

To: Dr. Sarah Woodward, Director of Institutional Research
From: Elsie Liu, Data Analyst
Re: University Programs with Most Promising Workforce Outcome

OVERVIEW

Dr. Patricia Bartlett has expressed her concerns over possible program eliminations due to impending cuts of state funding for the university. In this memo, I demonstrate the effectiveness of state funding for universities by showcasing how university programs have generated positive career outcomes. More specifically, several programs have demonstrated statistically significant career benefits for graduates in both salary and job satisfaction through data acquired from 2003-2010 Nation Survey of College Graduates. And I give recommendations on 2 programs as follow:

Recommended Program	Successful Career Outcomes
Doctorate Program in Management and Administration (MA)	<ul style="list-style-type: none">Salary: boosted yearly salary by \$24314¹ when compared with graduates with a bachelor's degree in the same major.Job Satisfaction: More satisfied with job than bachelor's and master's degree in the same major.
Doctorate Program in Electrical, Electronics and Information Engineering (EEIE)	<ul style="list-style-type: none">Salary: boosted yearly salary by \$21183 compared with bachelor's degree in the same majorJob Satisfaction: More satisfied with job than bachelor's and master's degree in the same major.

Compared with other programed surveyed, these two recommended programs not only have the most significant income boost, but at the same time yield quantitative evidence on improving graduates' job satisfaction.

RATIONALE

I evaluate the effectiveness of a program by analyzing differences in outcomes for students who studied in such program and those who has not. To conduct program specific analysis, I decompose the dataset into groups of majors. For every group of data, the observations are majored in the same field with difference only in the highest degree acquired. My hypothesis here is that taking part in either the master's or the doctorate program will yield positive career outcomes for the graduates. So I run regressions on **the salary** and **job satisfaction** respectively of **the highest degree earned** with each group of data, and analyze the regression metrics to understand if any of the graduate degrees would yield positive outcome when compared to the bachelor's degree. The program recommendation is a direct result of major-specific analysis of the surveyed dataset, which had significant salary boost as well as positive benefit to career satisfaction.

DATA ANALYSIS

Control variables: To analyze the data effectively, I take demographic and career characteristics into consideration by holding constant of 4 demographic and 4 career-related variables, including gender, citizenship, race, children status, hours at work per week, if degree is related to the job duty, if any job training is done, as well as if the person is currently employed. In addition, I believe the number of years on hire would also have an impact on career outcomes, however that number is not directly given. So I

¹ All numbers of salary appeared in this memo have adjusted to 2021 dollars according to the CPI inflation ratios provided by U.S. Bureau of Labor Statistics.

estimate the number of years on hire by deducting the year when the highest degree is earned from the survey year. Given the granularity of the entry, I group this number by the interval of 5, with 0 representing 0-4 years on hire, 1 representing 5-9 years on hire, 2 representing 10-14 years on hire, and etc. This control also allows us to make use of answers from the same participants from different years of survey.

Linear Regression on Salary: Both regressions on salary outcome² of the doctorate degree earned in the majors of MA and EEIE yield very positive results with statistical significance (Table 1, Table 2). More specifically, studying the doctorate program in MA is expected **to help you earn \$24314 more** than only having the bachelor's degree in MA; and that earning a doctorate degree in EEIE is estimated to **boost the yearly salary by \$21183** compared with a bachelor's degree in EEIE. Given the statistical significance of the t test result, **this analysis provide strong evidence for the effectiveness of MA and EEIE doctorate programs.**

Linear Regression on Job Satisfaction Level: To do a linear regression on job satisfaction, I mapped the the job satisfaction level acquired from the survey from categorical to numerical, with "very dissatisfied" recoded as 0, "somewhat dissatisfied" as 3.33, "somewhat satisfied" as 6.67, and "very satisfied" as 10. When demographic and career factors are not controlled for, the linear regression analysis yielded a statistically significant positive impact on career satisfaction for the doctorate program for both majors (Table 3, Table 4). **This means that those who own a doctorate degree in MA or EEIE would likely to be more satisfied with their job compared to those who's highest degree is the bachelor's degree in the same field major.** However, when I take into the consideration of demographic characteristics and career stages, I no longer have statistically significant results on the positive job satisfactory impact on neither of the major (Table 5, Table 6). I believe this is likely to be a result of limited doctorate entry for this program for each of the controlled groups given the relatively small size of the dataset.

CONCLUSION AND CONSIDERATIONS

Considering the analysis above, **I strongly recommend using the doctorate program in management and administration and the doctorate program in electrical, electronics, and information engineering as examples to demonstrate the effectiveness of our education on positive career outcomes.** The findings on promising career outcome, the significant salary boost as the main evidence and the higher job satisfaction as supplementary evidence, support the argument that the university programs provide our students with great preparation for their future careers. However, I see a few limitations in this study. The dataset size is relatively small, which I believe to be the main reason that we cannot see a significant job satisfaction boost when controlling various factors. In addition, the dataset is not collected from graduate of our university. In fact, it does not differentiate university education from the public and private sector. In the future, it would help us make more convincing arguments if we could collect similar survey data from our own graduates. In addition, the regression modeling I conducted involves a simple linear regression which I see as an appropriate tool for small dataset. If more data are available, we can try more complex alternative modeling tools such support vector regression or deep neural networks to help yield further insights program evaluations.

² The data on salary in the dataset has been adjusted to 2021 dollars according to the CPI inflation ratios provided by U.S. Bureau of Labor Statistics

Appendix

Table 1: Linear Regression on Salary of the Highest Degree in Management and Administration

Residuals:

Min	1Q	Median	3Q	Max
-144218	-27231	-2485	24027	205362

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)	
(Intercept)	37417	8396	4.456	8.53e-06	***
management\$dgr_typedoctorate	24314	7670	3.170	0.001534	**
management\$dgr_typedmaster's	14560	1662	8.761	< 2e-16	***
management\$femalemale	11645	1343	8.674	< 2e-16	***
management\$minrtyyes	-7850	1730	-4.539	5.80e-06	***
management\$citz_usyes	-9735	3487	-2.792	0.005265	**
management\$chd_totone child	3239	1625	1.993	0.046328	*
management\$chd_tottwo or more children	4745	1402	3.384	0.000721	***
management\$wrk_trngyes	3257	1260	2.584	0.009786	**
management\$deg_relnot related	-14314	1672	-8.563	< 2e-16	***
management\$deg_relsomewhat related	-1273	1374	-0.927	0.354128	
management\$hrs_wk21 - 35	31680	4604	6.882	6.72e-12	***
management\$hrs_wk36 - 40	52697	3981	13.239	< 2e-16	***
management\$hrs_wkgreater than 40	72150	3977	18.142	< 2e-16	***
management\$year_hired1	5946	6938	0.857	0.391479	
management\$year_hired10	-9588	12493	-0.767	0.442827	
management\$year_hired11	-28571	29584	-0.966	0.334222	
management\$year_hired2	8398	6828	1.230	0.218734	
management\$year_hired3	9574	6815	1.405	0.160152	
management\$year_hired4	14077	6856	2.053	0.040098	*
management\$year_hired5	16197	6893	2.350	0.018832	*
management\$year_hired6	8973	6961	1.289	0.197424	
management\$year_hired7	2871	7185	0.400	0.689506	
management\$year_hired8	10691	8158	1.311	0.190078	
management\$year_hired9	26461	9597	2.757	0.005856	**

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 40700 on 4540 degrees of freedom

Multiple R-squared: 0.2077, Adjusted R-squared: 0.2035

F-statistic: 49.59 on 24 and 4540 DF, p-value: < 2.2e-16

Table 2: Linear Regression on Salary of the Highest Degree in Electric, Electronic & Information Engineering (EEIE)

```
Call:
lm(formula = electric$salary ~ electric$dgr_type + electric$female +
    electric$minrty + electric$citz_us + electric$chd_tot + electric$wrk_trng +
    electric$deg_rel + electric$hrs_wk + electric$year_hired)
```

Residuals:

```
      Min       1Q   Median       3Q      Max
-166361  -26744   -1938    24782  238921
```

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	16188.3	8094.1	2.000	0.045528 *
electric\$dgr_typedoctorate	21182.7	4070.7	5.204	1.99e-07 ***
electric\$dgr_typedmaster's	19235.5	1060.4	18.140	< 2e-16 ***
electric\$femalemale	4496.1	1521.2	2.956	0.003128 **
electric\$minrtyyes	-7280.5	1325.5	-5.493	4.07e-08 ***
electric\$citz_usyes	-2983.5	1456.7	-2.048	0.040569 *
electric\$chd_totone child	4037.8	1228.2	3.287	0.001015 **
electric\$chd_tottwo or more children	6910.9	1042.2	6.631	3.51e-11 ***
electric\$wrk_trngyes	2105.4	892.3	2.360	0.018318 *
electric\$deg_relnot related	-33911.4	1727.4	-19.632	< 2e-16 ***
electric\$deg_relsomewhat related	-7043.2	972.8	-7.240	4.84e-13 ***
electric\$hrs_wk21 - 35	38178.1	3469.8	11.003	< 2e-16 ***
electric\$hrs_wk36 - 40	69761.3	2850.9	24.470	< 2e-16 ***
electric\$hrs_wkgreater than 40	85514.1	2830.1	30.216	< 2e-16 ***
electric\$year_hired1	23292.2	7600.6	3.065	0.002186 **
electric\$year_hired10	36486.4	9834.7	3.710	0.000209 ***
electric\$year_hired11	45779.7	30733.9	1.490	0.136377
electric\$year_hired2	25976.8	7478.6	3.473	0.000516 ***
electric\$year_hired3	30584.4	7476.8	4.091	4.34e-05 ***
electric\$year_hired4	36999.9	7491.2	4.939	7.99e-07 ***
electric\$year_hired5	40118.7	7515.1	5.338	9.60e-08 ***
electric\$year_hired6	40106.2	7560.7	5.305	1.16e-07 ***
electric\$year_hired7	34276.1	7607.5	4.506	6.70e-06 ***
electric\$year_hired8	36443.3	7798.5	4.673	3.01e-06 ***
electric\$year_hired9	26628.5	8317.6	3.201	0.001372 **

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 42120 on 9311 degrees of freedom

(1 observation deleted due to missingness)

Multiple R-squared: 0.239, Adjusted R-squared: 0.2371

F-statistic: 121.9 on 24 and 9311 DF, p-value: < 2.2e-16

Table 3: Linear Regression on Job Satisfaction of the Highest Degree in Management without Controlling variables

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	7.78203	0.03867	201.239	<2e-16 ***
management\$dgr_typedoctorate	0.95487	0.44033	2.169	0.0302 *
management\$dgr_typedmaster's	-0.05822	0.09180	-0.634	0.5260

Table 4: Linear Regression on Job Satisfaction of the Highest Degree in EEIE without Controlling variables

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	7.785510	0.027363	284.532	<2e-16 ***
electric\$dgr_typedoctorate	0.504755	0.218051	2.315	0.0206 *
electric\$dgr_typedmaster's	0.006965	0.056531	0.123	0.9019

Table 5: Linear Regression on Job Satisfaction of the Highest Degree in Management with Controlling variables

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	8.81449	0.48089	18.330	< 2e-16 ***
management\$dgr_typedoctorate	0.71987	0.43929	1.639	0.10134
management\$dgr_typemaster's	-0.11431	0.09518	-1.201	0.22982

Table 6: Linear Regression on Job Satisfaction of the Highest Degree in EEIE with Controlling variables

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	7.69648	0.43352	17.753	< 2e-16 ***
electric\$dgr_typedoctorate	0.37200	0.21802	1.706	0.0880 .
electric\$dgr_typemaster's	0.01212	0.05680	0.213	0.8310