented by the un-shaded portion of Figure 4.

The medium-quality school will receive candidates who do not go to either the high or low-quality schools and is therefore completely determined by the high and low-quality schools so its calculation is unnecessary.

Solving for the equilibrium levels of $\hat{\theta}_M$ and $\hat{\theta}_H$ under an average hiring policy.

We follow the same procedure as in Section 1 of the Appendix to solve for the equilibrium minimum threshold levels of quality, $\hat{\theta}_M$ and $\hat{\theta}_H$. The two equations necessary to for a solution are

$$(1-\alpha)\left(1-\hat{\theta}_H\right)+\alpha\left[\frac{1}{2}\left(2-2\hat{\theta}_H\right)^2\right]=\frac{1}{3} \tag{A.2.4}$$

for $\hat{\theta}_H$, and

$$(1-\alpha)\hat{\theta}_M+\alpha\left[\frac{1}{2}\left(2\hat{\theta}_M\right)^2\right]=\frac{1}{3} \tag{A.2.5}$$

for $\hat{\theta}_M$.

We first use equation (A.2.4) to solve for $\hat{\theta}_H$.

$$(1-\alpha)\left(1-\hat{\theta}_H\right)+\alpha\left[\frac{1}{2}\left(2-2\hat{\theta}_H\right)^2\right]-\frac{1}{3}=0$$

$$\Rightarrow 1-\alpha-\hat{\theta}_H+\alpha\hat{\theta}_H+2\alpha-4\alpha\hat{\theta}_H+2\alpha\hat{\theta}_H{}^2-\frac{1}{3}=0$$

$$\Rightarrow 2\alpha\hat{\theta}_H{}^2-(1+3\alpha)\hat{\theta}_H+\frac{2}{3}+\alpha=0$$

We plug this into the quadratic formula to obtain our solutions.

$$\frac{(1+3\alpha)\pm\sqrt{(1+3\alpha)^2-4(2\alpha)\left(\frac{2}{3}+\alpha\right)}}{2(2\alpha)}$$

$$=\frac{3+9\alpha+\sqrt{9+6\alpha+9a^2}}{12\alpha} \tag{A.2.6}$$

or

$$\frac{3+9\alpha-\sqrt{9+6\alpha+9a^2}}{12\alpha} \tag{A.2.7}$$

The solution in equation (A.2.6) is outside the relevant range and is not interpretable therefore the optimal value of $\hat{\theta}_H$ for any value of $\alpha \in (0,1]$ is given by equation (A.2.7).

Using equation (A.2.5) we solve for $\hat{\theta}_M$.

$$(1-\alpha)\hat{\theta}_M + \alpha\left[\frac{1}{2}\left(2\hat{\theta}_M\right)^2\right] - \frac{1}{3} = 0$$

$$\Rightarrow (2\alpha)\hat{\theta}_M{}^2 + (1-\alpha)\hat{\theta}_M - \frac{1}{3} = 0$$

And we use the quadratic formula to obtain the solutions.

$$\frac{-(1-\alpha) \pm \sqrt{(1-\alpha)^2 - 4(2\alpha)\left(-\frac{1}{3}\right)}}{2(2\alpha)}$$

$$= \frac{3\alpha - 3 - \sqrt{9 + 6\alpha + 9\alpha^2}}{12\alpha} \qquad \text{(A.2.8)}$$

or

$$\frac{3\alpha - 3 + \sqrt{9 + 6\alpha + 9\alpha^2}}{12\alpha} \qquad \text{(A.2.9)}$$

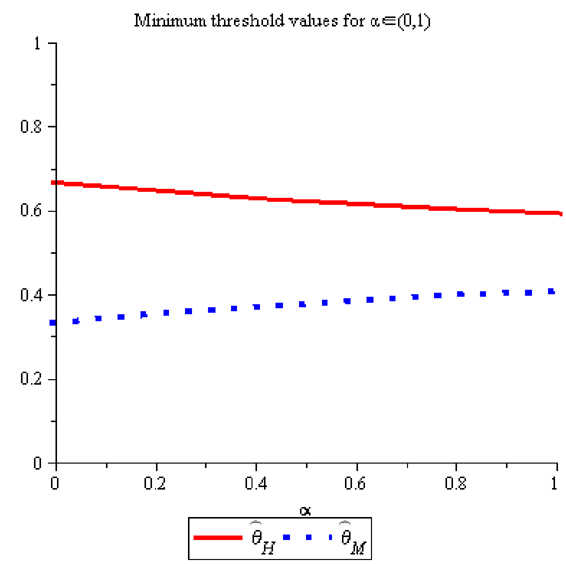
The solution in equation (A.2.8) is outside the relevant range and is not interpretable therefore the optimal value of $\hat{\theta}_M$ for any value of $\alpha \in (0,1]$ is given by equation (A.2.9).

As before, we provide both Table 7 and Figure 6 to illustrate the equilibrium values that $\hat{\theta}_M$ and $\hat{\theta}_H$ take as α increases. The high-quality school will still have to reduce its threshold level of quality, $\hat{\theta}_H$, in order to fill all open positions. However the medium-quality school will actually increase its minimum threshold level of quality because it will have too many applicants for its open positions.

Table 7: Threshold levels for increasing levels of α (Average Quality Policy)

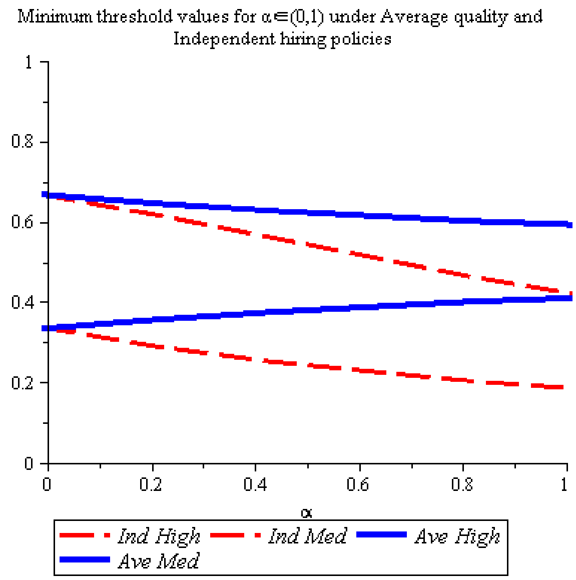
α	$\hat{\theta}_H$	$\hat{\theta}_M$	$\hat{\theta}_H - \hat{\theta}_M$
0.0	0.667	0.333	0.333
0.1	0.656	0.344	0.312
0.2	0.646	0.354	0.292
0.3	0.637	0.363	0.274
0.4	0.628	0.372	0.257
0.5	0.621	0.379	0.242
0.6	0.614	0.386	0.228
0.7	0.608	0.392	0.215
0.8	0.602	0.398	0.204
0.9	0.597	0.403	0.193
1.0	0.592	0.408	0.184

Figure 6



Now if we combine Figure 3 from Section 2.3 of the paper and Figure 6 into a single graph (see Figure 7) it is easy to see that the average hiring policy would be preferred by both the medium- and high-quality schools as minimum threshold levels are higher than they would be under an independent policy ceteris paribus. Of course in reality it may not make sense in many cases to consider the average productivity of a couple. Candidates may be applying to different departments and fair hiring practices could prohibit one department from taking a lower quality candidate than they otherwise would so that another department could get a superstar. In cases such as this an independent hiring policy would be preferred to none at all.

Figure 7



Expected quality of a couple under an average hiring policy

Here we consider the expected quality of a couple hire within a university type when universities evaluate couples by considering their *average* quality. That is, the high- (medium-) quality institution hires couples for whom $\theta_i + \theta_i^S \geq 2\hat{\theta}_H$ ($\theta_i + \theta_i^S \geq 2\hat{\theta}_M$). If this is the case, the quality of members of couples in the high-quality institution has a triangular distribution between $2\hat{\theta}_H - 1$ and 1. As a result, the expected quality of such individuals is given by

$$E(\theta_i \mid \theta_i + \theta_i^S \geq 2\hat{\theta}_H) = \int_{2\hat{\theta}_H - 1}^{1} \frac{2x - 2(2\hat{\theta}_H - 1)}{(2 - 2\hat{\theta}_H)^2} x dx = \frac{2\hat{\theta}_H + 1}{3}. \qquad \text{(A.2.10)}$$

And the expected quality of a non-couple hire is simply $\frac{1+\hat{\theta}_H}{2}$. Thus under an average evaluation policy in the high-quality school, the expected quality of non-couple hires is strictly greater than that of couple hires since $\frac{1+\hat{\theta}_H}{2} > \frac{2\hat{\theta}_H + 1}{3}$ for $\hat{\theta}_H \in (0,1)$.

To determine the average quality of couple hires in the low-quality institution, we again note that the low-quality school will end up hiring couples for whom $\theta_i + \theta_i^S < 2\hat{\theta}_M$. The quality of members of these couples is again triangularly distributed (between 0 and $2\hat{\theta}_M$). Their expected quality is thus

$$E(\theta_i \mid \theta_i + \theta_i^S < 2\hat{\theta}_M) = \int_0^{2\hat{\theta}_M} \frac{2(2\hat{\theta}_M - x)}{(2\hat{\theta}_M)^2} x dx = \frac{2\hat{\theta}_M}{3}. \quad \text{(A.2.11)}$$

And the expected quality of a non-couple hire is $\frac{\hat{\theta}_M}{2}$. Thus in low-quality universities, the expected quality of non-couple hires is strictly less than that of couples, since $\frac{\hat{\theta}_M}{2} < \frac{2\hat{\theta}_M}{3}$.

Lastly, we use the fact that the average quality across all individuals who are members of couples must be 0.5 (since their quality is uniformly distributed between 0 and 1) to determine the average quality of couples in medium-quality institutions. That is, we set

$$\begin{aligned}
&\Pr(\theta_i + \theta_i^S < 2\hat{\theta}_M)E(\theta_i \mid \theta_i + \theta_i^S < 2\hat{\theta}_M) \\
&+\Pr(2\hat{\theta}_M < \theta_i + \theta_i^S < 2\hat{\theta}_H)E(\theta_i \mid 2\hat{\theta}_M < \theta_i + \theta_i^S < 2\hat{\theta}_H) \\
&+\Pr(\theta_i + \theta_i^S \geq 2\hat{\theta}_H)E(\theta_i \mid \theta_i + \theta_i^S \geq 2\hat{\theta}_H) \\
&= \frac{1}{2}.
\end{aligned}$$

Filling in pieces that we already have, this equation becomes

$$\begin{aligned}
&2(\hat{\theta}_M)^2\left(\frac{2\hat{\theta}_M}{3}\right) \\
&+\left(1 - 2(\hat{\theta}_M)^2 - 2(1-\hat{\theta}_H)^2\right)E(\theta_i \mid 2\hat{\theta}_M < \theta_i + \theta_i^S < 2\hat{\theta}_H) \\
&+2(1-\hat{\theta}_H)^2\left(\frac{2\hat{\theta}_H + 1}{3}\right) \\
&= \frac{1}{2}.
\end{aligned}$$

Solving for the expected quality of couples in medium-quality institutions yields

$$E(\theta_i \mid 2\hat{\theta}_M < \theta_i + \theta_i^S < 2\hat{\theta}_H) = \frac{-8(\hat{\theta}_H)^3 - 8(\hat{\theta}_M)^3 + 12(\hat{\theta}_H)^2 - 1}{-12(\hat{\theta}_H)^2 - 12(\hat{\theta}_M)^2 + 24(\hat{\theta}_H) - 6}.$$

This becomes

$$E(\theta_i \mid 2\hat{\theta}_M < \theta_i + \theta_i^S < 2\hat{\theta}_H) = \frac{1}{2} \ \ if \ \ \hat{\theta}_H + \hat{\theta}_M = 1. \quad \text{(A.2.12)}$$

It can be shown that when all university types use an average evaluation policy, $\hat{\theta}_H + \hat{\theta}_M$ must be equal to 1. If this is the case, the expected quality of non-couple hires in medium-quality institutions is $\frac{\hat{\theta}_H + \hat{\theta}_M}{2} = \frac{1}{2}$. Thus, the average quality of couple hires is the same as that of non-couple hires in medium-quality institutions under an average hiring policy.

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