THE GENDER WAGE GAP AT UMASS AMHERST:
A CROSS SECTIONAL AND LONGITUDINAL ANALYSIS OF TENURE TRACK FACULTY

INSTITUTE FOR SOCIAL SCIENCE RESEARCH

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I. Executive Summary

There is both good news and bad news about advances in gender equity at UMass. On average, women faculty make 83.8 cents for every dollar that their men colleagues make at the University of Massachusetts Amherst (UMass). The good news is that when examining what factors help explain this gap in pay, there is no statistically significant difference in salaries of men and women at the same rank in the same college. This is good news, and indicates that UMass has a smaller within-job gender gap than other US public research universities that have conducted faculty salary equity studies. Although within-job pay gaps are not significant, there are other areas of gender equity in which UMass (like other universities) has not seen improvements in the last dozen years. The durable underrepresentation of women faculty in a number of colleges, for example, needs to be addressed. The fact that UMass has conducted a rigorous analysis of gender equity on its campus that looks at weaknesses as well as strengths is another piece of good news: this study puts UMass in a strategic position to be able to take a lead in creating an equitable university that can be a model for other research universities.

We examine questions of gender equity by studying data on faculty salaries at UMass Amherst from 2003 through 2015. Additionally, we draw on available data on faculty representation from UMass Office of Equal Opportunity and Diversity (EOD). We use methodological approaches commonly used in salary equity studies such as descriptive statistics, multivariate regression, and regression decomposition. We also introduce several methodological innovations, such as using longitudinal salary growth-models, to understand how the salary trajectories for men and women evolve over time and at different ranks.

While we find that women tenure-track faculty earn on average 84 cents for every dollar men faculty make, most of this gap closes once we introduce statistical controls for other factors commonly associated with differences in salary. In particular, faculty members' rank and college explain much of the initial salary differences associated with gender. Men and women with similar characteristics in the same college and rank earn similar salaries.

These within-job results do not dismiss the existence of gender inequities at UMass Amherst. Rather, the results clearly show that the underrepresentation of women in higher-paying positions and colleges creates an institution-wide imbalance in salary. Over time, gains have been made so that women now comprise over half of all assistant professors and nearly half of all associate professors. However, women still hold only 29 percent of full professorships at UMass. The persistent underrepresentation of women at the rank of full professor suggests the need for an in-depth evaluation of the University's retention and promotion processes.

Women were also underrepresented in the four colleges with the highest average salaries: Information and Computer Science (8 percent of faculty are women), Engineering (14 percent), Natural Sciences (30 percent), and Management (34 percent). Underrepresentation of women in these colleges appears to be an institutional pattern beyond national underrepresentation of women in certain fields. According to data from the UMass Office of Equal Opportunity and Diversity, 20 departments across the university underutilize the available pool of women with a doctoral degree in those fields. Out of these 20

departments, 16 of them (80 percent) are in the four colleges identified above. Over 60 percent of the departments in those four colleges underutilize the national pool of expert women who could be hired as faculty at UMass. The disparities in certain fields suggests attention should be given to reevaluating faculty recruitment, hiring, and retention in departments where gender imbalances have proved durable over time.

Our longitudinal analysis examines possible salary differences in starting conditions at hire and in salary growth between men and women. Women tend to start at lower salaries than men. This extends to women having lower salaries than men as associate professors. However, perhaps in part due to UMass policies that address salary anomalies, women associate professors have a higher salary growth rate, allowing women faculty to catch up to their men colleagues by the time they reach full professor. As in the cross sectional analysis, the inclusion of statistical controls for college explains much of the initial gender pay gap, however, the faster rate of salary growth among women associate professors remains. This finding could be a product of selection mechanisms in which women who make full professor outperform their colleagues with relatively better research, publication, and grant records than men who reach the highest rank, and thus attain higher salaries due to merit bonuses and other salary negotiations. It may also be a product of effective UMass policies, such as anomaly pay increases, that address and reduce original disparities.

UMass has the opportunity to be a leading institution in gender equity, which fits squarely in the university's strategic plan for diversity, equity, and inclusion. While starting from a position of strength, there is need to continue to collect data and develop supportive policies. Our results suggest that policies and practices that increase the recruitment and retention of women faculty members and provide support for their promotion can help reduce the overall gender salary gap.

II. Introduction

This report presents the findings from a study to identify gender inequities in salaries for tenure track faculty at the University of Massachusetts Amherst. The study tries to answer one fundamental question: Is there a significant difference in salary between male and female tenure track faculty?

The study was jointly commissioned by the Massachusetts Society of Professors (MSP) and the Office of the Provost.[1] A team of one graduate student and three faculty researchers affiliated with the Institute for Social Science Research (ISSR) conducted the analysis. The UMass Office of Institutional Research (OIR) compiled and provided most of the administrative data, including information on salaries, position/rank, gender, race, and years of service. Information on the number of grant awards held by faculty, downloaded from the Online Data Warehouse of the Office of Grant and Contract Administration (OGCA), was incorporated into the dataset by the ISSR team.[2]

We follow the general template used in the UC Berkeley Salary Equity Study, with some notable modifications.[3] The richness of our data allowed us to incorporate novel methodological techniques that reveal interesting aspects of the overall gender salary gap. The methodology and data for the study were agreed upon by MSP and the Office of the Provost.

We present findings of three separate but connected analyses. First, we present descriptive statistics on the number and average salaries of tenure track faculty at the university, at each college, and at each rank by gender. Next, we develop a series of multivariate regression models that isolate the effect of gender on salary accounting for factors widely known to determine salary levels for tenure track faculty. The multivariate regression results are accompanied by regression decompositions that explain why there was a gap in wages in 2015. Lastly, we report results of longitudinal models that track the salary trajectory of male and female faculty members over time as they move along the tenure track. Our longitudinal models are a unique methodological contribution that has rarely been used in salary equity studies, and has not yet been utilized in previous studies at other large public universities.

After describing the results, we discuss possible mechanisms behind the trends we found in the analysis and suggest attention be given to possible policy measures to improve gender equity across the university, at specific colleges, and across academic ranks. We conclude the report with steps for future research to further explore possible gender inequities in the promotion and retention of women.

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[1] Funding for the study was provided by the Office of the Provost.
[2] For details on data management, and definitions of variables, please see Appendix D.
[3] For details on UC Berkeley's Faculty Salary Equity Study see UC Berkeley Office of the Vice Provost for the Faculty, "Report on the UC Berkeley Salary Equity Study", January 2015, available at http://vpf.berkeley.edu/sites/default/files/Equity%20Study%20Report%20final%201-26-15%20--revised.pdf

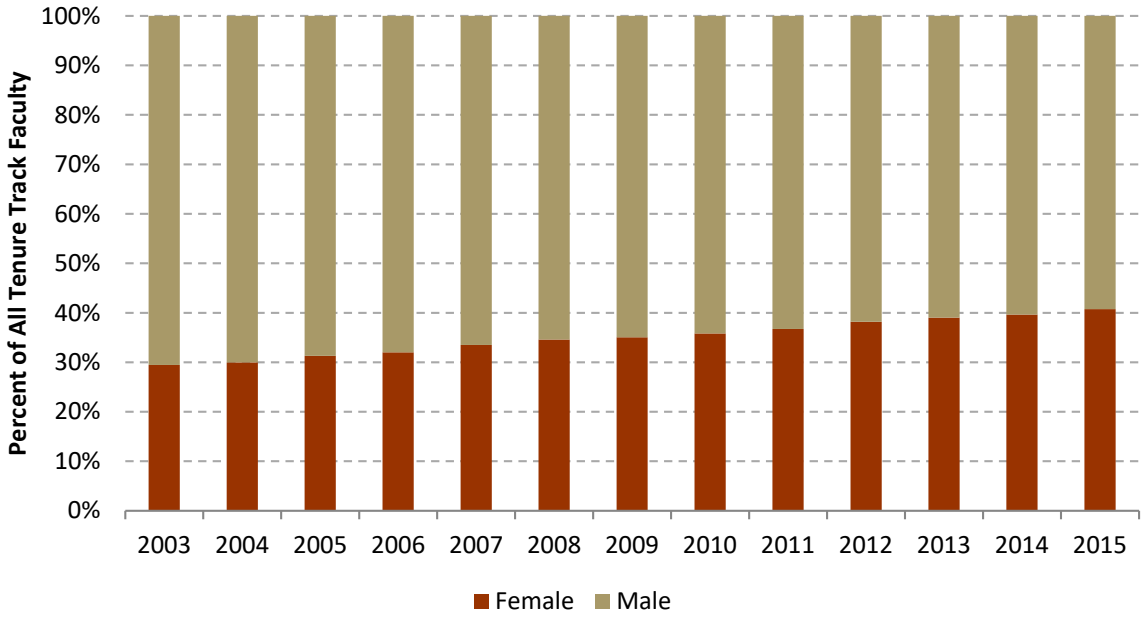
III. Descriptive Statistics

This section presents detailed descriptions about the number of faculty members by sex, their distributions across colleges and ranks, and their average salaries.

A. Number of Faculty by Gender, Rank, and College

Men comprise the majority of the tenure track faculty at UMass Amherst, but the gap has closed in the past few years (Figure 1). In 2015, 59 percent (650) of all tenure-track faculty were men and 41 percent (447) women. However, the proportion of women has grown from 29.5 percent in 2003. The increase in the proportion of women faculty is a result of the 64 percent increase in the number of female faculty and no increase in the number of male faculty members in the past 13 years.

Figure 1: Percent of Tenure Track Faculty by Sex, 2003-2015

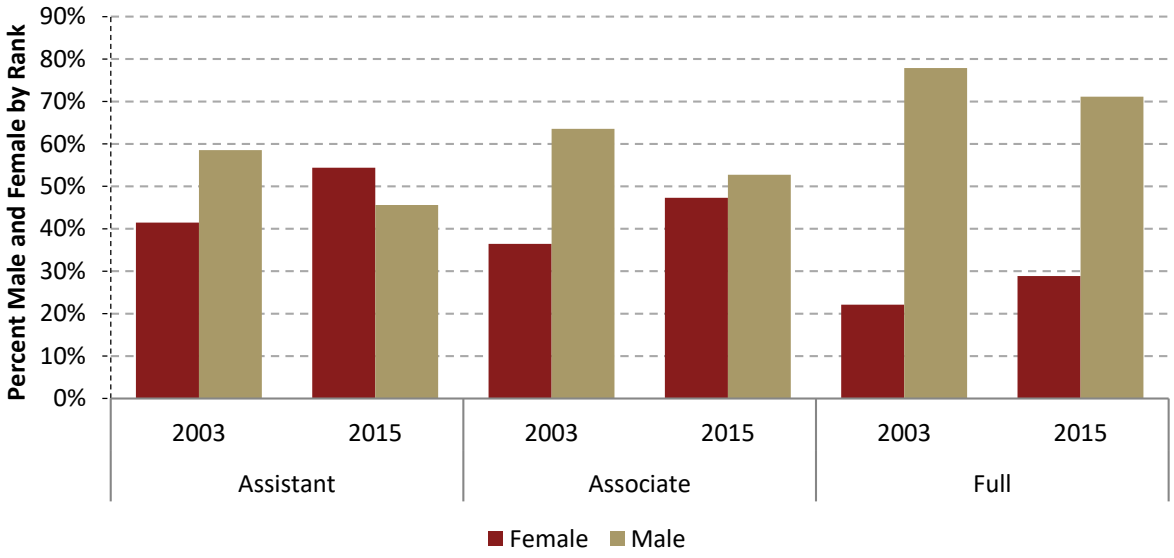


The skewed gender balance is particularly prevalent among senior faculty. In 2015, women comprised 54 percent of all assistant professors and 47 percent of all associates, but only 29 percent of full professors (Figure 2). In absolute numbers, there are more than twice as many men as women at the highest rank; however, the underrepresentation of women at that rank has decreased. In 2003 there were 3.5 times more male full professors than women. This gap has decreased as the number of male full professors decreased by 9 percent, while the number of female full professors increased by almost 30 percent between 2003 and 2015.

There has been more substantial growth in the number of women at the assistant and associate professor levels. The number of women at the assistant professor level has more than doubled between 2003 and 2015, while the number of women at the associate level increased by 50 percent. In contrast,

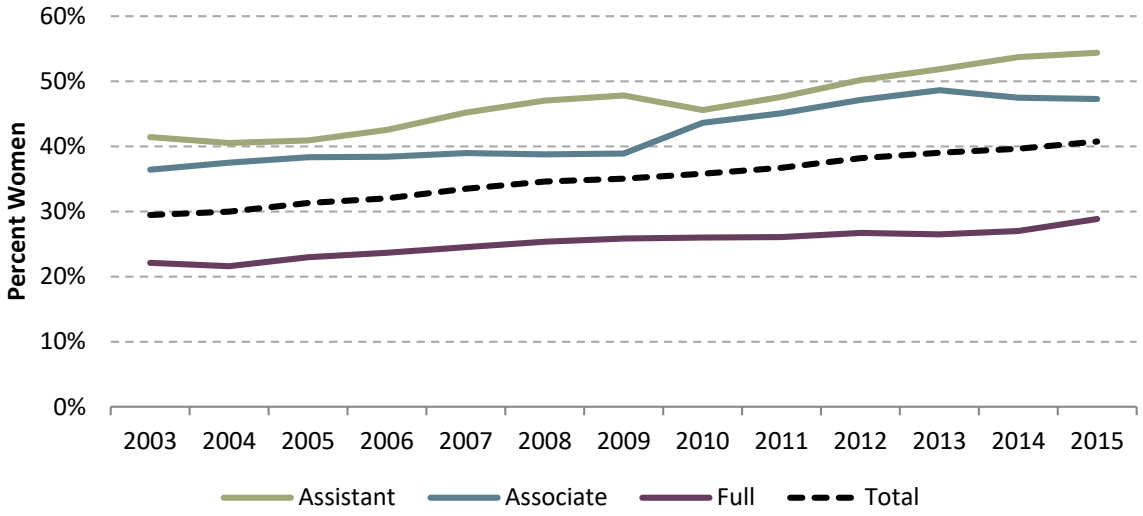
the number of male assistant professors increased by only 46 percent during this time, while the number of male associates decreased slightly since 2003.

Figure 2: Number of Tenure Track Faculty by Rank and Sex, 2003 and 2015.



The proportion of women at each rank has grown steadily over time (Figure 3). In the mid-1990s, women comprised roughly 40 percent of all junior faculty. Starting in 2012 the number of female assistant professors surpassed the number of males and has remained above 50 percent in the years since. The proportion of women at the associate rank peaked in 2013 at 49 percent, and declined slightly to its current level of 47 percent. This small decrease is likely a temporary departure from the general upward trend, given the steady increase in the number of women in the junior faculty pipeline; It could reflect either a slow-down in promotions of women from assistant to associates, or, the growing number of women at the full professor rank, which reached its highest level ever in 2015 at 29 percent.

Figure 3: Percentage of Women Tenure Track Faculty by Rank, 2003-2015



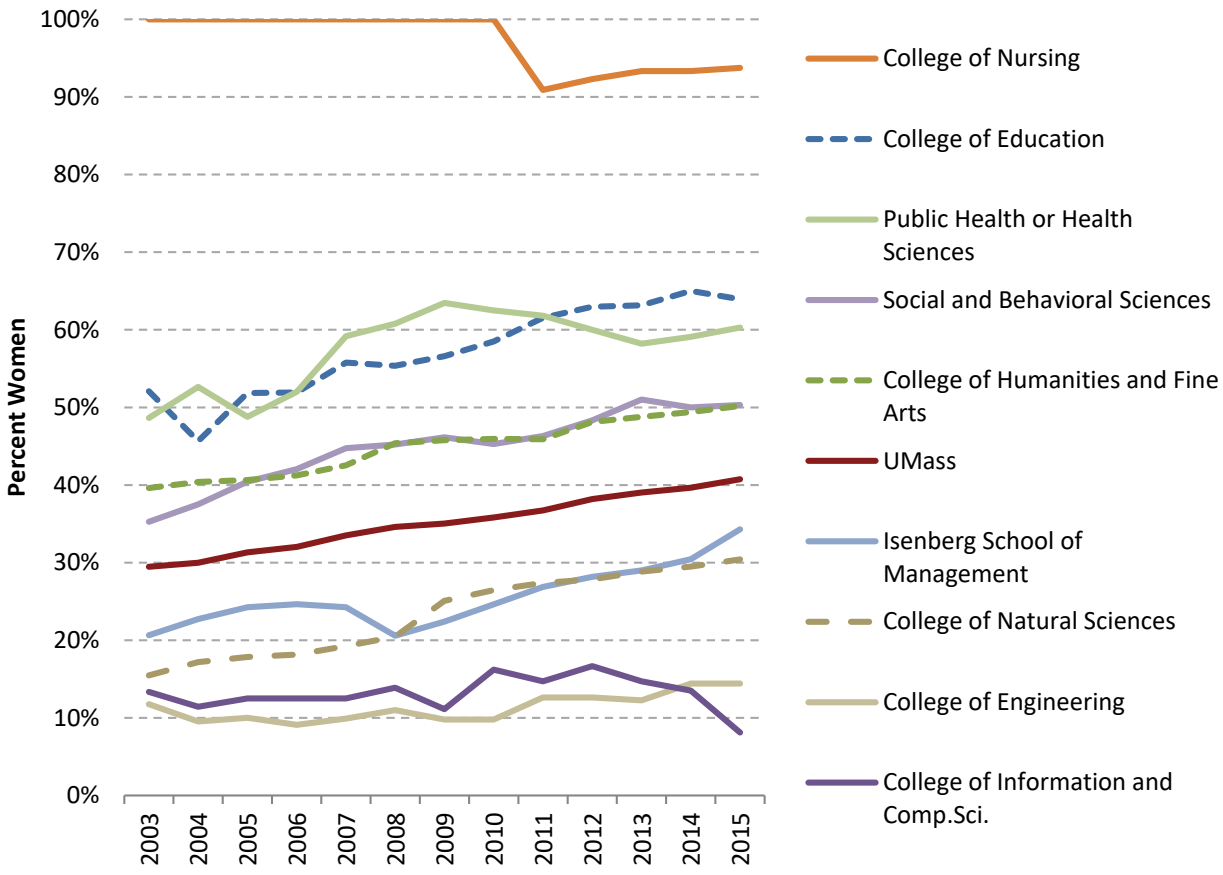
There are considerable differences in the gender balance of faculty by college (Table 1). Women comprise less than a third of all faculty in Information and Computer Science (CICS), Engineering, and Natural Sciences. Note that Engineering and Natural Sciences are two of the four largest colleges at UMass in number of faculty, so women's underrepresentation in these colleges affects women faculty's underrepresentation in the university as a whole. In the Isenberg School of Management, women represent about a third (34 percent) of all tenure track faculty. By contrast, nearly all of the faculty in the College of Nursing and more than 60 percent of faculty in the colleges of Education and Public Health are women. These three colleges where women are most highly represented are the smallest colleges at UMass in faculty numbers (except for the new CICS), so these colleges do not have the same effect on women faculty's representation in the university as a whole as do the larger colleges. There is a near even balance of female and male faculty in the colleges of Humanities and Fine Arts and Social and Behavioral Sciences, which are two of the larger colleges.

Table 1: Number and Percentage of Tenure Track Faculty by College and Sex, 2015.

College / School	Female		Male		Total	
Education	39	63.9%	22	36.1%	61	100%
Engineering	15	14.4%	89	85.6%	104	100%
Humanities and Fine Arts	129	50.2%	128	49.8%	257	100%
Information and Computer Science	3	8.1%	34	91.9%	37	100%
Isenberg School of Management	24	34.3%	46	65.7%	70	100%
Natural Sciences	94	30.4%	215	69.6%	309	100%
Nursing	15	93.8%	1	6.3%	16	100%
Public Health or Health Sciences	41	60.3%	27	39.7%	68	100%
Social and Behavioral Sciences	82	50.3%	81	49.7%	163	100%
UMass Amherst	447	40.7%	650	59.3%	1,097	100%

The proportion of women has increased in the majority of colleges over the past thirteen years (Figure 4). The exceptions are Nursing (which once was entirely comprised of women) and Information and Computer Science. Among the four Colleges where women comprised less than half the faculty in 2015, there has been the most growth in the proportion of women in the School of Management, which rose from 21 percent in 2003 to 34 percent in 2015, as well as in the College of Natural Sciences, where the share of female faculty rose from 16 percent in 2003 to 30 percent in 2015. Engineering and Information and Computer Science have not fared as well. Engineering is just 2.6 percentage points above its 2003 value. In Information and Computer Science, the proportion of women has declined since 2012 and is now 5.2 percentage points below its 2003 level.

Figure 4: Trends in the Proportion of Women by College, 2003-2015



The percentage of faculty made up by women varies by rank in each of the nine colleges (Table 2). This is complicated by the fact that women are underrepresented at the highest rank in seven out of the nine colleges. Only in the Colleges of Public Health and Nursing do women represent over 50 percent of the faculty in the highest rank. At the associate level, women are underrepresented in four colleges — Computer Science, Engineering, Natural Sciences and Isenberg—, equally represented in one — Social

and Behavioral Sciences (SBS)—, and the majority in four (Humanities and Fine Arts, Public Health, Education, and Nursing). At the assistant level, women are under-represented in two —Computer Science and Engineering—, almost equally represented in one —Natural Sciences—, and the majority in the remaining six.

Table 2: Percent Female and Percent Male by College and Rank, 2015. (Faculty Counts in Parenthesis)

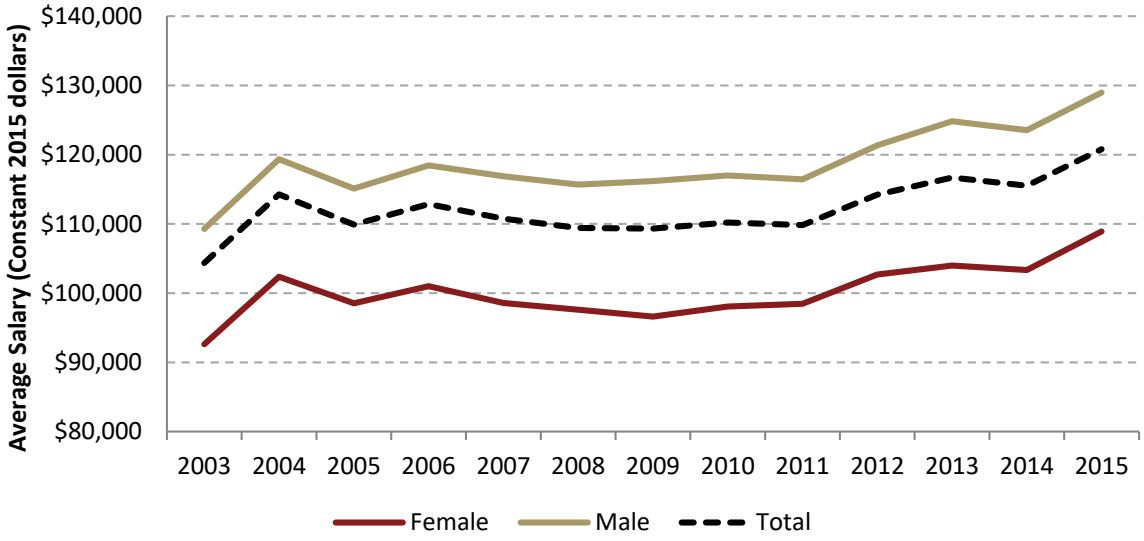
	Assistant		Associate		Full		Overall	
	Female	Male	Female	Male	Female	Male	Female	Male
Education	73.3%	26.7%	70.4%	29.6%	47.4%	52.6%	63.9%	36.1%
	(11)	(4)	(19)	(8)	(9)	(10)	(39)	(22)
Engineering	34.8%	65.2%	12.5%	87.5%	7.0%	93.0%	14.4%	85.6%
	(8)	(15)	(3)	(21)	(4)	(53)	(15)	(89)
Humanities and Fine Arts	56.1%	43.9%	58.7%	41.3%	39.0%	61.0%	50.2%	49.8%
	(46)	(36)	(44)	(31)	(39)	(61)	(129)	(128)
Information and Comp. Sci.	18.2%	81.8%	0.0%	100%	5.6%	94.4%	8.1%	91.9%
	(2)	(9)	(0)	(8)	(1)	(17)	(3)	(34)
Isenberg SOM	55.6%	44.4%	30.4%	69.6%	24.1%	75.9%	34.3%	65.7%
	(10)	(8)	(7)	(16)	(7)	(22)	(24)	(46)
Natural Sciences	47.5%	52.5%	37.5%	62.5%	21.9%	78.1%	30.4%	69.6%
	(28)	(31)	(27)	(45)	(39)	(139)	(94)	(215)
Nursing	100%	0.0%	100%	0.0%	80.0%	20.0%	93.8%	6.3%
	(5)	(0)	(6)	(0)	(4)	(1)	(15)	(1)
Public Health	60.7%	39.3%	60.0%	40.0%	60.0%	40.0%	60.3%	39.7%
	(17)	(11)	(15)	(10)	(9)	(6)	(41)	(27)
Social and Behavioral Sci.	63.6%	36.4%	50.0%	50.0%	41.8%	58.2%	50.3%	49.7%
	(28)	(16)	(26)	(26)	(28)	(39)	(82)	(81)
UMass Amherst	54.4%	45.6%	47.3%	52.7%	28.9%	71.1%	40.7%	59.3%
	(155)	(130)	(148)	(165)	(144)	(355)	(447)	(650)

B. Average Salaries by Gender and Rank

On average, men faculty have a baseline salary just over $20,000 more than female faculty at UMass Amherst (Figure 5).[4] In 2015, men faculty members had an average salary of $128,968 compared to $108,904 for women. This means that women faculty make an average of 84 cents for every dollar made by men faculty. However, this institution-wide average does not account for factors such as rank and/or college—for instance a greater proportion of senior faculty are men, and women are underrepresented in colleges that have higher baseline salaries. As we show later, these two factors explain much of the gender wage disparity found for UMass as a whole.

[4] Baseline salary does not include any additional compensation paid to faculty, such as summer salary from grants and contracts.

Figure 5: Faculty Salaries by Sex, 2003 to 2015 (in 2015 dollars)

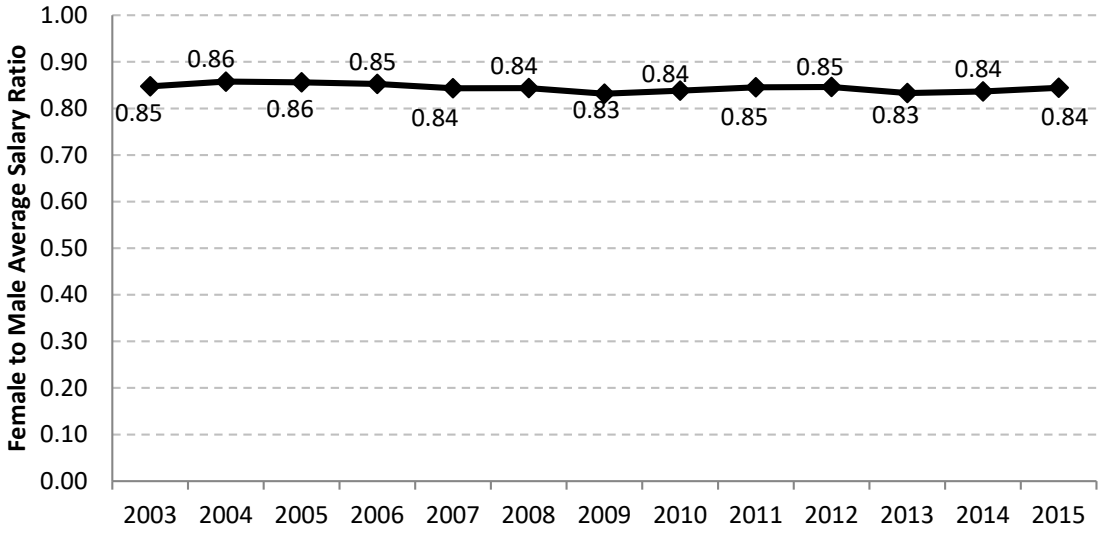


Overall salary growth for men and women follow a very similar trend between 2003 and 2015. Faculty salaries saw real dollar stagnation and decline around 2008 as a consequence of the global economic slowdown and University budget cuts, but have steadily risen since, in conjunction with improvement in the broader economy.

The wage gap between women and men has remained persistent over the recent past, with average salary for female faculty hovering between 83 and 86 percent of male faculty (Figure 6). The persistence of the gender salary gap is somewhat surprising as the growing number of women at higher ranks should reduce gender wage disparities. However, the relatively faster addition of female assistant professors, who make considerably less than senior faculty regardless of gender, may help explain the mostly stagnant pay gap. The absolute gap has actually widened slightly since 2003. In 2003, the absolute pay difference between women and men was $16,662, slightly less than the current (2015) gap of $20,068.

Next we consider whether there is a salary gap between women and men of similar rank. Rank is an important consideration in understanding the sources of the wage gap among UMass faculty. There are more male faculty at higher ranks, especially full professors, and senior faculty make considerably more than junior faculty, other factors notwithstanding. The number of female faculty at all ranks has been rising in recent years. At the same time, the growth of women at the assistant rank has been faster than the growth of women at the associate and full ranks, which might actually make it seem like wage disparities are growing if one does not account for rank.

Figure 6: Trend in Ratio of Women's Average salary to Men's Average Salary



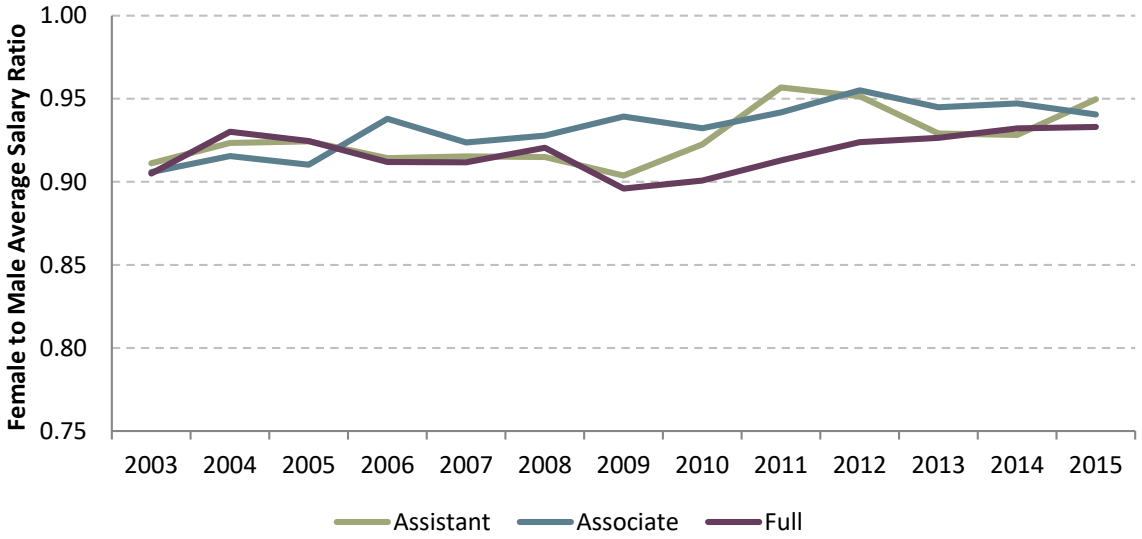
Controlling for rank, we find that men still earn more than women within each of the three ranks (Table 3). However, if we compare men and women's average salary at the same rank, the overall salary gap is reduced considerably. Within rank, women earn between 93 to 95 cents per every dollar earned by their male counterparts—compared to 84 cents on the dollar when we do not account for rank. There is a positive relationship between rank and the gender salary gap. The gap is widest among full professors, where women earn $10,287 (7 percent) less than men. It is lowest among assistant professor where women earn $4,448 (5 percent) less than men. Some of this gap at the senior faculty ranks may be due to seniority differences within rank—if women were more recently promoted than men, for instance. This seniority gap, however, is less likely to explain wage differences among pre-tenure faculty.

Table 3: Average salaries by sex and rank, 2015.

	Female	Male	Difference	Ratio
Assistant	$84,004	$88,452	$4,448	0.95
Associate	$101,532	$107,953	$6,422	0.94
Full	$143,285	$153,572	$10,287	0.93
All Ranks	$108,904	$128,968	$20,063	0.84

The gap between female and male faculty has shrunk at every rank since 2003 (Figure 7). At the assistant rank, the gap shrank from 0.91 in 2003 to 0.95 in 2015. For assistant professors, the gap shrank from 0.91 to 0.94, and for full professors it shrank from 0.90 to 0.93.

Figure 7: Female to Male Salary Ratio, 2003-2015.



C. Average Salaries by Gender and College

Large differences in average pay by college coupled with differences in the gender composition in each college are part of the overall salary gap between male and female faculty. Faculty salaries are highest in the Isenberg School of Management, followed by the Colleges of Information and Computer Science, Engineering, and Natural Sciences (Table 4). These are also the colleges with the lowest percentages of women faculty members, and are among the largest colleges (except CICS).

Table 4: Average Salaries by College and Gender, 2015.

	Female	Male	Salary Difference	Salary Ratio
Other	$172,687	$220,462	$47,775	0.78
Information and Comp. Sci.	$119,835	$150,064	$30,229	0.80
Engineering	$113,609	$138,706	$25,097	0.82
Natural Sciences	$114,047	$130,562	$16,515	0.87
Education	$99,502	$114,326	$14,824	0.87
Isenberg SOM	$157,035	$174,224	$17,188	0.90
Humanities and Fine Arts	$99,073	$108,620	$9,547	0.91
Social and Behavioral Sciences	$108,717	$116,407	$7,690	0.93
Public Health	$100,059	$98,420	-$1,638	1.02
UMass Amherst	$108,904	$128,968	$20,063	0.84

Notes: Colleges are ordered from lowest to highest salary ratio. Salary data for the college of Nursing is not reported in this table because of low numbers of faculty members. Other College includes tenure-track faculty that are not hired as part of one of the 8 established academic colleges. The majority of tenure-track faculty in the "Other College" hold administrative positions.

An important question is whether female faculty make as much as their male counterparts within each college. Women make less than men in most colleges (Table 4). The College of Public Health is the only college where women make more than men—although the gap is much smaller (2 cents on the dollar) than the other colleges where men make more than women. Among the others, the gender wage gap is lowest in the two gender integrated colleges—Social and Behavioral Sciences and the College of Humanities and the Fine Arts. The gender gap is also relatively low in the Isenberg School of Management, despite the fact that this school is among those where women represent a small share of faculty. The College of Nursing has the highest gender wage gap. However, this college of 16 faculty has only one male faculty member, who also holds an administrative position within the college. The Colleges of Engineering and Computer Science have the highest pay gap between men and women. These Colleges are among those with the lowest shares of women faculty, and have made less relative progress in increasing gender diversity among faculty. However, our descriptive analysis of College-level differences does not account for rank differences within college, and so we turn to our multivariate analyses that can control for multiple factors.

IV. Multivariate Regression Results: Explaining the Gender Gap in 2015

A. Data and Methodology

In this section we use multivariate regression analysis to better understand the possible causes of the gender differences in salary among tenure-track faculty. A multivariate regression approach allows us to control for numerous influences that might be associated with salary and gender—such as college, rank, the number of years employed at UMASS, research productivity — in order to isolate the effect of gender on salary.

Differences in faculty salaries are a result of several factors, some pertaining to characteristics of the individual and some related to structural or institutional bias.

We can conceptually estimate an individual *i*'s salary using the linear equation:

$$Log\ (Salary)_i = \alpha + \beta_1 x1_i + \beta_2 x2_i + \beta_3 x3 + \varepsilon_i$$

where $x1$ is a vector of observed personal characteristics, $x2$ a vector of unobserved personal characteristics, and $x3$ is a vector that accounts for unobserved structural and institutional factors that affect a person's salary. Differences in salary that are a result of pure random variation uncorrelated with any of the other three sets of factors are captured by an error term ε, and α is a constant term. The coefficients— represented by the different *B*s in the equation— are estimates of the effect of these different groups of factors on income.

The data we have only allow us to capture some important observed characteristics. Unobserved personal characteristics such as work ethic, reputation, and quality of teaching are not measured directly in the model. However, these factors would only be relevant if we expect them to differ

systematically by gender (which is not found in the research literature). To approximate the effects of unobserved institutional and structural factors that are associated with gender, we include a variable for gender (*Female*). The effects of unobserved factors that affect pay will be partially captured by the error term, but will also bias the coefficients of the variables we include in the model.

We use Ordinary Least Squares (OLS) regression to measure the net effect of gender on salary. We take a nested and sequential model building approach. We start with a simple model that only considers the effect of gender on salary. We then incrementally add more observed characteristics to our baseline model, allowing us to determine how these other factors alter the observed relationship between gender and salary. We present results on the following five models:

- Model 1 includes only a dummy variable for gender that indicates whether tenure track faculty member is female (*Female*).
- Model 2 adds controls for race, measured as two dummy variables, one indicating whether the faculty was Asian (*Asian*) a second that identifies whether the faculty is a member of an underrepresented minority group such as African American, Hispanic, Native American, or Multiracial (*Minority*).[5]
- In Model 3 we add controls for experience at UMass, highest degree attained, and research productivity. To measure experience at UMass we control for whether the faculty member held an administrative position (*Admin Position*), was a department head (*Dept. Head*), and the number of years the faculty has been at UMass (*Years at UMass*). To measure highest degree attained, we include dummy variables that indicate a law degree (*Law Degree*), a doctoral degree (*PhD*), or another degree (*Other Degree*), and we use master's degree as the reference category. To approximate research productivity, we include the number of grants awarded in 2015 (Grants).[6]
- Model 4 accounts for rank (*Associate* and *Full*) using assistant as the reference category.
- Model 5 adds controls for college, using the College of Humanities and Fine Arts as the reference group.

[5] The small number of Native American, Hispanic, African American, and Multiracial faculty did not allow us to estimate effects of these racial categories separately.

[6] We recognize that the number of grants is an imperfect measure of research productivity. Grants differ greatly in terms of amount and duration, prestige of the funding entity, and by differences in the availability of grants in different disciplines and sub-disciplines. Furthermore, grants data provided do not cover all grants and contracts, especially smaller external and internal awards. Despite these limitations, and lacking better alternatives, we believe that the number of external grant awards does provide a general indicator of which faculty are active in external research. We also tried lagging grants variable by one and two years, but the effects were similar. Appendix C includes a discussion of the alternate specifications.

Our analysis is conducted on the 1,097 faculty who worked at UMass in 2015.[7] The dependent variable (*Salary*) is measured in natural logarithms, to help normalize the distribution of salaries. All salaries are measured in full-time equivalents to account for salary differences among faculty working on a part-time basis during 2015.

Because salary is transformed to its logged form, the coefficients can be interpreted as the percent difference in average salary between a specific group and their respective reference in our categorical independent variables (gender, race, admin position, dpt. head, highest degree, rank, and college), or as the percent change in salary for a one unit increase in continuous independent variables (Years at UMass).

B. University-Wide Regression Results

Table 5 presents the results of the OLS regression models for all tenure track faculty employed at UMass during 2015. According to the baseline results provided in Model 1, women made roughly 16.2 percent less than their men counterparts in 2015, without controlling for other possible factors. Adding race reduces the gender gap, but only slightly to 15.8 percent (Model 2). Although not an explicit focus of this study, we also find that members of under-represented minority groups earn an average of 14.3 percent less than white faculty, controlling for gender. Asian faculty earn roughly 7 percent less than white faculty.

[7] The approach presented in this section only examines faculty attributes as measured in 2015 and does not account for historical processes that might have led to current salary levels. For results on longitudinal analyses using data between 2003 and 2015, see section VI.

Table 5: OLS Regression Results, 2015 (Standard Errors in Parentheses)

	Model 1	Model 2	Model 3	Model 4	Model 5
Female	-0.162	-0.157	-0.085	-0.049	-0.014
	(0.018)***	(0.018)***	(0.014)***	(0.011)***	(0.009)
Asian		-0.072	0.019	0.031	0.005
		(0.026)**	(0.020)	(0.016)*	(0.013)
Minority		-0.143	-0.083	-0.071	-0.046
		(0.029)***	(0.023)***	(0.018)***	(0.015)**
Admin Position			0.488	0.342	0.303
			(0.035)***	(0.028)***	(0.026)***
Dept. Head			0.228	0.115	0.096
			(0.032)***	(0.026)***	(0.021)***
Years at UMass			0.012	0.002	0.002
			(0.001)***	(0.001)**	(0.001)**
Law Degree			0.152	0.104	-0.193
			(0.098)	(0.077)	(0.063)**
PhD			0.139	0.102	0.028
			(0.033)***	(0.026)***	(0.022)
Other Degree			-0.010	-0.011	0.002
			(0.163)	(0.129)	(0.103)
Grants			0.024	0.015	0.012
			(0.005)***	(0.004)***	(0.003)***
Associate				0.180	0.184
				(0.016)***	(0.013)***
Full				0.466	0.472
				(0.019)***	(0.015)***
Education					0.013
					(0.021)
Pub. Health & Nursing					0.021
					(0.019)
SBS					0.079
					(0.015)***
CNS					0.086
					(0.013)***

Engineering & Comp Sci.					0.190
					(0.017)***
Management					0.453
					(0.020)***
Other College					0.123
					(0.049)*
Intercept	11.71	11.741	11.338	11.259	11.230
	(0.012)***	(0.013)***	(0.035)***	(0.028)***	(0.022)***
R^2	0.07	0.09	0.47	0.67	0.79
N	1,097	1,097	1,097	1,097	1,097

* $p<0.05$; ** $p<0.01$; *** $p<0.001$

Notes: *Other College* includes tenure-track faculty that are not hired as part of one of the 8 established academic colleges. The majority of tenure-track faculty in the *"Other College"* hold administrative positions.

Model 3 controls for factors related to faculty's experience and position at UMass, their highest degree achieved, and the number of grants obtained that year. Together these factors reduce the gender salary gap by almost half. Women now earn 8.5 percent less than their male counterparts, although this smaller pay gap remains significant at a high level of statistical confidence. This gap is not surprising considering that men tend to have more seniority and are more likely to hold higher paying administrative positions. Furthermore, adding these variables improves the explanatory power of the model. The independent variables in Model 2 (gender and race) together explain 9 percent of the variation in logged salary. With experience and position controls added, the independent variables now explain roughly 47 percent of the variation in faculty salary. It is worth noting that the inclusion of experience, education, and grant variables also reduces the wage gap for under-represented minorities down to 8.3 percent less than white faculty.

Including rank dummy variables reduces the gender salary gap even further, from 8.3 to 4.9 percent (Model 4, Table 5). Yet the gap remains statistically significant. Including rank increases the explanatory power of the model by 20 percentage points from explaining 47 percent of the variation in salary to 67 percent.

The final model (Model 5) adds college-level controls. Adding college reduces the gender difference in salary to 1.4 percent and it is no longer statistically significant at conventional confidence thresholds. The inclusion of college also greatly increases the total explanatory power of the model. Together the variables included in Model 5 explain 79 percent of the total variation in faculty salaries, leaving only 21 percent of the possible variance in salary unexplained. College also helps explain a portion of the remaining wage gap for underrepresented minorities, which is now 4.6 percent lower than that of whites, although it remains statistically significant.

These results are not surprising given the ways in which men and women faculty members are distributed by rank and college. As explained in the descriptive statistics discussion, there are fewer women at higher ranks, where earnings tend to be higher. Women faculty are also under-represented in the highest paying schools and colleges, namely the Isenberg School of Management, Engineering, Computer Science, and the College of Natural Sciences.

C. Results by College

The preceding analysis shows that much of the observed salary gap between women and men is explained by the underrepresentation of women in higher paying colleges. However, this analysis does not examine whether there is a gender wage gap within specific colleges. For that, we developed a series of college-specific regression models, that include controls for race, rank, number of years at UMass, administrative position, department head, highest degree achieved, and the number of grants obtained that year. We combined Public Health with Nursing, and Engineering with Computer Science, because of the small number of faculty and/or insufficient gender diversity in these colleges. The combined colleges and schools paid generally similar salaries (see Table 4 above for information on average salary by college), as well as having overlapping research agendas.

We find no significant difference in the salaries of men and women within any of the seven colleges, controlling for rank or other relevant factors (Table 6). In the Colleges of Humanities and Fine Arts, Public Health/Nursing, and Social Behavioral Sciences, the salary gap is virtually absent. The estimated salary gap in Natural Sciences and Engineering/Computer Science is somewhat larger (ranging between 1.8 and 2.4 percent lower for women), but this was not consistently large enough to attain statistical significance. In the College of Education and the Isenberg School of Management we estimate that women made 4.6 percent and 5.9 percent less than men respectively. But again, this difference was not statistically significant at conventional thresholds.[8]

The results suggest that the observed gender wage gap for the whole University is more the product of the under-representation of women in different colleges, as opposed to salary inequity among women and men working within the same college. At the same time, we must be cautious in interpreting both the magnitude and statistical significance of our estimates. The small number of women faculty in some colleges (particularly Engineering/Computer Science and the School of Management) makes estimation rather precarious. This is especially true if we consider the extremely low numbers of women represented at higher faculty ranks in some colleges.

[8] Note that the standard error for the Female dummy variable in the Isenberg School of Management is particularly large which indicates that there was considerable variance around salaries between men and women.

Table 6. OLS Regression Results by College

	Education	Engineering + Comp. Sci.	Humanities and Fine Arts	Management	Natural Sciences	Public Health + Nursing	SBS
Female	-0.046	-0.018	0.004	-0.059	-0.024	0.003	-0.001
	(0.029)	(0.036)	(0.012)	(0.054)	(0.020)	(0.024)	(0.020)
Asian	0.020	0.003	-0.043	0.087	0.003	-0.046	0.007
	(0.062)	(0.027)	(0.020)*	(0.064)	(0.026)	(0.034)	(0.030)
Minority	-0.052	-0.050	-0.041	-0.074	-0.026	-0.041	-0.054
	(0.032)	(0.080)	(0.018)*	(0.107)	(0.041)	(0.039)	(0.025)*
Associate	0.218	0.159	0.197	0.038	0.183	0.220	0.195
	(0.034)***	(0.036)***	(0.017)***	(0.085)	(0.029)***	(0.031)***	(0.028)***
Full	0.475	0.450	0.494	0.265	0.485	0.486	0.483
	(0.046)***	(0.039)***	(0.021)***	(0.097)**	(0.031)***	(0.052)***	(0.036)***
Admin. Pos.	0.363	0.196	0.165	0.328	0.447	0.370	0.408
	(0.060)***	(0.051)***	(0.050)**	(0.102)**	(0.073)***	(0.061)***	(0.088)***
Dept. Head	0.121	0.089	0.161	0.061	0.073	0.043	0.038
	(0.062)	(0.085)	(0.028)***	(0.092)	(0.044)	(0.059)	(0.044)
Years UMass	0.004	0.002	0.004	-0.005	0.001	0.004	-0.001
	(0.001)**	(0.001)	(0.001)***	(0.003)	(0.001)	(0.002)*	(0.001)
Grant Awards		0.012			0.008	0.018	0.018
		(0.005)*			(0.005)	(0.013)	(0.026)
Law			-0.025				-0.119
			(0.099)				(0.137)
PhD			0.029	0.176			0.026
			(0.016)	(0.110)			(0.048)
Other Degree			-0.100				
			(0.072)				
Intercept	11.242	11.465	11.173	11.764	11.346	11.227	11.340
	(0.036)***	(0.029)***	(0.019)***	(0.126)***	(0.024)***	(0.028)***	(0.053)***
R^2	0.88	0.76	0.89	0.44	0.70	0.89	0.75
N	61	141	257	70	309	84	163

* $p<0.05$; ** $p<0.01$; *** $p<0.001$

D. Blinder-Oaxaca Regression Decompositions

Blinder-Oaxaca decomposition is commonly used in studies of wage inequality to help identify the factors that explain differences in pay. The Blinder-Oaxaca decomposition technique asks whether wage gaps are due to different groups having different wage-related characteristics or whether they receive different returns for those characteristics.

The decomposition imagines two counterfactual scenarios:

1. What would happen to women's wages if they had the same characteristics than men?

2. What would happen to women's wages if they received the same returns for their experience?

The same regression model is estimated separately for men and women. Then, the decomposition applies the two counterfactual scenarios. In the first scenario, women are assumed to have the same characteristics as men. That means women are given men's characteristics in terms of rank, distribution by college, highest degree achieved, time since being hired at UMass, etc. Using these characteristics, their average salary is estimated using the coefficients obtained through the regression for women, only. The results of the first counterfactual scenario are usually referred to as the "explained" part of the gap, or the "endowment effects."

The results of the second counterfactual scenario are usually referred to as the "unexplained" part of the gap or as the "coefficient effects." In this scenario, women's salary is predicted using women's characteristics, but applying the coefficients obtained in the regression to predict men's salary. The simultaneous effect on salary that comes from differences in characteristics and differences in returns is captured by an interaction term.

We ran a Blinder-Oaxaca regression decomposition based upon the same specification used for Model 5, which includes the full set of controls (race, rank, college, degree, etc.). The regression decomposition shows a difference of 16.2 percent between men and women, consistent with our baseline estimates from Model 1 (Table 7). Of that mean difference, 14.9 percentage points are explained by differences in human capital and position. In other words, most of the total difference in average salaries between men and women would go away if women had similar characteristics than men in terms of rank, college, administrative positions, number of years at UMass, and number of grants awarded. The coefficient and interaction effects were not significant, which suggests that a within-job pay gap is an unlikely explanation for the difference in salaries between male and female faculty.

Table 7. Blinder Oaxaca Regression Decomposition Results, 2015

Male mean log salary	11.718
	(0.012)***
Female mean log salary	11.557
	(0.013)***
Difference	0.162
	(0.018)***
Endowments	0.149
	(0.017)***
Coefficients	0.014
	(0.010)
Interaction	-0.002
	(0.008)

* $p<0.05$; ** $p<0.01$; *** $p<0.001$

V. Longitudinal Analysis

While other universities have conducted salary equity studies with multivariate analysis, we offer a unique methodological contribution by studying dynamic differences in faculty salaries using a longitudinal approach. This approach allows us to examine how salaries change over the course of an individual's academic career through the typical process of tenure and promotion. With this approach we can identify whether salary gaps exist at specific points in an individual's career, and answer the following three critical questions:

- Is there a difference in the starting salaries of women and men? If so, does this gap persist, widen, or diminish over time?
- Do women who are promoted to associate or full professor receive equitable pay increases as their male counterparts?
- Is there a difference in the rate at which salaries grow over time by gender?

A. Data and methods

The longitudinal approach adds a time-dimension to our analysis where individual faculty members are measured repeatedly each year they are employed at UMASS Amherst. Specifically, we use a random-effects model that accounts for the repeated measurement of individuals, while allowing for both time-variant and time-invariant variables, such as gender.[9] The estimating equation is:

$$y_{it} = \mu_t + \beta x_{it} + \gamma z_i + \alpha_i + \varepsilon_{it}$$

[9] Repeated measurement of the same individuals violates the independence assumption of standard (OLS) regression models and leads to misleading statistical significance tests. Maximum likelihood estimates with random effects accounts for the non-independence of individuals measured over time.

where: μ is an intercept term allowed to vary with time, β is a vector of coefficients representing the effects of time- and person-variant attributes (x_{it}), γ is a coefficient vector to capture the effects of the time-invariant attributes (z_i), ε_{it} is a random distribution term, and α_i as a normally-distributed random variable for each individual that is assumed independent of x_{it}, z_i, and ε_{it}. The inclusion of α_i accounts for the within-person correlation in the repeated measurements of the dependent variable, and adjusts the standard errors accordingly. As before, our dependent variable is the natural log of each faculty member's annual baseline salary, inflation-adjusted to 2015 dollar values. The interpretation of coefficients is similar to a standard cross-sectional OLS regression as the percent change in annual salary per unit change in each independent variable.

The time-invariant variables (z_i) are attributes that may differ across individuals but do not change over time. The primary time-invariant measure is a dummy (0,1) variable indicating whether the faculty member is female (*Female*). The coefficient estimates on the *Female* variable indicate the average percent difference in the salaries of women compared to men, after controlling for other variables included in the model. Some of our models also include time-invariant measures capturing salary differences by College. We include dummy variables representing the College of Education (*Education*), the College of Natural Sciences (*CNS*), The Isenberg School of Management (*Management*), and the College of Social and Behavioral Sciences (*SBS*). To ensure a sufficient number of female and male faculty for estimation, we combine the College of Engineering with the College of Information and Computer Science (*Engineering and Comp. Sci.*) and the School of Public Health and Health Sciences with the College of Nursing (*Public Health and Nursing*). The College of Humanities and Fine Arts (*HFA*) serves as the withheld group.

The remaining variables are all time-variant measures – they can potentially change over time. These include:

- *Years from hire*: Measured as a count of the number years employed at UMASS. The coefficient for this variable measures the annual rate of salary growth.
- *Female * Years from hire:* An interaction term that measures the difference in the annual rate of salary growth for female faculty compared to male faculty as captured by the *Years from hire* measure.
- *Department Head*: A dummy variable indicating whether the faculty member was Department Head or Chair in the specific year measured.
- *Associate Professor*: A dummy variable identifying the years that the faculty member served at the rank of associate professor. It measures as the average percent increase in base salary for associates compared to assistant professors (the withheld group).
- *Full Professor*: A dummy variable identifying the years that the faculty member served at the rank of full professor. It measures the average percent increase in base salary for full professors compared to assistant professors (the withheld group).

- *Female, Associate Professor*: A dummy variable identifying the years that a female faculty member served at the rank of associate professor. It measures as the average percent difference in base salary for female associates compared to male associate professors.
- *Female, Full Professor*: A dummy variable identifying the years that a female faculty member served at the rank of full professor. It measures as the average difference in log base salary for female full professors compared to male full professors.
- *Years from Associate*: Measured as a count of the number years each faculty member has served in the rank of associate professor. It measures the annual rate of salary growth for associate professors.
- *Female*Years from Associate* - Measured as a count of the number years each female faculty member has served in the rank of associate professor. The coefficient for this variable measures the difference in the annual rate of salary growth for female associate professors compared to male associate professors.

Because we are attempting to simulate the typical process of tenure and promotion, we only include full-time tenure track faculty hired at the rank of assistant professor on or after 2003. We have no information prior to this year, and thus cannot reconstruct the employment or salary history of faculty before this period. Lecturers, librarians, upper-level administrators, and other non-tenure stream faculty are not included. We also exclude those employed at UMASS Amherst for two years or less because they lack a sufficient employment history to track the year-to-year changes in their salary. Most of these are recent hires (hired after 2013). In addition, we exclude senior faculty hires (i.e. those hired at the rank of associate or full professor) over concerns that the recruitment of a relative few highly paid scientists might distort salary trends that were more typically of tenure track faculty. Our final dataset includes 3,500 observations, covering 501 tenure-track faculty consisting of 240 women and 261 men.

As before, we first conduct our analysis for UMass as a whole, followed by an analysis within each of the seven college-units.

B. University Wide Longitudinal Results

Our first model measures how salaries differ for female tenure track faculty compared to their male counterparts, controlling for rank and whether serving as Department Head or Chair (Table 8, Model 1). On average, women earn $4,325 less than men during their first year at UMASS, absent controls for college.[10] There is no significant difference in their rate of salary growth for women and men, as indicated by the small and insignificant parameter estimate on the "*Female*Years from hire*" variable.

[10] Because the model is estimated using log salary as the dependent variables, we first take the anti-log to convert the coefficients into dollar units.

Table 8: University-wide, Longitudinal Analysis of Logged Tenure Track Faculty Salaries, 2003-2015

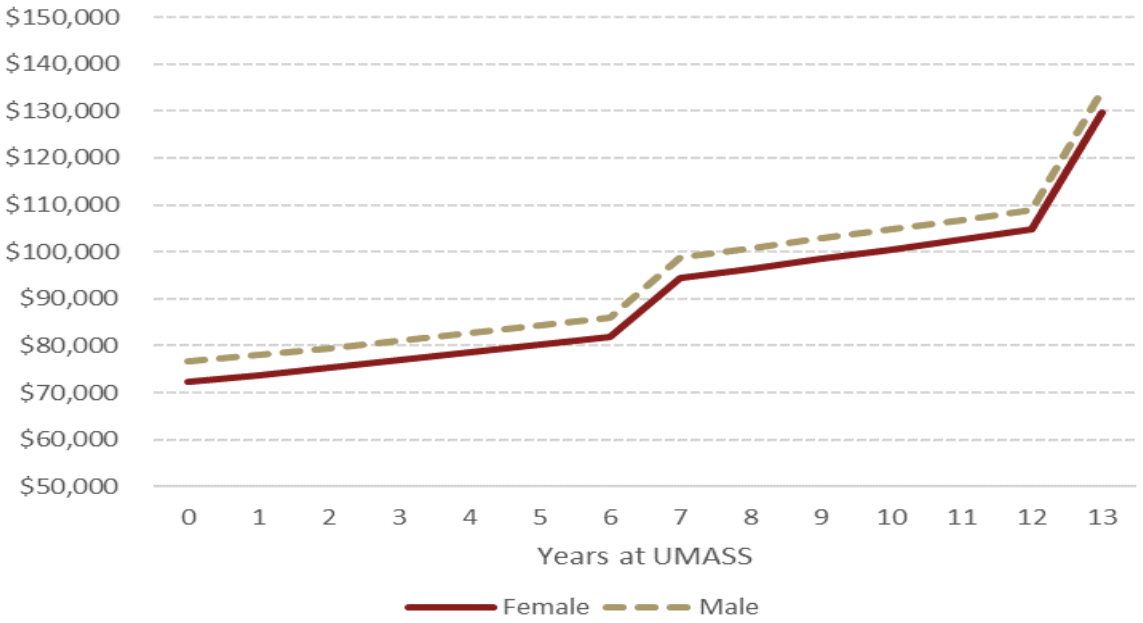
	Model 1		Model 2		Model 3	
Years from hire	0.0191	***	0.0172	***	0.0170	***
Female	-0.0582	***	-0.0482	***	-0.0102	
Female*Years from hire	0.0017		-0.0007		-0.0003	
Department Head	0.0595	***	0.0500	***	0.0496	***
Associate Professor	0.1224	***	0.0956	***	0.0961	***
Full Professor	0.3137	***	0.3456	***	0.3486	***
Female, Associate Professor			0.0028		0.0025	
Female, Full Professor			0.0686	***	0.0691	***
Years from Associate			0.0187	***	0.0190	***
Female*Years from Associate			0.0055	**	0.0058	***
Education					-0.0122	
Engineering and Comp. Sci.					0.3089	***
CNS					0.1446	***
Management					0.6956	***
Public Health and Nursing					0.0584	***
SBS					0.1573	***
Intercept	11.2457	***	11.2467	***	11.0918	***
N	501		501		501	
Max Obs per Subject	13		13		13	
-2 Log Likelihood	-10146.3		-10514.9		-11215.9	
AIC (Smaller is Better)	-10124.3		-10484.9		-11173.9	
AICC (Smaller is Better)	-10124.2		-10484.8		-11173.6	
BIC (Smaller is Better)	-10077.9		-10421.7		-11085.3	

* $p<0.05$; ** $p<0.01$; *** $p<0.001$, based on a two-tailed test

Figure 8 presents a graphical depiction of our results, where we use the estimated coefficients from Model 1 to predict how the salary of male and female faculty change over time. For graphing purposes only, Figure 8 assumes a promotion to associate professor in year 7, and a promotion to full in year 13. Women have lower starting salaries, but the year-to-year change in their salary is similar to men.

However, this model does not allow for possible gender differences in salary changes due to promotion nor does it control for salary differences by college. The next two models address these shortcomings.

Figure 8: Predicted Annual Salaries by Gender and Year (Visualization of Table 8, Model 1 Results)



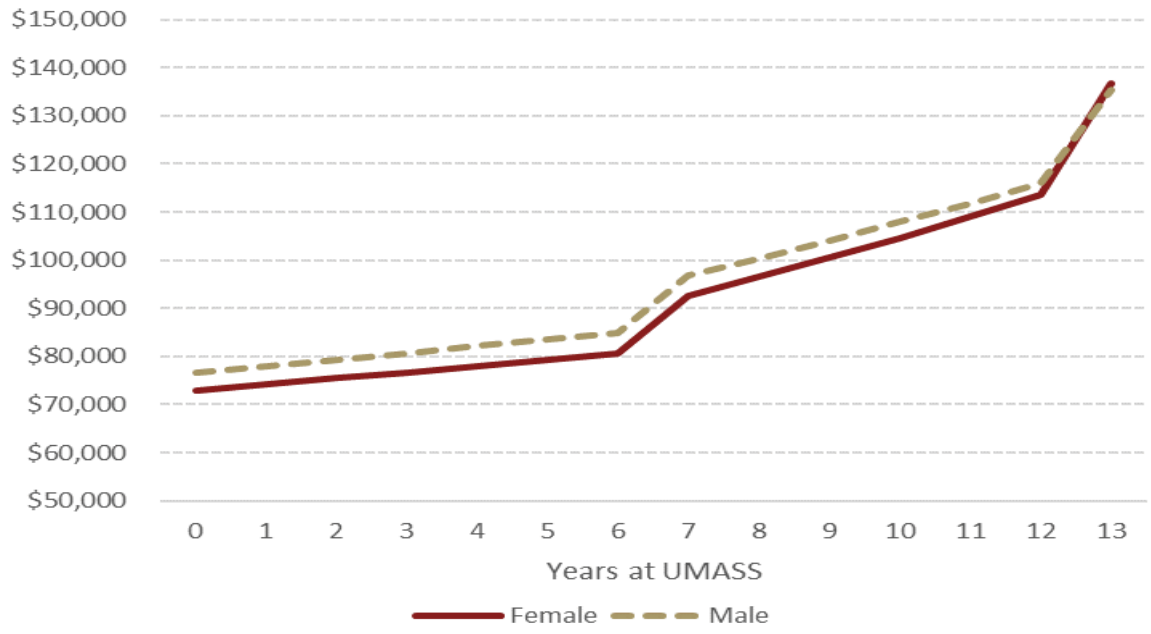
Our second model (Model 2) allows for possible gender differences following a promotion to Associate or Full professor. We also account for possible differences in the rate of yearly salary growth among assistant and associate professors.[11]

Allowing for gender differences associated with rank reduces the initial salary gap from $4,325 to $3,606, but it remains significant (Table 8). Men and women have a similar rate of salary growth as assistant professors, as indicated by the small and insignificant coefficient on the *Female*Years from hire* variable. Women and men also receive a similar salary bump when promoted to associate (*Female, Associate Professor*). However, female associate professors have a faster rate of salary growth than their male colleagues do, as indicated by the positive and significant coefficient on the *Female*Years from Associate* variable. Furthermore, women who are promoted to full professor appear to receive a significantly larger one-time increase than their male counterparts (*Female, Full Professor*). Together, the faster rate of increase as associates and the higher salary with a promotion to full professor help to reduce the gender salary gap among senior faculty (Figure 9). However, our model cannot explain why women who reach full professor receive higher salary increases than men. It could be that policies such as salary anomaly increases benefit women more than men, and help reduce initial disparities. There

[11] Because the dataset only includes faculty hired on or after 2003, there is not a sufficient time-span to estimate separately the annual salary growth following a promotion to full professor. These effects will be captured by the *Full Professor* dummy variable, but we are not able to distinguish the one-time salary increase due to promotion for the annual rate of change.

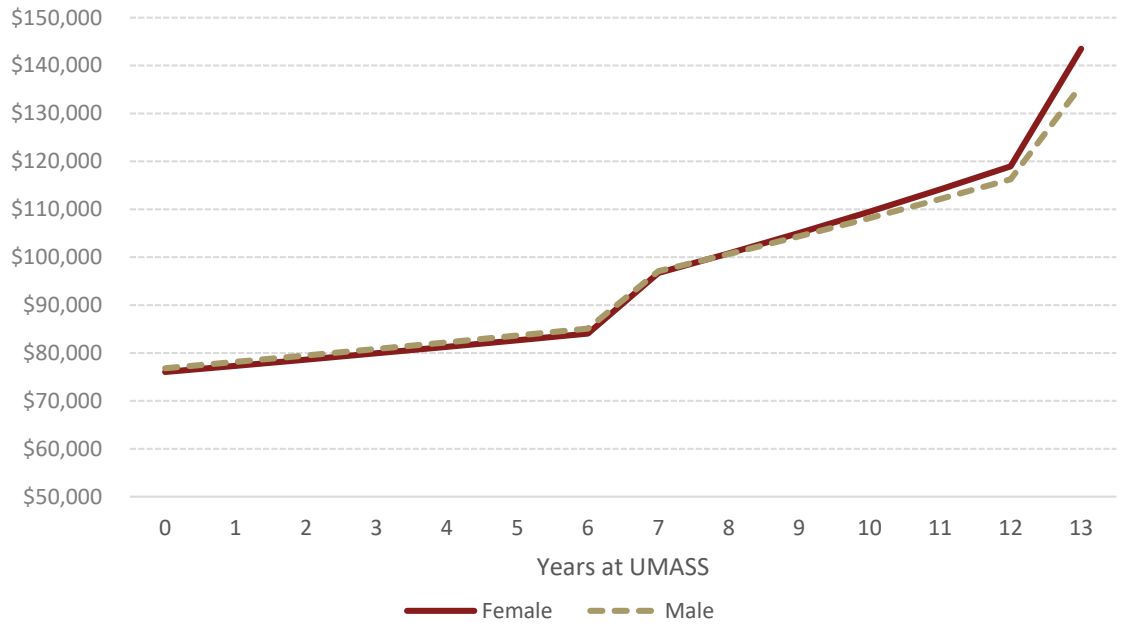
may also be selection mechanisms at work, whereby women professors who survive tenure and promotion to full are relatively more productive than their men counterparts receiving the same promotion, and thus gradually earn more through merit bonuses or negotiated salary increases. Or it may be that women faculty in higher paid colleges (such as management and engineering) are relatively more likely to reach full professor status than women in lower paying colleges, thus resulting in the appearance of proportionate higher earnings for women at higher ranks. We must also be cognizant of the relatively few faculty in our dataset who have reached the highest ranks. Of the 501 tenure-stream faculty who started as assistant professors on or after 2003, only 11 women and 25 men had been promoted to full professor by 2015.

Figure 9: Predicted Annual Salaries by Gender and Year, allowing for Gender Differences by Rank (Visualization of Table 8, Model 2 Results)



Our final University-wide model controls for salary differences associated with the faculty-members' college. When we account for college-level differences, the initial gender wage gap nearly disappears and is no longer significant at conventional levels of confidence (Table 8). This suggests that much of the university-wide wage gap is due the gender imbalance of faculty across colleges. Women are underrepresented in colleges—namely Management, Engineering, and Information and Computer Science—that offer higher starting salaries. However, we cannot yet rule out the possibility of salary inequality between women and men within colleges. Even with the college-level controls, the relatively faster rate of salary growth among female associate professors and the larger rise in salary with a promotion to full professor remain significant.

Figure 10: Predicted Annual Salaries by Gender over time, allowing for Gender Differences by Rank with College-level Controls (Visualization of Table 8, Model 3 Results)



C. College-Specific Longitudinal Results

Next, we investigate whether there are gender salary disparities among tenure track faculty within colleges. There are fewer observations at the college level, warranting some minor changes to our empirical specification. As before, we combine Engineering with Information and Computer Science and Public Health with Nursing to ensure a sufficient number of faculty of each gender. Because we focus on faculty that were hired as assistant professors since 2003, we also lack a sufficient number of department heads, full professors, or female full professors to include controls for these factors—depending on the college.

We find little evidence of gender-based salary inequity within most colleges (Table 9 and Figure 11), consistent with our prior results. The coefficients for the *Female* variable are not significant at any college. Although the average starting salary for women in most colleges (all but Education and SBS) are lower than starting salaries for males, such differences are not large or consistent enough to rule-out the possibility that such differences are due to pure random chance. Likewise, there appears to be no significant difference in the rate of salary growth among female assistant professors (*Female*years from hire*) compared to male assistant professors. Female associate professors also have similar pay scales to males, with one exception – in the College of Humanities and Fine Arts (HFA). In our model of the predicted changes in salary over the course of a faculty-member's career (Figure 11), the average female associate professor in HFA makes roughly $3,000 less than the average male. Female associate

professors in CNS also have a slightly faster rate of salary growth (*Female*Years from Associate*) than males.

We were only able to measure gender-based salary gaps among full professors in three colleges (HFA, CNS and SBS). All show significant differences among male and female faculty. In HFA, women full professors earn significantly less than men. But in CNS and SBS, women full professors earn significantly more. However, even in these larger and more diverse colleges these estimates are based on a relatively small number of senior faculty and thus are highly susceptible to the influence of outliers (HFA – 5 women, 6 men; CNS 3 women, 12 men; SBS 3 women, 5 men).

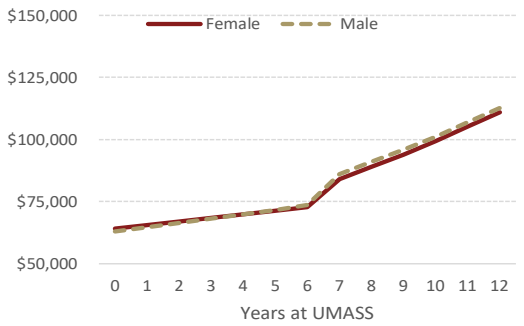
Table 9: College-specific Results, Longitudinal Analysis of Logged Tenure Track Faculty Salaries, 2003-2015

	Education		Engineering + Comp. Sci.		Humanities and Fine Arts (HFA)		Natural Sciences (CNS)		Management		Public Health + Nursing		Social and Behavioral Science (SBS)	
Years from hire	0.026	***	0.011	***	0.020	***	0.020	***	0.014	**	0.014	***	0.015	***
Female	0.019		-0.031		-0.014		-0.009		-0.027		-0.004		0.015	
Female*Years from hire	-0.005		0.008		0.000		-0.002		-0.004		-0.004		-0.002	
Department Head							0.018		0.111	***			0.037	*
Associate Professor	0.104	***	0.089	***	0.109	***	0.095	***	0.056	***	0.106	***	0.110	***
Full Professor			0.443	***	0.433	***	0.285	***					0.308	***
Female, Associate Professor	-0.014		0.010		-0.026	**	0.004		-0.028		0.029		-0.009	
Female, Full Professor					-0.093	***	0.133	***					0.194	***
Years from Associate	0.028	***	0.027	***	0.025	***	0.010	***	0.021	**	0.025	***	0.020	***
Female*Years from Associate	0.007		-0.001		0.003		0.013	***	0.014		0.006		-0.001	
Intercept	11.049	***	11.416	***	11.088	***	11.243	***	11.806	***	11.154	***	11.229	***
Subjects	33		57		125		124		25		59		90	
Max Obs per subject	13		13		13		13		12		12		13	
-2 Log Likelihood	-886.9		-1484.5		-2855.4		-3150.5		-398.4		-1256.9		-1697.8	
AIC (Smaller is Better)	-862.9		-1458.5		-2827.4		-3120.5		-372.4		-1232.9		-1667.8	
AICC (Smaller is Better)	-861.5		-1457.5		-2826.9		-3120.0		-369.4		-1232.0		-1667.0	
BIC (Smaller is Better)	-844.9		-1431.9		-2787.8		-3078.2		-356.6		-1208.0		-1630.3	

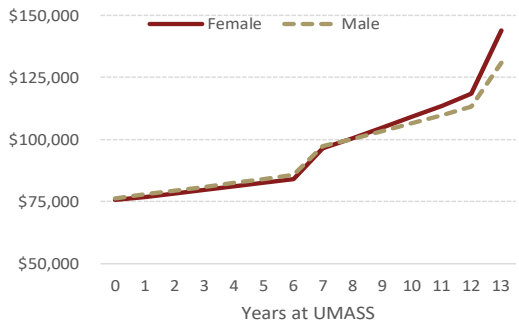
* $p<0.05$; ** $p<0.01$; *** $p<0.001$, based on a two-tailed test

Figure 11: Predicted Salaries by Gender and Year, by College

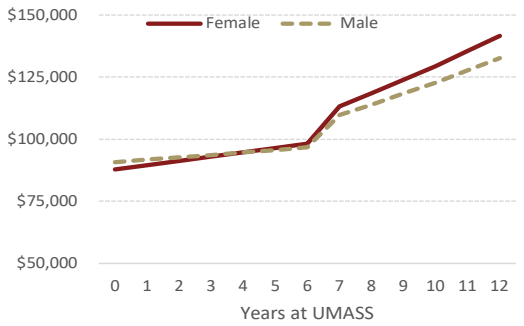
Education



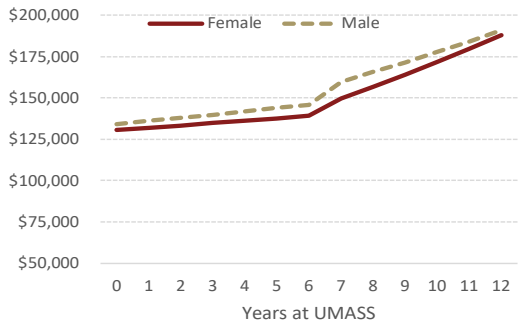
Natural Sciences (CNS)



Engineering and Computer Science



School of Management



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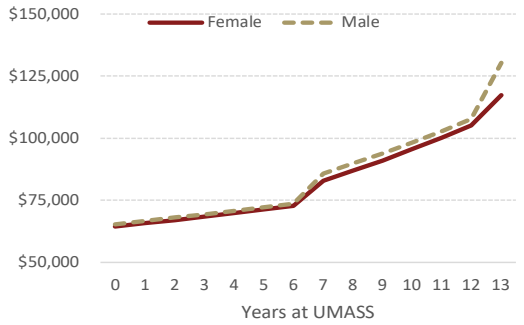
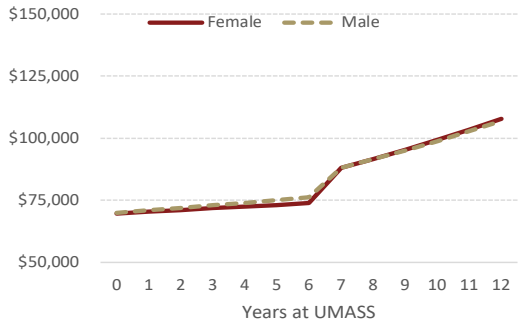
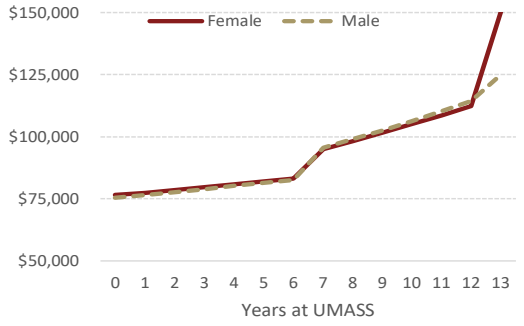


Public Health and Nursing



Social and Behavioral Sciences (SBS)



VI. Discussion

A. Findings

UMass has an average salary gap between men and women. Women faculty make 83.8 cents for every dollar their men counterparts make. In other words, women faculty make 16.2 cents less for every dollar their men coworkers make. However, this pay gap is not due to within-job disparities but rather is closely associated with two institutional trends related to underrepresentation of women. First, women are underrepresented at the full rank. Second, women comprise very small numbers of the total faculty at the colleges that have the highest average salaries, namely Information and Computer Science, the School of Management, Engineering, and Natural Sciences (the latter two are also among the largest colleges in faculty numbers).

The underrepresentation of women at the full rank highlights the need to carefully evaluate the tenure track process at UMass Amherst. A study with data collected at UMass Amherst in 2008 and 2009 found that women took longer than men to be promoted to full professorship.[12] Structural factors of gendered work in academia like higher teaching and service demands for women as well as higher care burdens were identified as the causes for slower promotion. Since 2009, the percentage of full professors that are women grew by only three percentage points from 26 percent to 29 percent. The stubbornly low number of women full professors may indicate the persistence of factors that slow down the promotion of women.

Underrepresentation of women in the Colleges of Information and Computer Science, Management, Engineering, and Natural Sciences, may be attributed to the low national availability of women with doctoral degrees in those fields; however, data presented in the Office of Equal Opportunity and Diversity (EO&D) 2014-2015 Affirmative Action Plan show that 20 out of 53 departments across the university are underutilizing the pool of available women with a doctoral degree in those fields.[13] While the underutilization of women is particularly salient in the colleges we identified as having a larger underrepresentation of women, the colleges of Humanities and Fine Arts and Social and Behavioral Sciences also have departments that fall below utilization standards for female representation (Table 10).

[12] Misra et al 2011, "Associate Professors and Gendered Barriers to Advancement", University of Massachusetts Amherst, available at http://people.umass.edu/misra/Joya_Misra/work-life_files/Associate%20Professors%20and%20Gendered%20Barriers%20to%20Advancement%20Full%20Report.pdf .

[13] EO&D defines underutilization when the workforce composition of a department is less than 80% of the availability estimate and there is a one-person or greater shortfall in the respective job group. EO&D did not report underutilization estimates for units with fewer than three employees. Availability data for faculty was drawn primarily from a 10 year composite of the Survey of Earned Doctorates (SED) 1998-2008, which includes the gender composition of degree recipients. Office of Equal Opportunity and Diversity, "Affirmative Action Plan 2014-2015", University of Massachusetts Amherst, available at http://www.umass.edu/eod/AAPlan%202014-2015.pdf

Table 10: Number of Departments with Underutilization of Women by College.

College	Depts. In College
Education	0 of 3
Engineering	4 of 4
Humanities and Fine Arts	3 of 12
Information and Computer Science	1 of 1
Isenberg School of Management	4 of 7
Natural Sciences	7 of 14
Nursing	0 of 1
Public Health or Health Sciences	0 of 4
Social and Behavioral Sciences	1 of 7
UMass Amherst	20 of 53

Note: underutilization is when unit does not hire at the rate of available pool of PhDs in the field

We also examined Information on tenure track faculty hires and job offers over the two most recent academic years, as indicative of the University's efforts to promoting gender diversity in hiring. Overall, it appears that the University is committed to gender diversity, although the results vary by college and still lag in several key colleges with higher salaries.

Over the two most recent academic years (2014-15 and 2015-16), UMass conducted 154 faculty searches. Of the 121 new faculty hired, 46% were women (Table 11). The female hiring rate was notably lower in the College of Natural Sciences (26%) and the College of Information and Computer Science (33%)– two of the four colleges where women faculty are a distinct minority. Engineering filled five out of its twelve new hires (42%) with women—still below the UMass average but a notable improvement in a College where women comprise only 14% of faculty. The School of Management performed better in new hires: half were women faculty. Although not currently underrepresented, the College of Social and Behavioral Sciences also hired relatively fewer women in the past two years.

Table 11: Faculty Searches and Hiring Patterns by College and Sex (AY 2014-15 and 2015-16).

	Faculty Searches		Women Hired	
College/School	Total	Hired	Number	Percent
Information and Computer Science	10	6	2	33%
College of Natural Sciences	33	23	6	26%
Education	4	4	2	50%
Engineering	18	12	5	42%
Humanities and Fine Arts	25	23	14	61%
Isenberg School of Management	17	16	8	50%
Nursing and Public Health	21	14	11	79%
Social and Behavioral Sciences	26	23	8	35%
UMass Amherst	**154**	**121**	**56**	**46%**

The lower hiring rates for women in some fields may reflect heightened competition in areas where women are historically underrepresented. To investigate this further, we looked at the gender distribution of job offers as well as acceptance rates (the percentage of women accepting positions as a share of all offers made to women). UMass made 180 faculty job offers over the past two years (omitting a few cases where the gender of candidates was not recorded); see Table 12. Women received 46% of all offers and had an overall acceptance rate of 67%--slightly higher than the acceptance rate for men. The College of Natural Sciences made relatively few offers to women (32%), followed by Social and Behavioral Science (34%), and Engineering (40%). Despite making relatively fewer offers to women, Engineering was successful in recruiting the women candidates offered positions (acceptance rate of 83%). Computer Science had a different problem—of the six positions offered to women only two accepted (33%). This rate is notably lower than the 50% of offers accepted by male candidates in that field. This acceptance gap deserves investigation so that a deeper understanding of why few women computer scientists seem to want to work at UMass can be gained. The college may want to explore whether women are rejecting jobs because of heightened competition for women in Computer Science coupled with relatively less attractive offers (including accommodation for partners), or whether there are some cultural or institutional factors that may be sending negative signals to candidates, even unintentionally. Women's acceptance rates were also relatively low in Social and Behavioral Science--73% compared to 86% for men. Nursing and Public Health (where male faculty are underrepresented) and Humanities and Fine Arts saw relatively low acceptance rates among men candidates compared to women.

Table 12: Faculty Job Offers by College and Gender (AY 2014-15 and 2015-16).

	Offers (Gender	Women's Offers		Acceptance Rates	
College/School	**known)**	**Number**	**Percent**	**Female**	**Male**
Information and Computer Science	14	6	43%	33%	50%
College of Natural Sciences	38	12	32%	50%	50%
Education	4	2	50%	100%	100%
Engineering	15	6	40%	83%	78%
Humanities and Fine Arts	30	17	57%	82%	54%
Isenberg School of Management	21	12	57%	67%	67%
Nursing and Public Health	26	17	65%	65%	33%
Social and Behavioral Sciences	32	11	34%	73%	86%
UMass Amherst	**180**	**83**	**46%**	**67%**	**62%**

The existence of offers to women assistant professors in the colleges where they are underrepresented is a good start. Another factor that must be considered in why women candidates are not accepting offers at the same rate as men, however, is the gender climate in which faculty find themselves. Retention is often a good indicator of how healthy the climate is in a department or college. We were not able to obtain data on retention or faculty turnover in these colleges, but anecdotally, there is some

evidence from focus group data that suggests a perception exists that there has been a lot of turnover, particularly among women faculty in the colleges where women are not well represented. UMass is currently conducting a climate survey, which may shed some light on this question.

The lower acceptance rate by women candidates may also be related to another key finding from our longitudinal analyses: women have lower starting salaries at their time of initial hire. If women are not being offered as much or if fewer women are being recruited as senior hires, this may contribute to the gender difference in acceptances.

Within rank, a large portion of the initial gender difference in salaries comes from the underrepresentation of women assistant professors in higher paying colleges. Although no longer statistically significant by conventional thresholds after controlling for college, the one percent gap that remains between assistant professor women and men is estimated over the universe of UMass faculty, not just a sample, and may still contribute to a persistent salary gap. Note that this gap (hundreds of dollars difference in pay per year) hits women faculty members at a crucial time when newly minted PhDs need resources to make the transition to life as a faculty member.

Over time, and controlling for college, women's salaries grow faster than men's as they ascend in rank. This trend of women earning a higher salary bump could be a product of at least two different mechanisms: first, institutional tenure review procedures may incorporate unconscious gender biases so that women associates with on average better research records than men achieve promotion to full professorship (i.e., women have to be better than men, and this merit is reflected in pay); second, salary correction mechanisms promoted by the faculty union (MSP), such as anomaly pay increases, may help equalize pay. More data would need to be collected to determine what is behind these pay trajectories that differ by gender.

B. Recommendations

UMass has the opportunity to be a leading institution in gender equity. While starting from a position of strength, there is need to continue to collect data and develop supportive policies. In this section we do not offer specific remedies, but rather note places where UMass could develop policies to have an effect on salary equity. Our findings suggest that policies to increase the starting salary of newly recruited women are the most immediate need in terms of salary adjustment. Other policies regarding recruitment, promotion, and retention of female tenure track faculty previously recommended by EO&D need to be strengthened and sped up. Based on our findings we recommend attention to the following:

- Adjust any starting salaries that fall below the inflation adjusted median starting salary for assistant professors hired in the previous five years in a given department.
- Gather information on start-up packages for faculty, which are crucial for all faculty members but perhaps even more so for faculty in the lab sciences.

- Enhance existing mentoring support programs, especially for women associate professors to achieve full rank.
- Assign all faculty as mentors to other faculty (including peer mentors). Provide recognition of faculty for mentoring colleagues, such as providing a space on the annual faculty report about what the faculty member has done for their mentees.
- Create departmental policies that distribute teaching, service, and mentoring requirements equally across men and women at the associate and full ranks.
- Provide administrative incentives and guidelines that will encourage the recruitment of women faculty in departments identified by EO&D as underutilizing the pool of PhDs, speeding up the hiring goals delineated in the Affirmative Action Plans.
- Conduct and distribute results from an organizational climate study in departments with the goal of finding specific aspects of the organizational culture and structure that are related to women faculty members leaving the institution.
- Conduct exit surveys in a central office for faculty who leave the university prior to retirement.

Some of the policy areas we suggest attention to are not new and have been recommended by other university units in previous years. However, our longitudinal results indicate that these policies need continual follow through in order to increase the number of women professors in departments where women are vastly underrepresented.

C. Methodology, Data Limitations, and Future Research

There is consensus in existing salary equity studies in academic contexts that academic experience, educational attainment, and field or discipline should be included in models explaining salary.[14] The OLS and longitudinal models we use include at least one measure that captures all of these factors. Unfortunately, we did not have data readily available on several other important factors, such as service commitments, mentoring responsibilities, and citations that may also have an effect on salary. But even without including these factors, we are able to explain 79 percent of the variation in salary at UMass Amherst—a very good fit for these types of models. The fact that we find little within-job gap may have different explanations. For one, it may be that women faculty are more productive and are paid the same salary, but we cannot observe this without better productivity data.

The inclusion of rank in the models could be capturing part of the real salary disparity between men and women. In other words, if there is gender bias in the promotion of faculty, including rank in our models

[14] For review articles on the existing literature about gender biases in salaries in academia, see Becker, W. E., & Toutkoushian, R. K. (2003). Measuring gender bias in the salaries of tenured faculty members. *New Directions for Institutional Research*, *2003*(117), 5-20, and Rosser, V. J., & Mamiseishvili, K. (2014). Using Salary as a Measure of Glass Ceiling Effects: Lessons for Institutional Researchers. *New Directions for Institutional Research*, *2013*(159), 13-23.

could understate the gender salary gap.[15] Gender differences in the promotion from assistant through the ranks are less likely to bias our coefficient for the female variable since faculty who do not obtain tenure and promotion typically leave the institution. If gender inequities in the promotion from associate to full exists, then the inclusion of rank would artificially reduce the size of our estimate of the gender salary gap. Our models cannot capture possible inequity in the prospects for advancement into higher levels. Because differences in rank help explain so much of the gender pay gap, understanding gendered differences in the promotion is necessary and require further study.

The effect of retention offers on the gender salary gap also requires additional attention. We conducted a descriptive analysis of 92 retention offers in May 2016, and found that 62 percent of those offers were given to male faculty compared to 38 percent to female faculty. The average pay increase from retention offers was 14.3 percent for men and 13.1 for women. The descriptive statistics of this small number of retention offers shows evidence that further investigation on this is needed.[16]

Finally, it is necessary to maintain and study data on the people who leave UMass Amherst. Our data and models do not allow us to capture the possibility that women may be leaving the institution more often than men as a result of dissatisfaction with salary or other working conditions.

The existence of this report in itself is an important step and indicator that UMass takes gender equity seriously. The fact that the UMass administration and the faculty labor union collaborated in commissioning this study by an independent unit (the Institute for Social Science Research) is a sign of our institutional strength in working together to develop new strategies for chipping away at persistent inequalities that are not going to disappear on their own accord.

[15] For a more detailed discussion of the effects of including and excluding rank in faculty gender salary studies see Becker, W. E., & Toutkoushian, R. K. (2003). Measuring gender bias in the salaries of tenured faculty members. *New Directions for Institutional Research*, *2003*(117), 5-20, and Rosser, V. J., & Mamiseishvili, K. (2014). Using Salary as a Measure of Glass Ceiling Effects: Lessons for Institutional Researchers. *New Directions for Institutional Research*, *2013*(159), 13-23.

[16] See Appendix A for descriptive statistics on the 92 retention offers available.

Appendix A. Retention Data Analysis

Retention offers may be a factor that increases salary gaps by sex and race. Employment offers in academia are likely influenced by structural inequities based on sex and race. While white males may be more likely to get more job offers outside of UMass because of these structural inequities in academia, retention offers may be increasing internal gaps in salary across gender. In this document, we present a summary of the number of retention offers and the average percentage and amount salary increases for these offers by rank, sex, and rank and sex together to explore whether these offers increase existing salary gaps. The descriptive statistics we report suggest that retention offers tend to increase existing gender salary gaps.

The data were provided by the Provost's Office on April 29, 2016, and include 92 retention offers between 2002 and 2015.[17] The data included a variable containing the effective date of the change in pay, the percent change in pay, the dollar amount increase in a person's bi-weekly pay, and the person's title on the year of the offer. We merged that data with the sex, race, and base salary data in the dataset provided by OIR in January 2016. All dollar amounts were adjusted for inflation and transformed into constant 2015 dollars.

The analysis presented here is merely descriptive and does not account for other factors that may influence either who gets a retention offer or how these retention offers interact with other factors that affect the pay gap for the whole population of UMass tenure track faculty.

A. Retention Offers by Rank or Position

The largest number of retention offers was given to associate and full professors, but they were almost equally divided among the three tenure track ranks. We separated out department chairs and associate deans because of their distinctiveness. Two retention offers were given to people who served as department chairs or heads, and two retention offers were given to one person who served as associate dean in a college. Additionally, two retention offers were given to lecturers.[18]

As seen in the third column of Table 1, the mean percent of increase in pay increases as rank goes from Lecturer to Associate professor. The mean percent pay increase for lecturers was 6.5 percent, for assistant professors, 10.4 percent and for associate professors 16%. The average percent increase for full professors (13.7 percent) is lower than associate professors, but higher than the mean for department chairs. The retention offers to the person in the associate dean position had the highest percent increase in pay with 36.6 percent. Overall, the mean percent increase was 13.85 percent.

[17] The original data included 93 retention offers. We excluded a retention offer that was clearly a duplicate entry.
[18] Note that in every other analysis, we exclude lecturers from the universe of tenure track faculty since their salary trajectory is qualitatively different than those at the assistant, associate, and full ranks.

The bi-weekly pay increase in constant 2015 dollars increases as rank increases. There is one exception: the bi-weekly amount for department chairs is lower than for full professors. The mean yearly pay increase follows a similar trend increasing by rank but with offers to department chairs being smaller.

Table A1. Retention Offers Descriptive Statistics by Rank.

	Number of Retention Offers	Percent of Total Retention Offers	Mean percent Pay Increase	Bi-Weekly Pay Increase	Yearly Pay Increase
Lecturer	2	2.2%	6.5%	$179	$4,108
Assistant	25	27.2%	10.4%	$336	$8,475
Associate	31	33.7%	16.0%	$535	$13,077
Full	30	32.6%	13.7%	$775	$19,708
Department Chair	2	2.2%	9.8%	$564	$13,317
Associate Dean	2	2.2%	36.6%	$5,393	$99,126
Total	92	100%	13.85%	$658	$15,486

Notes: Department chairs and associate deans were separated out because their salaries were considerably higher. All dollar amounts were adjusted to 2015 constant dollars. The yearly pay increase was estimated by multiplying the percent increase from the retention offer by the salary reported the month of September before the offer's effective date. The mean yearly pay increase was estimated only for those with retention offers effective in 2004 or later since base salary data for 2002 and 2001 was unavailable.

In general, as rank increases, the percentage and dollar amount of pay increase from a retention offer go up. This is important to note first, since, as we break down the data by sex, the number of people from each sex in the different ranks can determine overall differences in percent and amount increases for women.

B. Retention Offers by Sex

The majority of the retention offers were given to men: 62 percent of all offers were given to male faculty compared to 38 percent to female faculty. Table 2 presents the retention offer numbers by sex.

The average percent increase in pay was larger for men than for women. Men received an offer that increased their pay by 14.3 percent on average, while women received offers that increased their pay by 13.1 percent.

The average dollar amount of the bi-weekly pay increase for men is also larger than the increase for women. On average, men received a bi-weekly pay increase of $782 and women received only a $455 bi-weekly increase.

Lastly, men also see a larger increase in yearly pay than women as a product of retention offers. Men saw an $18,269 dollars increase in yearly salary, while women saw an $11,572 dollars increase.

As a result of larger retention offers for men, the gap between the men and women measured as the cents on the dollar of an average woman's salary below a man's average salary increased from 22.4 cents to 24.3 cents.[19]

Table A2. Retention Offers Descriptive Statistics by Sex.

	Number of Retention Offers	Percent of Total Retention Offers	Mean Percent Pay Increase	Mean Bi-Weekly Pay Increase	Mean Yearly Pay Increase	Mean Base Yearly Salary	Mean Yearly Salary With Offer
Women	35	38%	13.1%	$455	$11,572	$89,622	$101,194
Men	57	62%	14.3%	$782	$18,269	$115,441	$133,709

Notes: All dollar amounts were adjusted to 2015 constant dollars. The yearly pay increase was estimated by multiplying the percent increase from the retention offer by the salary reported the month of September before the offer's effective date. The mean yearly pay increase and salary gaps were estimated only for those with retention offers effective in 2004 or later since base salary data for 2002 and 2001 was unavailable.

C. Results by Sex and Rank

As noted above, the differences in the average percent and amount increase in pay between men and women might be a result of less women being in the ranks that received higher pay increases. To explore this, Table 3 presents the data on retention offers broken down by rank or position and sex.

Women received 8 out of the 30 (27 percent) retention offers given to full professors. The two offers given to an associate dean were both to the same male. Lower representation of women at the highest ranks or administrative positions may explain part of the lower percent and amount pay increases in Table 2.

However, at every rank, men received larger average percent pay increases from retention offers between 2002 and 2015. The mean bi-weekly pay increase was also larger for men than women at every rank or position. These two trends, combined with already unequal base salaries, resulted in larger gender salary gaps after retention offers. [20]

Salary gaps between men and women appear to increase after retention offers at every rank. Based on the 77 offers made in or after 2004, the gender salary gap between women and men increased

[19] This average salary gap is only estimated for the 77 offers effective on or after 2004.

[20] Please note that gender gaps were only estimated for the 77 offers effective on or after 2004. In offers to full professors during that time, females received a larger mean percent increase 14.8% vs 13.98%. That's why the gap between male and female full professor appears to have dropped. At every other rank, men received higher percent increases than women for offers effective after 2004.

from 3.6 to 5.4 cents for lecturers. The gender gap increased from 11.6 to 11.9 cents for assistant professors and from 6.3 to 7.4 cents for associate professors. The gap for department chairs increased from 19.2 cents to 22.7 cents. The gender gap was reduced only for full professors from 18.3 to 17.8 cents.

These differences are estimated on a small number of retention offers. Some of the salary gaps are estimated comparing only one male to one female faculty member in the same rank. Yet, they represent the universe of retention offers data provided.

Table A3. Retention Offers Descriptive Statistics by Sex and Rank.

	Frequency		Mean Percent Pay Increase		Mean Bi-Weekly Pay Increase		Mean Yearly Pay Increase		Mean Gap Before Offer	Mean Gap After Offer
	Female	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**
Lecturer	1	1	5.5%	7.5%	$158	$201	$3,413	$4,803	3.6	5.4
Assistant	9	16	10.2%	10.5%	$312	$349	$7,640	$8,945	11.6	11.9
Associate	16	15	16.0%	16.0%	$477	$597	$12,278	$14,408	6.3	7.4
Full	8	22	12.2%	14.3%	$625	$830	$17,547	$20,518	18.3	17.8
Department Chair	1	1	7.4%	12.3%	$334	$793	$8,685	$17,949	19.2	22.7
Associate Dean	0	2	NA	36.6%	NA	$5,393	NA	$99,126	NA	NA

Notes: Department chairs and associate deans were separated out because their salaries were considerably higher. All dollar amounts were adjusted to 2015 constant dollars. The yearly pay increase was estimated by multiplying the percent increase from the retention offer by the salary reported the month of September before the offer's effective date. The mean yearly pay increase and salary gaps were estimated only for those with retention offers effective in 2004 or later since base salary data for 2002 and 2001 was unavailable

Appendix B: Descriptive Statistics Tables

In this Appendix, we include detailed tables on the number of faculty members and average salaries by gender, rank and department. While we include only general trends in the body of the report, the specific information contained in these tables can be used by the Provost's Office and MSP to cite specific numbers.

Table B1: Number of Tenure Track Faculty by Gender and Year

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Female	272	280	306	316	334	347	349	360	375	396	413	429	447
Male	651	654	671	671	663	656	647	645	646	641	645	653	650
Total	923	934	977	987	997	1,003	996	1,005	1,021	1,037	1,058	1,082	1,097
% Women	29.5%	30.0%	31.3%	32.0%	33.5%	34.6%	35.0%	35.8%	36.7%	38.2%	39.0%	39.6%	40.7%

Table $B2_a$: Number and Percent of Tenure Track Faculty by Rank, Sex and Year, 2003-2007.

	2003			2004			2005			2006			2007		
	Female	Male	Total	Female	Male	Total	Female	Male	Total	Female	Male	Total	Female	Male	Total
Assistant	63	89	152	75	110	185	88	127	215	94	127	221	108	131	239
	41.4%	58.6%	100%	40.5%	59.5%	100%	40.9%	59.1%	100%	42.5%	57.5%	100%	45.2%	54.8%	100%
Associate	98	171	269	102	170	272	107	172	279	106	170	276	108	169	277
	36.4%	63.6%	100%	37.5%	62.5%	100%	38.4%	61.6%	100%	38.4%	61.6%	100%	39.0%	61.0%	100%
Full	111	391	502	103	374	477	111	372	483	116	374	490	118	363	481
	22.1%	77.9%	100%	21.6%	78.4%	100%	23.0%	77.0%	100%	23.7%	76.3%	100%	24.5%	75.5%	100%
All Ranks	272	651	923	280	654	934	306	671	977	316	671	987	334	663	997
	29.5%	70.5%	100%	30.0%	70.0%	100%	31.3%	68.7%	100%	32.0%	68.0%	100%	33.5%	66.5%	100%

Table $B2_b$: Number and Percent of Tenure Track Faculty by Rank, Sex and Year, 2008-2012.

	2008			2009			2010			2011			2012		
	Female	**Male**	**Total**	**Female**	**Male**	**Total**	**Female**	**Male**	**Total**	**Female**	**Male**	**Total**	**Female**	**Male**	**Total**
Assistant	119	134	253	121	132	253	114	136	250	120	132	252	132	131	263
	47.0%	53.0%	100%	47.8%	52.2%	100%	45.6%	54.4%	100%	47.6%	52.4%	100%	50.2%	49.8%	100%
Associate	109	172	281	107	168	275	123	159	282	129	157	286	132	148	280
	38.8%	61.2%	100%	38.9%	61.1%	100%	43.6%	56.4%	100%	45.1%	54.9%	100%	47.1%	52.9%	100%
Full	119	350	469	121	347	468	123	350	473	126	357	483	132	362	494
	25.4%	74.6%	100%	25.9%	74.1%	100%	26.0%	74.0%	100%	26.1%	73.9%	100%	26.7%	73.3%	100%
UMass	347	656	1,003	349	647	996	360	645	1,005	375	646	1,021	396	641	1,037
	34.6%	65.4%	100%	35.0%	65.0%	100%	35.8%	64.2%	100%	36.7%	63.3%	100%	38.2%	61.8%	100%

Table $B2_c$: Number and Percent of Tenure Track Faculty by Rank, Sex and Year, 2013-2015.

	2013			2014			2015		
	Female	**Male**	**Total**	**Female**	**Male**	**Total**	**Female**	**Male**	**Total**
Assistant	139	129	268	144	124	268	155	130	285
	51.9%	48.1%	100%	53.7%	46.3%	100%	54.4%	45.6%	100%
Associate	142	150	292	151	167	318	148	165	313
	48.6%	51.4%	100%	47.5%	52.5%	100%	47.3%	52.7%	100%
Full	132	366	498	134	362	496	144	355	499
	26.5%	73.5%	100%	27.0%	73.0%	100%	28.9%	71.1%	100%
UMass	413	645	1,058	429	653	1,082	447	650	1,097
	39.0%	61.0%	100%	39.6%	60.4%	100%	40.7%	59.3%	100%

Table $B3_a$: Number and Percent of Tenure Track Faculty by College, Sex and Year, 2003-2007.

	2003			2004			2005			2006			2007		
	F	M	Total	F	M	Total	F	M	Total	F	M	Total	F	M	Total
Education	25	23	48	21	25	46	28	26	54	27	25	52	29	23	52
	52.1%	47.9%	100%	45.7%	54.3%	100%	51.9%	48.1%	100%	51.9%	48.1%	100%	55.8%	44.2%	100%
Engineering	10	75	85	8	76	84	9	81	90	8	80	88	9	82	91
	11.8%	88.2%	100%	9.5%	90.5%	100%	10.0%	90.0%	100%	9.1%	90.9%	100%	9.9%	90.1%	100%
Humanities and Fine Arts	82	125	207	84	124	208	89	130	219	94	134	228	97	131	228
	39.6%	60.4%	100%	40.4%	59.6%	100%	40.6%	59.4%	100%	41.2%	58.8%	100%	42.5%	57.5%	100%
Information and Comp. Science	4	26	30	4	31	35	5	35	40	5	35	40	5	35	40
	13.3%	86.7%	100%	11.4%	88.6%	100%	12.5%	87.5%	100%	12.5%	87.5%	100%	12.5%	87.5%	100%
Isenberg School of Management	13	50	63	15	51	66	16	50	66	17	52	69	16	50	66
	20.6%	79.4%	100%	22.7%	77.3%	100%	24.2%	75.8%	100%	24.6%	75.4%	100%	24.2%	75.8%	100%
Natural Sciences	39	213	252	44	212	256	46	212	258	47	212	259	51	214	265
	15.5%	84.5%	100%	17.2%	82.8%	100%	17.8%	82.2%	100%	18.1%	81.9%	100%	19.2%	80.8%	100%
Nursing	17		17	15		15	16		16	15		15	14		14
	100%	0.0%	100%	100%	0.0%	100%	100%	0.0%	100%	100%	0.0%	100%	100%	0.0%	100%
Other	3	8	11	3	7	10	3	7	10	3	7	10	3	8	11
	27.3%	72.7%	100%	30.0%	70.0%	100%	30.0%	70.0%	100%	30.0%	70.0%	100%	27.3%	72.7%	100%
Public Health	18	19	37	20	18	38	20	21	41	26	24	50	29	20	49
	48.6%	51.4%	100%	52.6%	47.4%	100%	48.8%	51.2%	100%	52.0%	48.0%	100%	59.2%	40.8%	100%
Social and Behavioral Sciences	61	112	173	66	110	176	74	109	183	74	102	176	81	100	181
	35.3%	64.7%	100%	37.5%	62.5%	100%	40.4%	59.6%	100%	42.0%	58.0%	100%	44.8%	55.2%	100%
UMass	272	651	923	280	654	934	306	671	977	316	671	987	334	663	997
	29.5%	70.5%	100%	30.0%	70.0%	100%	31.3%	68.7%	100%	32.0%	68.0%	100%	33.5%	66.5%	100%

Table $B3_b$: Number and Percent of Tenure Track Faculty by College, Sex, and Year, 2008-2012.

	2008			2009			2010			2011			2012		
	Female	**Male**	**Total**	**Female**	**Male**	**Total**	**Female**	**Male**	**Total**	**Female**	**Male**	**Total**	**Female**	**Male**	**Total**
Education	31	25	56	30	23	53	31	22	53	32	20	52	34	20	54
	55.4%	44.6%	100%	56.6%	43.4%	100%	58.5%	41.5%	100%	61.5%	38.5%	100%	63.0%	37.0%	100%
Engineering	10	81	91	9	83	92	9	83	92	12	83	95	12	83	95
	11.0%	89.0%	100%	9.8%	90.2%	100%	9.8%	90.2%	100%	12.6%	87.4%	100%	12.6%	87.4%	100%
Humanities and Fine Arts	103	124	227	103	122	225	102	120	222	106	125	231	115	124	239
	45.4%	54.6%	100%	45.8%	54.2%	100%	45.9%	54.1%	100%	45.9%	54.1%	100%	48.1%	51.9%	100%
Information and Comp. Science	5	31	36	4	32	36	6	31	37	5	29	34	6	30	36
	13.9%	86.1%	100%	11.1%	88.9%	100%	16.2%	83.8%	100%	14.7%	85.3%	100%	16.7%	83.3%	100%
Isenberg School of Management	54	210	264	77	230	307	82	228	310	86	228	314	86	223	309
	20.5%	79.5%	100%	25.1%	74.9%	100%	26.5%	73.5%	100%	27.4%	72.6%	100%	27.8%	72.2%	100%
Natural Sciences	10		10	10		10	10		10	10	1	11	12	1	13
	100%	0.0%	100%	100%	0.0%	100%	100%	0.0%	100%	90.9%	9.1%	100%	92.3%	7.7%	100%
Nursing	14	54	68	15	52	67	16	49	65	18	49	67	20	51	71
	20.6%	79.4%	100%	22.4%	77.6%	100%	24.6%	75.4%	100%	26.9%	73.1%	100%	28.2%	71.8%	100%
Other	4	8	12	2	9	11	2	10	12	3	10	13	3	8	11
	33.3%	66.7%	100%	18.2%	81.8%	100%	16.7%	83.3%	100%	23.1%	76.9%	100%	27.3%	72.7%	100%
Public Health	31	20	51	33	19	52	35	21	56	34	21	55	36	24	60
	60.8%	39.2%	100%	63.5%	36.5%	100%	62.5%	37.5%	100%	61.8%	38.2%	100%	60.0%	40.0%	100%
Social and Behavioral Sciences	85	103	188	66	77	143	67	81	148	69	80	149	72	77	149
	45.2%	54.8%	100%	46.2%	53.8%	100%	45.3%	54.7%	100%	46.3%	53.7%	100%	48.3%	51.7%	100%
UMass	347	656	1,003	349	647	996	360	645	1,005	375	646	1,021	396	641	1,037
	34.6%	65.4%	100%	35.0%	65.0%	100%	35.8%	64.2%	100%	36.7%	63.3%	100%	38.2%	61.8%	100%

Table $B3_C$: Number and Percent of Tenure Track Faculty by College, Sex and Year, 2013-2015.

	2013			2014			2015		
	Female	**Male**	**Total**	**Female**	**Male**	**Total**	**Female**	**Male**	**Total**
Education	36	21	57	39	21	60	39	22	61
	63.2%	36.8%	100.0%	65.0%	35.0%	100.0%	63.9%	36.1%	100.0%
Engineering	12	86	98	15	89	104	15	89	104
	12.2%	87.8%	100.0%	14.4%	85.6%	100.0%	14.4%	85.6%	100.0%
Humanities and Fine Arts	120	126	246	125	128	253	129	128	257
	48.8%	51.2%	100.0%	49.4%	50.6%	100.0%	50.2%	49.8%	100.0%
Information and Comp. Science	5	29	34	5	32	37	3	34	37
	14.7%	85.3%	100.0%	13.5%	86.5%	100.0%	8.1%	91.9%	100.0%
Isenberg	90	222	312	92	220	312	94	215	309
	28.8%	71.2%	100.0%	29.5%	70.5%	100.0%	30.4%	69.6%	100.0%
Natural Sciences	14	1	15	14	1	15	15	1	16
	93.3%	6.7%	100.0%	93.3%	6.7%	100.0%	93.8%	6.3%	100.0%
Nursing	20	49	69	21	48	69	24	46	70
	29.0%	71.0%	100.0%	30.4%	69.6%	100.0%	34.3%	65.7%	100.0%
Other	2	11	13	1	9	10	5	7	12
	15.4%	84.6%	100.0%	10.0%	90.0%	100.0%	41.7%	58.3%	100.0%
Public Health	39	28	67	39	27	66	41	27	68
	58.2%	41.8%	100.0%	59.1%	40.9%	100.0%	60.3%	39.7%	100.0%
Social and Behavioral Sciences	75	72	147	78	78	156	82	81	163
	51.0%	49.0%	100.0%	50.0%	50.0%	100.0%	50.3%	49.7%	100.0%
UMass	413	645	1,058	429	653	1,082	447	650	1,097
	39.0%	61.0%	100.0%	39.6%	60.4%	100.0%	40.7%	59.3%	100.0%

Table $B4_a$. Mean Salaries by Sex and Year, 2003-2010

	2003	2004	2005	2006	2007	2008	2009	2010
Female	$92,618	$102,382	$98,539	$101,003	$98,587	$97,601	$96,627	$98,072
Male	$109,280	$119,363	$115,102	$118,464	$116,893	$115,682	$116,181	$116,993
Overall	$104,370	$114,272	$109,914	$112,874	$110,760	$109,427	$109,329	$110,215
F/M Ratio	0.85	0.86	0.86	0.85	0.84	0.84	0.83	0.84

Table $A4_b$. Mean Salaries by Sex and Year, 2011-2015

	2011	2012	2013	2014	2015
Female	$98,462	$102,694	$103,998	$103,342	$108,904
Male	$116,451	$121,354	$124,828	$123,541	$128,968
Overall	$109,844	$114,228	$116,697	$115,533	$120,792
F/M Ratio	0.85	0.85	0.83	0.84	0.84

Table $B5_a$: Mean Salaries by Sex, Rank, and Year, 2003-2005

	2003				2004				2005			
	Female	Male	Total	Ratio	Female	Male	Total	Ratio	Female	Male	Total	Ratio
Assistant	$69,185	$75,933	$73,136	0.91	$74,589	$80,779	$78,270	0.92	$72,323	$78,240	$75,818	0.92
Associate	$86,721	$95,730	$92,448	0.91	$98,312	$107,387	$103,984	0.92	$95,190	$104,573	$100,974	0.91
Full	$111,125	$122,796	$120,215	0.90	$126,648	$136,155	$134,102	0.93	$122,551	$132,555	$130,256	0.92
UMass	$92,618	$109,280	$104,370	0.85	$102,382	$119,363	$114,272	0.86	$98,539	$115,102	$109,914	0.86

Table $B5_b$: Mean Salaries by Sex, Rank, and Yea, 2006-2008

	2006				2007				2008			
	F	M	Total	Ratio	F	M	Total	Ratio	F	M	Total	Ratio
Assistant	$73,770	$80,693	$77,749	0.91	$72,783	$79,516	$76,474	0.92	$71,668	$78,335	$75,199	0.91
Associate	$98,634	$105,163	$102,655	0.94	$96,435	$104,403	$101,296	0.92	$95,596	$103,030	$100,146	0.93
Full	$125,235	$137,336	$134,471	0.91	$124,174	$136,196	$133,246	0.91	$125,370	$136,199	$133,451	0.92
UMass	$101,003	$118,464	$112,874	0.85	$98,587	$116,893	$110,760	0.84	$97,601	$115,682	$109,427	0.84

Table $B5_c$: Mean Salaries by Sex, Rank, and Year, 2009-2011

	2009				2010				2011			
	F	M	Total	Ratio	F	M	Total	Ratio	F	M	Total	Ratio
Assistant	$71,696	$79,332	$75,680	0.90	$72,973	$79,102	$76,307	0.92	$74,851	$78,226	$76,618	0.96
Associate	$94,575	$100,684	$98,307	0.94	$94,257	$101,109	$98,121	0.93	$93,369	$99,136	$96,535	0.94
Full	$123,371	$137,702	$133,997	0.90	$125,148	$138,932	$135,348	0.90	$126,163	$138,200	$135,060	0.91
UMass	$96,627	$116,181	$109,329	0.83	$98,072	$116,993	$110,215	0.84	$98,462	$116,451	$109,844	0.85

Table $B5_d$: Mean Salaries by Sex, Rank, and Year, 2012-2014

	2012				2013				2014			
	F	M	Total	Ratio	F	M	Total	Ratio	F	M	Total	Ratio
Assistant	$78,471	$82,471	$80,463	0.95	$79,109	$85,146	$82,015	0.93	$79,482	$85,629	$82,326	0.93
Associate	$97,023	$101,586	$99,435	0.96	$98,050	$103,771	$100,989	0.94	$96,677	$102,071	$99,510	0.95
Full	$132,588	$143,507	$140,589	0.92	$136,607	$147,445	$144,572	0.93	$136,494	$146,433	$143,748	0.93
UMass	$102,694	$121,354	$114,228	0.85	$103,998	$124,828	$116,697	0.83	$103,342	$123,541	$115,533	0.84

Table $B5_e$: Mean Salaries by Sex, Rank, and Year, 2015

	2015			
	F	M	Total	Ratio
Assistant	$84,004	$88,452	$86,033	0.95
Associate	$101,532	$107,953	$104,917	0.94
Full	$143,285	$153,572	$150,603	0.93
UMass	$108,904	$128,968	$120,792	0.84

Appendix C. Sensitivity Analysis: Including Grants Data in Logged Salary Models.

Including grants data in regression models that predict income is rare in the existing literature. Therefore, we ran exploratory models to understand the ways in which the number of grants awarded and the amount of grants obtained by a faculty member affects their salary.

We theorized that the number of grants obtained by a faculty member in a current year may not have an effect on their income until maybe a year or two years later. Therefore, we ran models that included the variable capturing the number of grants awarded in the current year (Grants), but also in the year before, and two years before. Table C.1 below shows the result of the sensitivity analysis of including the number of grants in these three different forms.

It is important to understand the way in which including the number of grants in different forms affect three estimates: 1. The size and significance of the coefficient of the grant variable; 2. The coefficient of Female, our independent variable of interest; and 3. The R^2 which indicates model fit.

The coefficient of the grants variable increases in size when we lag it. Using grants in the current year, an additional grant award is associated with a 1.2 percent increase in salary. Using a 1-year lag of grants, we obtain that an extra grant awarded increases salary by 1.4 percent, and including a 2 year lagged grants variable results in an association of a 1.8 percent increase in salary for each additional grant. The grants variable is statistically significant in all three forms.

The coefficient on our variable of interest remains very similar in size and statistically insignificant irrespective of which form of the grants variable we use.

Finally, changing the form of the grants variable has no impact on the R^2 or model fit of our model.

Based on these results, for simplicity, we decided to include the current grants variable in our OLS models.

Table C.1: Sensitivity Analysis Results for Number of Grants Variable.

	Number of Grants in Current Year	Number of Grants Obtained One Year Before	Number of Grants Obtained 2 years before.
Female	**-0.014**	**-0.014**	**-0.013**
	(0.009)	**(0.009)**	**(0.009)**
Asian	0.005	0.007	0.004
	(0.013)	(0.013)	(0.013)
Minority	-0.046	-0.047	-0.047
	(0.015)**	(0.015)**	(0.015)**
Admin Position	0.303	0.298	0.297
	(0.026)***	(0.026)***	(0.026)***
Dept. Head	0.096	0.100	0.102

	(0.021)***	(0.021)***	(0.021)***
Years at UMass	0.002	0.002	0.002
	(0.001)**	(0.001)***	(0.000)***
Law Degree	-0.193	-0.188	-0.187
	(0.063)**	(0.063)**	(0.063)**
PhD	0.028	0.029	0.028
	(0.022)	(0.022)	(0.022)
Other Degree	0.002	0.003	0.002
	(0.103)	(0.103)	(0.102)
Associate	0.184	0.183	0.178
	(0.013)***	(0.013)***	(0.013)***
Full	0.472	0.468	0.462
	(0.015)***	(0.015)***	(0.015)***
Education	0.013	0.011	0.009
	(0.021)	(0.021)	(0.021)
Pub. Health & Nursing	0.021	0.019	0.017
	(0.019)	(0.018)	(0.018)
SBS	0.079	0.079	0.078
	(0.015)***	(0.015)***	(0.014)***
CNS	0.086	0.082	0.078
	(0.013)***	(0.013)***	(0.013)***
Engineering & Comp Sci.	0.190	0.188	0.184
	(0.017)***	(0.016)***	(0.016)***
Management	0.453	0.453	0.452
	(0.020)***	(0.020)***	(0.020)***
Other College	0.123	0.127	0.125
	(0.049)*	(0.049)*	(0.049)*
Grants	**0.012**		
	(0.003)* **		
Number Awards 1 year lag		**0.014**	
		(0.003)* **	
Number Awards 2 year lag			**0.018**
			(0.003)* **
_cons	11.230	11.228	11.233
	(0.022)***	(0.022)***	(0.022)***
R^2	**0.79**	**0.79**	**0.79**
N	1,097	1,097	1,097

* $p<0.05$; ** $p<0.01$; *** $p<0.001$

Appendix D. Data Management and Explanation of Variables

This appendix describes the ways in which certain variables were constructed for the analysis in the report.

The following are the most important changes made to the original data in order to create our variables:

Colleges: The departments that comprise each of the nine colleges that exist today changed in the time range for our data. We recoded colleges to reflect their 2015 composition. For example, faculty in the department of computer science were back-coded as members of the College of Information and Computer Science. Faculty in the Psychology department were also recoded to the College of Natural Sciences, where the department is now hosted.

Race: The original data had 53 faculty members who did not report their race in 2015. Data for race in these cases were manually imputed and cross checked internally.

The Minority variable includes all faculty members coded as American Indian or Alaska Native, Black or African American, Hispanic, or multiracial.

Number of Grants: The number of grants data was downloaded and aggregated from the OGCA data warehouse. For each faculty member, we counted the number of grants received in each year. Since the OGCA data did not use the faculty ID number as an identifier, the grants data was merged with the salary data based on First and Last Names.