MODEL FOR ANALYSIS OF CO-OP WAGES

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Students in cooperative education programs are very interested in the earnings they receive from their co-op placements.[1] Who earns what is a perennial topic of conversation among students. While it is popular in some academic circles to complain about how crass and materialistic this generation of students is, students can hardly be blamed for their concern. College costs have gone up constantly at all types of schools for the past ten years (see Table 1). These increases have outstripped inflation for the last seven. One study of the wage strength of co-op earnings (i.e. the average cost of tuition compared to the average wage for co-op)

Table 1
Average Tuition Increases Four Year Institutions

Year	Public	Private
1977-78	0%	6%
1978-79	5%	7%
1979-80	6%	7%
1980-81	4%	10%
1981-82	16%	13%
1982-83	20%	13%
1983-84	12%	11%
1984-85	8%	9%
1985-86	9%	8%
1986-87	6%	8%
1987-88	6%	8%
1988-89	5%	9%

Source: The College Board's 1988 Survey of College Costs, reported in "The Chronicle of Higher Education," 10 August, 1988

shows that while wages have been increasing, the cost of tuition has increased at an even faster rate, so that students in all majors are comparatively worse off now than they were in 1970.[2] To compound the problem, shifts in federal financial

1 I need to acknowledge the assistance of many friends and colleagues. Dean Paul Pratt provided the initial financial assistance to hire Lisa Micali, who performed much of the coding and data entry. My colleagues in the Electrical Engineering Coop Program Richard Canale, Phillip Dunphy, and our assistants, Donnal Riggs, Lynda Garow, Maria Kyranos, and Carol Ann Chait were very helpful in providing their records, and forbearing while I examined them. Robert Tillmand and Paul Harrington provided continuing peripatetic dialogue on these and other matters, and Carol Owen provided me with great insight into the techniques of analysis I employed. All errors, mistakes, and ridiculous notions are my own.

2 See Tillman, Robert R. and Finn, Kathleen L., "A Model for Determining the Wage Strength of a Cooperative Education Program", *Journal of Cooperative Education*, Volume XIX, Number 1, 1982.

aid policy have caused students to rely more and more on loans to finance their educations. In 1986-87, the average Guaranteed Student Loan amount was $2,375, and the average National Deferred Student Loan was $925.[3] With these averages, it is easy for students to pile up $15,000 or more in debt in order to graduate from college. No wonder students today care about their earnings from co-op.

Co-op coordinators and college administrators ought to be concerned about student earnings, as well. This is not to say that wages ought to be the only focus of coordinators and administrators. What students learn on co-op, and how co-op contributes to their professional development is of primary concern. But still, coordinators should be concerned that their students are being compensated fairly. Only careful examination of the wage structure of a co-op program will reveal if there is any discrimination or exploitation. Since admissions offices often use average salary figures in recruitment literature, administrators have an obligation to use accurate and realistic information in such literature. But understanding earnings has pragmatic benefits, as well. If coordinators better understand the forces at work in the labor market, they can adopt strategies to maximize student earnings. An analysis of wages might reveal that certain industries pay comparatively more than others. Coordinators may want to focus their job development efforts in those industries. Higher earnings may assist in admissions efforts, since they make a school's co-op program more attractive. Higher co-op wages may also have an impact on retention, since if students are not making enough on co-op to meet their tuition and expenses, they may drop out of school, or work more hours per week while they are in school.

This paper will examine the factors which influence wages for electrical engineering co-op students using multiple regression and path analysis on a sample of electrical engineering students in a mandatory co-op program. Similar factors may influence wages for other engineering students, and also for students in non-engineering disciplines, but these are matters for further investigation. Since wages in the general labor market vary by occupational field, it is reasonable to expect the same for co-op wages. But what else influences earnings? This article will examine the effect of a student's experience, academic success, citizenship, race, sex, and the industry in which he or she is employed, on his or her earnings from co-op.

Description of Data

The sample for this study is drawn from the winter 1988, co-op work period. During this three month period, 366 electrical engineering students worked in jobs arranged by the co-op department, or in their own jobs which were approved by the co-op department.[4] The data for this model came from several sources.

[3] See *The Condition of Education: A Statistical Report*, Office of Educational Research and Improvement, Washington, DC 1987.

[4] Three coordinators, assisted by four counselors, were responsible for these students.

The salary information is self-reported, taken from student evaluations of their co-op assignments; the GPA data from the registar's records; and the race, sex, and citizenship data from an information form students fill out when they are freshmen. Of the 366 students out on co-op during this time, 244 of them returned their evaluations in time to be included in this study.

There are several potential problems with this salary data. One small problem is that some students simply fail to report their salaries, but only 9 of the 244 failed to report any salary. A larger problem may be non-random bias in which a student submits his/her evaluation. Those who submit evaluations could be the more responsible students. So the average salary estimates drawn from this data may be upwardly biased. A further problem may be reporting and conversion error. The evaluation asks for gross salary, but some students may be confused and report their net salary. We converted the reported figures to hourly wages based on the number of hours worked per week that each student reported. For those on a weekly or monthly salary which provides for no overtime, but who average more than the reported hours per week, this figure is not an accurate reflection of hourly earnings. One other sort of error that crops up in self-reported salary data is exaggeration. This happens with the figures reported through the census—people wish to appear more successful than they are, so they inflate how much they earn. If there is significant exaggeration of salaries, the averages and predictions of this model will be upwardly biased. Since students know that coordinators can easily verify salaries by simply calling their employers, salary data probably are not corrupted by this sort of exaggeration.

The industry coding was done in the spring of 1988 using the Standard Industry Classification system, revised by the Department of Labor in 1972. The SIC system classifies each establishment based on its primary activity. An establishment means a "primary activity" at a particular location. One company may have many establishments at different locations, and one company may have two or more different establishments at the same location. Most Digital Equipment Corporation facilities are classified in SIC 357, Office and Computing Machinery, but an occasional facility which might merely perform final assembly of components produced elsewhere would be classified as SIC 508, Machinery and Equipment, Wholesale Trade.

Proper coding of facilities is critical to making legitimate comparisons. Unfortunately, it is not always easy to determine a company's correct SIC. State Division of Employment Security offices gather information relevant to coding once every three years from every establishment which employs more than 20 individuals. Establishments can go into and out of existence rapidly, and the number of employees an establishment has may fluctuate dramatically according to economic conditions. Since organizations change product lines, make acquisitions, and change the way they manufacture and distribute products, their SIC number may change over several years. Establishments may be coded by sources other than the DES, but these codes are not always in agreement with the DES coding. Almost all of the Massachusetts companies were coded with the use of *The Job Guide for Human Resource, Counseling, and Placement Professionals*[5] and with the help of the Division of Employment Security. Out of state establishments were called and asked for their SIC codes. Of the 244 evaluations, only 25 were from establishments for which a trustworthy SIC code could not be found.[6]

The Findings

The variable with the greatest effect on salary is a student's year of graduation (see table 2). While the overall average hourly salary for this sample was $8.89, the average by year of graduation was $7.55 for sophomores (the class of 1991), $8.40 for middlers (the class of 1990), $9.30 for juniors (the class of 1989), and $10.39 for seniors (the class of 1988). By itself, year of graduation explains 35% of the variation in salaries.[7] But there is a great degree of variability among students within the same year. Some might have expected year of graduation to explain more of the variablitiy in wages, but it is not a perfect proxy variable for experience. Some students have had electrical engineering experience before they enter Northeastern through hobbies, work, or vocational training. Other students may transfer in with less experience than their classmates in the same year of graduation. So year of graduation tells part of the story of wages, but it does not tell the whole story.

Table 2
Hourly Salary, by Year of Graduation Electrical Engineering Co-op Students
Winter 1988

Class	Mean	Std. Dev.	20 Ntile	50 Ntile	80 Ntile
Sample (n-235)	8.89	1.53			
1988 (n-38)	10.39	1.48	9.23	10.63	11.47
1989 (n-83)	9.32	1.45	8.50	9.45	10.39
1990 (n-72)	8.41	.97	7.66	8.25	9.15
1991 (n-42)	7.55	.90	6.94	7.27	8.41

5 Produced by the Center for Labor Market Studies at Northeastern University, in conjunction with the Division of Employment Security of the Commonwealth of Massachusetts.

6 These were eliminated from the regression equation.

7 I used "dummy variables" to recode all of the categorical data in this study in order to make them amenable to regression analysis. This is a popular technique, and described in, among other places, ppg. 66-71 of Lewis-Bech, M. *Applied Regression: An Introduction*. Sage University Paper Series on Quantitative Applications in the Social Sciences, no. 07-022. Beverly Hills and London. Sage Press, 1980. With the year of graduation dummy variables, the class of 1991 was the comparison group, and the differences were significant at an alpha of less than .0001.

Table 3
Massachusetts Industry-Employment Matrix
Electrical Engineers

SIC	Industry	Number	Percent
	TOTAL	366	100.00
367	Electronic Components	3529	17.7
366	Communication Equipment	3088	15.5
357	Office and Computing Machinery	2847	14.3
382	Measuring and Controlling Devices	1337	6.7
892	Noncommercial Research	1158	5.8
891	Engineering and Architectural Services	1074	5.4
376	Guided Missiles, Space Vehicles, Parts	472	2.4
491	Electrical Services	203	1.0
386	Photographic Equipment and Supplies		1

1. Industry Employs less than 1.0 percent of Electrical Engineers.

The variable with the next largest effect on a student's salary is the industry in which he or she is employed. This is not much of a surprise, since staffing patterns vary widely by industry in the economy as whole. In the computer industry, for example, roughly 6% of those employed are electrical engineers, and about 7% electrical technicians. Some firms in the industry may have higher percentages, while some may have lower percentages, but the overall staffing patterns are very similar. Furthermore, the computer industry in Massachusetts accounts for 15 percent of the employment of all electrical engineers in the state (see Table 3).

The industry employment structure of this sample is very similar to the structure for all electrical engineers in Massachusetts. Four of the top co-op industries are also the top four employers of electrical engineers in Massachusetts, although not in the order (see Table 4).[8] Five industries account for the employment of 54% of these students, while the top nine industries employ 75% of them. One anomaly, SIC 376, Missiles and Space Vehicles, can be attributed to one establishment, which is the largest employer of students at a single establishment. Most other establishments within this organization are classified in SIC 367, Electrical Components.[9] Two other anomalies are the high percentage of students in SIC 491, Electric Utilities, and in SIC 386 Photographic Equipment. For this sample, SIC 386 means two firms, both of whom have active programs despite not hiring large percentages of electrical engineers. The comparatively high number of students in SIC 491 can be attributed to the university's academic concentration in power engineering. Once enrolling over 100 students, the power program now

[8] This has obvious implications for job development.

[9] Figures for the two are combined on table 4 because there was an error in coding of the overall matrix for coops which we caught in time to rectify on the evaluation coding. On table 5, the combined percentage for 376 and 367 is 20.1%

enrolls only 20. Electric utilities continue to recruit co-op students from that program, and their demand for power students often exceeds the supply. If students in SIC 963, Local Utilities, are included with 491, the number of students submitting evaluations who are employed in the power industry jumps to 17, or 7.0%. The return pattern of co-op evaluations follows closely the overall employment pattern for co-ops (see Table 5).

Table 4
Cooperative Education Industry-Employment Matrix
Electrical Engineers
(Winter 1988)

SIC	Industry	Number	Percent
	TOTAL	366	1100.00
376	Missiles and Space Vehicles		
367	Electronic Components	74	20.2
357	Office and Computing Machinery	41	11.2
382	Measuring and Controlling Devices	31	8.5
366	Communication Equipment	26	7.1
892	Noncommercial Research	17	4.6
491	Electrical Services	11	3.0
891	Engineering and Architectural Services	11	3.0
386	Photographic Equipment and Supplies	9	2.6

Table 5
Industry-Occupation Matrix
Students Submitting Co-op Evaluations
(Winter 1988)

SIC	Industry	Number	Percent
	TOTAL	244	100.0
376	Missiles and Space Vehicles	38	15.6
357	Office and Computing Machinery	36	14.8
366	Communications Equipment	24	9.8
382	Measuring and Controlling Devices	22	9.0
892	Noncommercial Research	16	6.6
367	Electrical Components	11	4.5
891	Engineering and Architectural Services	10	4.1
491	Electrical Utilities	10	4.1
386	Photographic Equipment and Supplies	9	3.7

Salaries vary widely from industry to industry. The industry that a student works in explains 13 to 20% of the variation in salaries (depending on how industries are combined) beyond the 35 percent attributable to year of graduation.[10] For example, a senior in the computer industry would be expected to make $11.64 per hour, while the same senior in the power industry would be expected to make $10.62 per hour (see table 6). But the wage differentials cannot be attributed to industries simply because of the number of engineers they hire. The computer industry, SIC 357, pays significantly more than the other major employers. But SIC 386, Photographic Equipment and Supplies, and SIC 342 Cutlery, Hand Tools, and Hardware, do not account for significant percentage of the total employment of Electrical Engineers in the state. Yet the difference in salaries between 357, 386, and 342 is slight and statistically insignificant.

Two of the largest employers, SIC 366 and 376 pay significantly less than the computer industry. This is not a difference which would have been predicted. The expectation is that those industries which employ the highest percentages of E.E.s would pay more, since the supply is limited, and their needs are the greatest. But the highest wage industries are not necessarily those which employ the highest percentages of electrical engineers.

Table 6
Predicted Salary, by Industry and Year of Graduation
Electrical Engineering Students
(for a student with a 2.7 QPA)

	SIC			
Year	1991	1990	1989	1988
Industry				
376	7.38	8.09	9.00	10.18
357	8.73	9.44	10.35	11.53
366	7.53	8.24	9.15	10.33
382	7.73	8.44	9.35	10.53
892	7.77	8.48	9.39	10.57
367	7.38	8.09	9.00	10.18
891	7.14	7.85	8.76	9.94
491	7.82	8.53	9.44	10.62
386	8.55	9.26	10.17	11.35
Other	7.08	7.79	8.70	9.88

10 First, I compared the six largest industries to the computer industry using "dummy variables," and grouping all other industries in the sample into one category. This predicted 13% of the variation in salaries at the alpha less than .001 level.

Wage rates may rather be a function of industry growth rates, or historical salary structures. Regrouping industries by their wage rates, yielded five major groups (see Table 7). Not every industry in the highest paying category, group 1 on the table, employs large numbers of electrical engineers or co-op students. But in the lowest paying category, group 5, no industry employs more than five students. Several of the largest employers of electrical engineers are in the middle category, group 3. It may be that those students who are less attractive to employers, for whatever reason, tend to end up in those industries where wages are lowest and where there may not be as many career possibilities after graduation. So wages are not determined by levels of industry employment for this sample.

GPA has an effect on wages, but much less than expected. Controlling only for year of graduation, GPA explains 4% of the variation in salaries, and accounts for .51 cents per hour for every 1.0 increase in GPA.[11] Controlling for industry, however, diminishes the explanatory effect of GPA to 1.6% of the variation in salaries, and a .33 per hour increase for every 1.0 increase in GPA. Why is the effect so much less than expected? One possible explanation, that this sample has significantly higher overall GPAs than the general population, can be readily dismissed. The median GPAs for the sample and the population are not significantly different.

It is possible that the higher paying industries may tend to hire students with higher GPAs. Path analysis is a technique which can test such theories about causal relationships. Path analysis is similar to multiple regression analysis, but requires a more thorough specification of the presumed causal relationships between variables. A path model tests the specified variables for statistical association in a particular order and under particular controls. If there is statistical association between the specified variables, reflected by significant path coefficients, then they may be causally related.[12] This association is a necessary condition for a causal relationship between the variables, but not sufficient in itself to prove that causal relationship. Lack of statistical association between the variables, reflected by insignificant path coefficients, is sufficient to prove that no casual relationship exists between the variables, at least in that sample. So path analysis could give some evidence the GPA and industry are causally related, specifically that the higher paying industries tend to take students with higher GPAs.

But a path model reveals that GPA does not influence the industries that students end up in. As the path diagram indicates, all of the effect of grades is direct (see table 8)[13] The model first tested the relationship between GPA and

11 This variation is significant at the .002 level

12 Path coefficients between variables show both the strength and the direction of the relationship between the variables. Specifically, a one standard deviation increase in the independent variable will lead to a b increase in the dependent variable, where b is the coefficient, controlling for the other variables in the model.

13 I ran this model use the Recursive Equation Modeling program, or REM. I first ran a model with all of the measured variables, but only the ones appearing on the diragram turned out to be significant. The path from one variable to another is significant if the coefficient is more than twice the standard error.

Table 7
Industry Goupings by Wage Rates
Electrical Engineering Co-op Students

	SIC	Industry	Rank In Co-op Employment
Group 1	357	Computing Machinery	2
	342	Cutlery and Hardware	14
	386	Photo Equipment & Supplies	8
Group 2	367	Electrical Components	6
	381	Eng & Sci Instruments	11
	382	Meas & Cont Devices	4
	892	Noncommercial Research	5
	920	Law Enforcement	12
Group 3	366	Comm Equipment	3
	384	Medical Intruments	12
Group 4	376	Missiles & Space Vehicles	1
	491	Electrical Services	7
	891	Eng & Arch Services	7
	963	Local Utilities	9
Group 5	962	Transportation Admin	12
	739	Misc Bus Services	13
	822	Coll & Universities	10
	383	Optical Intruments	14
	508	Wholesale Machinery	12
	737	Computer Services	13
	354	Metalworking Machinery	14
	355	Spec Ind Machinery	14
	284	Soap, Cleaner, Toilet Goods	14
	362	Electrical Apparatus	13
	364	Elec Light & Wiring Equipment	14
	373	Ship & Boat Building	14
	506	Wholesale Electrical Goods	11
	633	Fire & Marine Insurance	14

industry, but the path coefficients were not significant. This disproves the notion that industries sort students by GPA, or that the highest paying industries hire the students with the highest GPAs. The absence of a causal link between GPA and industry does not, however, diminish the direct effect of grades on salary. But that effect is still much less than expected.

One plausible explanation for the weakness of the GPA effect centers on employer motivation in hiring co-op students and current labor market conditions in this state, where most of the co-op students are employed. Employers often cite two main reasons for hiring co-op students. One is long range—the recruitment, training, and retention of college educated employees. For employers with this motivation, a student's GPA may be more important. The other main reason employers hire co-op students is short range—immediate project or task completion. In other words, employers with this motivation often have a pressing job which needs to be done, and a co-op student is one of several alternative means to completing that job. Under normal economic conditions, there may be salary differentials between employers based on their motivation in hiring a co-op student. With the current labor shortage in Massachusetts, however, there is a great deal of competition for engineering students, which may lessen the effect of GPA on student wages.

Or it could be that the effect of academic success is so much less than expected because GPA is the wrong way to measure it. Perhaps it would be more appropriate to compare the wages of this group with those of students who dropped out of electrical engineering. Since the E.E. curriculum is very difficult, many students drop out in the first year. If we view academic success as whether students are making normal academic progress, then the results might be different. If we know that employers value communication ability, but don't seem to value GPAs very highly, it could be that GPA is not a very good measure of communication ability. Perhaps SAT scores, or some other measure of basic skills would be a better predictor of wage differntials than GPA. This is an area for further investigation.

A very disturbing finding is that holding all else equal, the model predicts a significant difference in wages based on race. Blacks fare as well as whites, but the "other" category, composed predominanatly of Asians, does significantly worse than whites. Holding year of graduation, industry, and GPA equal, the model predicts that the "other" category earns approximately .82 cents less per hour than whites.[14] A closer examination of the descriptive statistics reveals that most of the difference in salaries is concentrated with the juniors in the sample, the class of 1989 (see table 9). The "other" category averages almost two dollars per hour less than whites for this year of graduation, whereas in the other years the "other" category averages no more than .20 cents per hour less than whites.

14 This is significant at the A-.001 level

While this discrepancy is still troubling, it is not as serious as it would appear from the coefficient on the initial regression. It appears that there is not widespread discrimination against this racial group, but rather a problem unusual to the class of 1989.

Table 9
Average Hourly Salary, by Year and Race
Electrical Engineering co-op Students
Winter 1988

		Mean	Std. Dev.
1988		10.38	1.48
	White	10.36	1.52
	Black	—	—
	Other	10.89	.35
1989		9.31	1.46
	White	9.58	1.25
	Black	9.21	.14
	Other	7.83	1.88
1990		8.40	.97
	White	8.47	.99
	Black	8.29	.00
	Other	8.19	.91
1991		7.55	.90
	White	7.63	.92
	Black	—	—
	Other	7.35	.86

This discrepancy in salary for the class of 1989 can be attributed to several factors. For the class of 1989, the other category consists of a large number of recent immigrants. While they have slighly higher GPAs than whites, many still have difficulty speaking colloquial English. Since employers value communication ability highly, they are in a competitively worse situation. These are also students who were beginning their co-op careers in 1985 and 1986, when it was very difficult for anyone to get a job in the electronics field. Co-op expereinces ought to be progressive in both responsibility and salary. Some of these students missed out on the bottom rung of the ladder when they were sophomores, and they are still struggling to catch up with their classmates. Discrimination against this group can not be entirely ruled out, but it seems less likely in light of the relative success of the "other" category in the other years of graduation.

The good news is that this model found no other differences which could be attributed to discrimination. The regression does not predict any significant differences by citizenship. Both resident aliens and foreign students do not fare

Table 10
Average Hourly Salary, by Year and Sex
Electrical Engineering co-op Students
Winter 1988

		Mean	Std. Dev.
1988		10.38	1.48
	Male	10.32	1.54
	Female	10.94	.65
1989		9.31	1.46
	Male	9.40	1.41
	Female	8.21	1.72
1990		8.40	.97
	Male	8.32	.91
	Female	8.99	1.21
1991		7.55	.90
	Male	7.60	.92
	Female	6.98.22	

significantly worse than U.S. citizens, under control. Sex does not have a significant influence on salaries. For the 22 women in this sample, the overall average salary was $8.85, only four cents less than the overall average. When controlled for year of graduation, the averages are sometimes greater, and sometimes less, than for men (see table 10). But the differences are not statistically significant.[15]

Conclusion

So while there is order in the salary structure of this sample of co-op students, there is less than might be expected. A student's year of graduation plays a large role in determining his or her salary, but there is still a broad range of salaries for each year. The hypothesis that wages will follow percentages of electrical engineers is quite plausible, but false. Industry growth rates, the history of the industry, and other contingencies must play an important part in determining the wage structure within an industry. And grades have much less of an effect than most would expect.

The moral of this story is that there is no substitute for periodic analysis and evaluation of wages in a co-op program. The co-op community needs to examine the wage structure of other programs in other schools and labor markets to determine if these phenomena are merely local. Those close to a program often have a good sense of what's going on with respect to wages, but it is easy to be wrong. Administrators should expect large variations in co-op wages based

[15] The regression equation yields a very small t score (-115) for sex when it is included, which means that the difference between men and women is not at all statistically signifigant.

on industry and year of graduation. Advertising one average salary figure for all co-ops in recruitment literature is highly misleading, and can lead to student dissatisfaction. Those hoping to start new co-op programs must carefully study their local labor markets to determine what the prevailing industries and wages are. Coordinators may wish to focus their job development efforts on the highest paying industries, or those that are fastest growing.

Students need to know what to expect in co-op, so that they can make good decisions about programs of study and employment. Accurate information about potential earnings within various fields is one important piece of the puzzle. The more information that students have, the better off they are. Some argue that giving students too much information about the co-op labor market will only make them unhappy. But it is our obligation to help make the best possible choices given their circumstances. Students should not base their career decisions solely on salary, but potential earnings will play an important part of the deliberation of many of our students. We have an obligation to gather and disseminate the best information on potential earnings available.