FACTORS AFFECTING DIFFERENCES IN SALARY AMONG SCIENCE DOCTORATES IN ITALY

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ABSTRACT

Salary studies have been of great interest to researchers across many disciplines for many decades of which science Doctorates are no exception. This paper seeks to examine the factors which influence salary differences among individuals with science Doctorates in Italy. The study revealed from the regression that major factors influencing the differences in salary are Field of Science, Age of Completion, Country of Work, Contract Type, Gender as well as Mother's Education as the factors influencing on the differences in salary. These results suggested that performance is not the only factor which determines salary levels.

Keywords: Doctorates, Heteroskedasticity, Regression, Salary

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1.0 INTRODUCTION

Does Education pay off? Most people think so. Currently, almost 90 percent of young adults graduate from high school and about 60 percent of high school seniors continue on to college the following year. People decide to go to college for many reasons. One of the most compelling is the expectation of future economic success based on educational attainment. Salary studies have been of great interest to researchers across many disciplines for many decades of which science Doctorates are no exception. Some countries have developed a tracking system to identify the factors that influence professionals' job choices, to identify factors that influence salary and totrack the professionals and these factors over time. Salary study of American AgriculturalEconomics Association (AAEA)membership found significant positive correlations of salary and with type of position, years ofexperience, and publications whereas significant negative correlations existed between salaryand teaching loads. These results supported research across other disciplines that suggested thatperformance is what determines salary levels; ethnicity and gender do not (Popp et al 2009).

The table below shows the salary difference among Science Doctorates who completed their studies in 2003 in the US. Table 1 suggests that individuals may receive the same level of education but there may exist differences in their salary structure; therefore for this and the above outlined reason calls for this research.

Table 1: Salary of recent S&E doctorate recipients 1–4 years after receiving degree: 2003 (Dollars)

	Percentile				
Doctorate Field	10th	25th	50th	75th	90th
All Fields	30,000	40,000	52,000	75,000	100,000
Engineering	44,000	63,000	75,000	88,000	102,000
Life Sciences	26,000	32,000	39,400	50,000	72,500
Mathematics/Computer Sciences	40,000	42,500	60,000	92,500	115,000
Physical Sciences	34,000	42,000	62,000	92,000	175,000
Social Sciences	20,000	41,000	50,000	67,000	82,000

National Science Foundation, Division of Science Resources Statistics, Survey of Doctorate Recipients (2003) -Science and Engineering Indicators 2006

The purpose of this study is to find out the major factors which contribute to the differences in salary among Science Doctorates which has been of great concern to many researchers.The following Science fields are of interest to this research; Natural Sciences, Medical and Health Sciences, Agricultural Sciences, Engineering and Technology, Humanities, Social Sciences and Political-Social Sciences.

The major questions to be answered in this work include the determinants of these differences and whether these determinants have a strong effect on salaries.In what sectors are Ph.D.s holdersemployed? What salary disparities exist between those in these fields? How is does it help a career to have apostdoctoral appointment? Findings of this research will be of interest to practitioners, faculty, and students in science and engineering as well as education administrators, employers, and researchers in these fields.

2.0 METHOD

PhDdata 3 was the data used for this research and R-statistical software was also used for the analysis. In all 1296 individual samples were used with 15 variables (questions) which constitute the following:

[1] "FieldScience" "CompletionYear" "Gender"
[4] "Citizenship" "AgeAtCompletion" "UnivDegreeEvaluation"
[7] "Conclusion" "Employed" "ContractType"
[10] "Earnings" "CountryWork" "CountryResidence"
[13] "FatherEducation" "MotherEducation" "MaritalStatus"

Based on the available literature, the dependent variable chosen was “Earnings” since it conveys information on salary and the others constitute the independent variables. Following this, a test was run on the independent variables to test for multicollinearity. According toLipovestky (2001),when two X variables are highly correlated, they both convey essentially the same information. In this case, neither may contribute significantly to the model after the other one is included. But together they contribute a lot. If you removed both variables from the model, the fit would be much worse. So the overall model fits the data well, but neither X variable makes a significant contribution when it is added to the last model. When this happens, the X variables are collinear and the results show multicollinearity. A test was run and it showed no

multicollinearity. Following this linear regression(LM) was run to get the final model. Linear regression was used because of the combination of a continuous dependent variable and categorical independent variables.

3.0 RESULTS

Earnings were chosen as the dependent variable because it is the only variable that carries information on the respondents' salaries. Hence the first model included:

log(Earnings)= (Field Sciences, Citizenship, Year of Conclusion, Father Education, Year of Completion, Age of Completion, Employment status, Country of Work, Mother Education,Gender, University Degree Evaluation, Contract Type, Country Residence, Marital Status)

As indicated from the model above, 14 variables were examined in the ordered linear regression and the following results were obtained, as in Table 2. Following this, the step function was used to stream line the significant variables from the insignificants variables. The final model obtained were the following results from the regression.The summaryresult of the final model is shown in Table 3:

Initial Model:

log(Earnings) ~ FildSci + Citiship + YrConclu + FEduc + YrCompltn + AgeCompltn + Emplyd + CountyWrk + MEduc + Gender + UniDegEva + ContractTyp + CountyRes + MariStat

Final Model:

log(Earnings) ~ FildSci + AgeCompltn + CountyWrk + MEduc + Gender + ContractTyp

	Step	Df	Deviance	Resid. Df	Resid. Dev	AIC
1				1248	795.3104	-536.8438
2	- Emplyd	0	0.00000000	1248	795.3104	-536.8438
3	- CountyRes	7	1.17661566	1255	796.4870	-548.9279
4	- UniDegEva	4	1.49342819	1259	797.9804	-554.5001
5	-MariStat	3	0.57810094	1262	798.5585	-559.5616
6	- FEduc	4	2.05723960	1266	800.6158	-564.2271
7	-YrConclu	1	0.09345132	1267	800.7092	-566.0759
8	-Citiship	1	0.13156811	1268	800.8408	-567.8629
9	- YrCompltn	1	0.66510935	1269	801.5059	-568.7870

Aresidual Test was done on the final model to know if its variances are around zero and figure 1 show the results obtained.

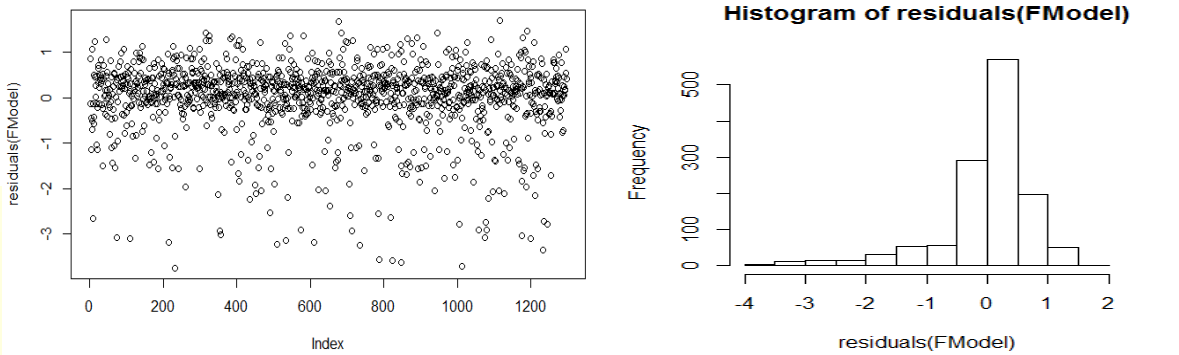

Figure 1: Residual Test

The figure shows that there exist heteroskedasticity in the final model since most of the variables are normally distributed around zero.The Analysis of Variance test was tested on the two models to know whether the models are significant to each other and test output the following results:

Res.Df	RSS	Df	Sum of Sq	F	Pr(>F)
1	1248	795.31			
2	1269	801.51	-21	-6.1955	0.463 0.9819

Following these results we can conclude that since p-value is large at 0.9819 we do not reject the null hypothesis and conclude that the two models are not statistically significant.That is there no difference between the two models. This is due to the fact that stepwise function might have removed some variable that might be of interest to the study. From the Analysis of Variance results in Table 5, it indicates that the various P-Values for all the variables in the final model are less at the 95% confidence interval. This means that we have to reject the Null hypothesis and say that really the above variables are the factors which influence salary differences.

4.0 DISCUSSION OF RESULTS

The ordered linear model identified the factors that salaries among science doctorates. The model came up with Field of Science, Age of Completion, Country of Work, Mother's Education, Gender as well as Contract Type as the main determinants of differences in salaries or earnings. With the constant coefficient of 3.90065 which represent the mean of the reference group. It estimated that an individual's choice in the field of science influences his salary. For instance individuals with Medical Science and Social Sciencedoctorates tends to have (22.6%)and (20.6%) respectively higher salaries than those in the other fields of science. Age at the Completion year also had a significant negative impact on salary difference. It was found that individuals who finished their doctorates at the age below 33years tend to have lower salaries whilst those who finished at the age more than 33 years tend to have (7.33%) difference in salary. Another determinant is Country of Work which also had a significant impact on salary; it indicated that those individual who work in European countries likeFrance, Germany, Spain and United Kingdom earn (54.3%) higher salary than those who work in other countries. Individuals Mother's Education also influenced their salary. It was found that individual whose mothers had have University or Post graduate education receives (31.7%) and (15.9%) salary higher that the others.The model also found out that Gender, specifically females tend to earn (13.13%) salary lower than their male counterpart. Finally the model also came up with Contract Type as a factor determining salary difference. It was estimated that individuals whose held contract as research scholarship and post doctoral positions earn (12.96%) and (58.75%) respectively higher than those with other contracts. Individuals with contract other than these two earn salary lower than these two.

5.0 CONCLUSIONS

Salary issues have been a focus of study in the labour economics in recent times. From the various statistical tests, our model suggest thatField of Science, Age of Completion, Country of Work, Mother's Education, Gender as well as Contract Type were the main factors which influence differences in salaries. This means that salary differences exist among people with the same qualification but these differences depend on those factors revealed by the model. It was established that the most factors influencing the differences in salary in order of significance are Field of Science, Age of Completion, Country of Work, Contract Type and Gender. Individuals Mother's Education has a lesser impact on the differences in salary. The study also suggested

that natural Sciences, Technology and Engineering; and Humanities were the fields which employ most doctorates holders in Italy.

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APPENDIX

Table 3:Summary of the Model

Coefficients: (1 not defined because of singularities)

	Estimate	Std. Error	t value	Pr(>|t|)	
(Intercept)	-0.48645	0.35185	-1.383	0.16706	
FildSciMedSc	0.22312	0.07737	2.884	0.00400	**
FildSciAgSc	0.03317	0.09988	0.332	0.73986	
FildSciEngTech	0.12966	0.07170	1.808	0.07078	.
FildSciHum	-0.07866	0.07458	-1.055	0.29178	
FildSciScSc	0.20561	0.07759	2.650	0.00815	**
FildSciPolSc	-0.11134	0.13772	-0.808	0.41898	
CitishipItaly	0.06010	0.28045	0.214	0.83036	
YrConcluMoretime	0.01649	0.07441	0.222	0.82461	
FEducPEdu	-0.07479	0.09122	-0.820	0.41244	
FEducSEdu	-0.05849	0.09578	-0.611	0.54154	
FEducUdeg	0.11195	0.16297	0.687	0.49225	
FEducPostgrad	0.00517	0.10382	0.050	0.96029	
YrCompltn2006	-0.04243	0.04593	-0.924	0.35576	
AgeCompltn30years	-0.01901	0.07234	-0.263	0.79272	
AgeCompltn31years	-0.07898	0.07922	-0.997	0.31894	
AgeCompltn32years	-0.17402	0.08423	-2.066	0.03904	*
AgeCompltnMore33	0.08035	0.06343	1.267	0.20546	
EmplydYes	4.07908	0.11075	36.830<	2e-16	***
CountyWrkOther	0.39714	0.28586	1.389	0.16500	

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CountyWrkN/A                    NA         NANANA
MEducPEdu                  0.19294    0.08726   2.211  0.02722 *
MEducSEdu                  0.10805    0.08835   1.223  0.22155
MEducUdeg                  0.21867    0.15468   1.414  0.15772
MEducPostgrad              0.13504    0.10171   1.328  0.18450
GenderFemale              -0.13870    0.04720  -2.939  0.00336 **
UniDegEva91-100            0.25795    0.33364   0.773  0.43958
UniDegEva101-105           0.21060    0.32517   0.648  0.51734
UniDegEva106-109           0.27878    0.32308   0.863  0.38836
UniDegEva110               0.29973    0.31967   0.938  0.34862
ContractTypNatFxtermPos   -0.21404    0.14140  -1.514  0.13036
ContractTypTemAgcy        -0.67858    0.07633  -8.890  < 2e-16 ***
ContractTypTrnAppContr    -0.44355    0.16668  -2.661  0.00789 **
ContractTypPrjtContr      -0.20655    0.07918  -2.609  0.00920 **
ContractTypOcasnalWork     1.06794    0.80776   1.322  0.18637
ContractTypNoContr        -0.26103    0.09445  -2.764  0.00580 **
ContractTypPostDoc         0.59368    0.19484   3.047  0.00236 **
ContractTypReschGrnt      -0.16671    0.12265  -1.359  0.17432
ContractTypReschSships     0.13278    0.07339   1.809  0.07065 .
CountyResEU                0.16983    0.34146   0.497  0.61902
CountyResFrance            0.28097    0.32785   0.857  0.39162
CountyResGermany          -0.06572    0.36840  -0.178  0.85844
CountyResUK                0.21419    0.35226   0.608  0.54327
CountyResSpain             0.06443    0.59226   0.109  0.91339
CountyResOther             0.10356    0.32992   0.314  0.75365
CountyResUSA               0.25110    0.40812   0.615  0.53850
MariStatMarried            0.01382    0.04852   0.285  0.77584
MariStatDivorced           0.17012    0.17544   0.970  0.33240
MariStatWidow             -0.04578    0.46744  -0.098  0.92199
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Signif.codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.7983 on 1248 degrees of freedom
Multiple R-squared: 0.6372,   Adjusted R-squared: 0.6236
F-statistic: 46.65 on 47 and 1248 DF,  p-value: < 2.2e-16
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Table 4: Coefficients

Variables	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	3.90065	0.08659	45.049	< 2e-16 ***
FildSciMedSc	0.22639	0.07612	2.974	0.00299 **
FildSciAgSc	0.03571	0.09853	0.362	0.71709
FildSciEngTech	0.11707	0.07021	1.667	0.09570 .
FildSciHum	-0.07202	0.07142	-1.008	0.31345
FildSciScSc	0.20564	0.07578	2.714	0.00674 **
FildSciPolSc	-0.10063	0.13528	-0.744	0.45711
AgeCompltn30years	-0.03066	0.07085	-0.433	0.66525

AgeCompltn31years	-0.08532	0.07666	-1.113	0.26589
AgeCompltn32years	-0.17558	0.08200	-2.141	0.03243 *
AgeCompltnMore33	0.07333	0.05968	1.229	0.21943
CountyWrkOther	0.54313	0.09523	5.703	1.46e-08 ***
CountyWrkN/A	-4.08355	0.10900	-37.463	< 2e-16 ***
MEducPEdu	0.16046	0.07470	2.148	0.03190 *
MEducSEdu	0.10815	0.06873	1.573	0.11586
MEducUdeg	0.31696	0.12361	2.564	0.01046 *
MEducPostgrad	0.15947	0.07461	2.137	0.03276 *
GenderFemale	-0.13136	0.04620	-2.844	0.00453 **
ContractTypNatFxtermPos	-0.22851	0.13866	-1.648	0.09961 .
ContractTypTemAgcy	-0.70319	0.07442	-9.449	< 2e-16 ***
ContractTypTrnAppContr	-0.45844	0.16466	-2.784	0.00545 **
ContractTypPrjtContr	-0.21393	0.07809	-2.740	0.00624 **
ContractTypOcasnalWork	1.08410	0.79845	1.358	0.17478
ContractTypNoContr	-0.26310	0.09332	-2.819	0.00489 **
ContractTypPostDoc	0.58753	0.19260	3.051	0.00233 **
ContractTypReschGrnt	-0.17735	0.12051	-1.472	0.14134
ContractTypReschSships	0.12963	0.07242	1.790	0.07369 .

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

Residual standard error: 0.7947 on 1269 degrees of freedom
Multiple R-squared: 0.6344, Adjusted R-squared: 0.6269
F-statistic: 84.7 on 26 and 1269 DF, p-value: < 2.2e-16

Table 5 Analysis of variance

Response: log(Earnings)

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
FildSci	6	80.31	13.38	21.1920	< 2.2e-16 ***
AgeCompltn	4	19.67	4.92	7.7863	3.373e-06 ***
CountyWrk	2	1196.93	598.47	947.5317	< 2.2e-16 ***
MEduc	4	5.42	1.35	2.1438	0.073290 .
Gender	1	6.84	6.84	10.8248	0.001029 **
ContractTyp	9	81.77	9.09	14.3856	< 2.2e-16 ***
Residuals	1269	801.51	0.63		

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