An Educational Brief

The Impact of Cooperative Education on Academic Performance and Compensation of Engineering Majors

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ABSTRACT

Several engineering programs around the country either require or encourage a cooperative education experience as part of their curriculum. In this paper, we examine the effects of cooperative education on grade point average, length of time in school, and starting salary. Statistical analyses show that cooperative education programs have significant effects on all three dimensions. These results are useful not only to students deciding whether to participate in cooperative education programs, but also to administrators in determining the role of cooperative education in the engineering curriculum.

Keywords: cooperative education, regression analysis

I. INTRODUCTION

Cooperative education began as an experiential education program for engineering students at the University of Cincinnati in 1906. Cooperative education still remains a key component of the many of engineering programs nationwide, a required component in some cases. Cooperative education provides opportunities for students to engage in experiential education, integrating course work with work experience.

Several studies have documented the value of cooperative education in terms of academic and labor market outcomes. Both Gardner, Nixon and Motschenbacker [1] and Lindenmeyer [2] found engineering majors who participated in cooperative education (coop) earned higher cumulative grade point averages (GPA) than non-coop engineering majors. Other studies have examined the effectiveness of cooperative education by examining labor market outcomes. For example, engineering students with cooperative education experience earned more than their engineering cohorts who did not participate in cooperative education. The quantity of cooperative education was also found to be positively correlated with salary [1]. Wessels and Pumphrey [3] found that cooperative education decreased job search time and positively influenced the likelihood of promotion and advancement once employed.

In the research presented here, we examine three dimensions of the coop experience. Specifically, we measure the effect that cooperative education has on the GPA, starting salary, and time until graduation of engineering students who participated in cooperative education relative to their peers who did not. Using regression analysis we are able to isolate the effect of cooperative education while, at the same time, controlling for other factors that might be influencing the outcomes.

This study uses data for the engineering majors who graduated from Mississippi State University (MSU) between the Fall 2000 and Spring 2002 semesters. Student records from the MSU Registrar's Office were matched with exit survey data collected by MSU's Office of Career Services. All local and national regulations regarding informed consent for human subjects were followed. MSU is a representative land-grant public university with approximately 16,000 students. The engineering sample included 773 graduates, who comprised 14 percent of the 5,506 graduating students. Table 1 summarizes demographic characteristics of engineering graduates and defines the variables used in this study. Only 18 percent of the engineering graduates were female and 8 percent were black. Forty-one percent of the students located in Mississippi upon graduation. Nearly fifty percent of the engineering students completed the cooperative education program; only 9 percent of the majors completed less than the requisite three semesters of coop. Engineering majors graduated with an average GPA of 3.16 and took 63.53 months to complete their degrees, 5.3 years. On average, they received starting salaries of $ 47,158.

In Table 2 we compare the mean outcomes of engineering majors with coop experience to those without. Coop engineers earned an average GPA of 3.24, which was higher than the average GPA of the non-coop engineers by 0.20 points. Coop students took approximately 4.8 months longer to graduate, a total of 5.4 years compared to 5.1 years. Coop graduates earned an average starting salary of $47,452, which was $2,593 higher than the non-coop graduates.

Simple comparisons of means provide some insight into the differences between cooperative education students and their non-coop cohorts. However, the differences in GPA, months in school, and salary reported in Table 2 may be driven by factors other than participation in cooperative education. Therefore, we extend our analysis to more accurately describe the determinants of GPA, salary, and time in school by employing regression analysis.

Variable	Definition	Engineering Graduates Fall 2000 to Spring 2002	
		N	Mean* (Standard Deviation)
BLACK	Student's race; 1= Black, 0=Other.	727	0.08 (0.28)
FEMALE	Student's gender;1= Female, 0=Male.	727	0.18 (0.39)
AGE	Student's age upon entering MSU.	727	19.40 (1.79)
ACT	High score on American College Test; 1 = composite score greater than 28, 0 = score of 28 or less.	643	0.34 (0.47)
PERCENT at MSU	Percentage of coursework completed at Mississippi State University.	727	0.80 (0.20)
MISSISSIPPI	Job location; 1 = in Mississippi, 0 = otherwise.	299	0.41 (0.49)
COOP	Student participated in cooperative education; 1 = coop, 0 = otherwise.	727	0.58 (0.49)
COOP≥3	Coop completion; 1 = completed at least 3 semesters of coop training, 0 = otherwise.	727	0.48 (0.50)
COOP<3	Coop completion; 1 = completed 1 to 2 semesters of coop training, 0 = otherwise.	727	0.09 (0.29)
GPA	Student's cumulative college grade point average; 4-point scale.	727	3.16 (0.50)
MONTHS	The average number of months from first college credit to graduation.	727	63.53 (10.24)
SALARY	Salary reported by students to the Office of Career Services on the graduation exit surveys.	255	47,158 (7,173)

*The mean value of binary variables such as black or female give the percentage of the sample with that characteristic.

Table 1. Variable definitions and descriptive statistics for the total sample.

Variable	Coop Engineering Graduates Fall 2000 to Spring 2002		Non-Coop Engineering Graduates Fall 2000 to Spring 2002		Difference between Coop and Noncoop
	N	Mean (Standard Deviation)	N	Mean (Standard Deviation)	Difference (t-statistic)
GPA	421	3.24 (0.43)	306	3.04 (0.58)	0.20* (5.85)
MONTHS	421	65.55 (8.86)	306	60.74 (11.31)	4.81* (6.43)
SALARY	226	47,452 (6,675)	29	44,859 (10,124)	2,593 (1.84)**

* Statistically significant at the 95 percent level; ** statistically significant at the 90 percent level.

Table 2. Outcome differences of the means between coop and noncoop graduates.

II. GPA Regression Analysis

In this section we estimate the effect of the cooperative education experience on GPA. We hypothesize that students' GPAs are influenced by their demographic characteristics, their innate intellectual ability, and their participation in a cooperative education experience if any. Specifically, we estimate a linear equation that includes a dummy variable for race (BLACK), a dummy variable for sex (FEMALE), and age upon entering MSU (AGE). We control for innate ability by including a dummy variable for high scores (greater than 28) on the American College Test (ACT). To capture the marginal impact of cooperative education on GPA, we separate the cooperative education experience into a dummy variable for those who completed the program of at least three semesters (COOP ≥ 3) and a dummy variable for those who

participated in cooperative education for less than three semesters (COOP < 3).

In order to be eligible for cooperative education, students are required to have a minimum 2.5 GPA after their first year; transfer students are required to achieve this GPA requirement after their first semester at MSU. Since the minimum GPA for the engineering major is 2.0, a simple comparison of GPAs between coop and noncoop students may lead to a bias in favor of the coop students. In order to account for this potential bias, we introduce an additional variable, ELIGIBLE, which equals one if a student is eligible for the cooperative education program after the student's second semester (first semester for transfer students) and zero otherwise. Including this variable in our regression analysis will control for the higher GPAs of the coop-eligible population. Our sample of 727 engineers included 607 who were eligible and 120 who were not. The functional form of the estimated equation is given as:

$$\begin{aligned} GPA = {} & INTERCEPT + \beta_1 BLACK + \beta_2 FEMALE \\ & + \beta_3 AGE + \beta_4 ACT + \beta_5 ELIGIBLE + \\ & \beta_6 COOP \geq 3 + \beta_7 COOP < 3 + \varepsilon_1. \end{aligned} \quad (1)$$

Equation (1) is estimated using Ordinary Least Squares (OLS); the results are presented in Table 3.

The results indicate that each of the independent variables has a statistically significant influence on GPA except for AGE and COOP < 3. Holding all else equal, black engineering graduates earn GPAs that are 0.340 points lower than non-black graduates. Female graduates' GPAs are 0.143 points higher than male graduates' GPAs. Students who are eligible for the cooperative education program, i.e., those students who begin their academic tenure at MSU with higher GPAs, also finish with GPAs that are higher by 0.306 grade points. Students who successfully complete the cooperative education program of at least three coop semesters graduate with even higher GPAs (0.153 points) than the coop-eligible group. The GPAs of those students who do not successfully finish the program are not statistically different from the GPAs of the non-eligible group.

III. Months Regression Analysis

In order to assess whether participation in the cooperative education program delays graduation, we estimate an equation for the duration of time in school, from the time of first college credit until the completion of degree (MONTHS). It is expected that this duration is affected by demographic characteristics (BLACK, FEMALE, AGE), innate intellectual ability (ACT), academic performance (GPA), and participation in the cooperative education program (COOP ≥ 3, COOP < 3). Specifically, we estimate the following equation using OLS:

$$\begin{aligned} MONTHS = {} & INTERCEPT + B_8 BLACK + B_9 FEMALE \\ & + \beta_{10} AGE + \beta_{11} ACT + \beta_{12} GPA \\ & + \beta_{13} COOP \geq 3 + \beta_{14} COOP < 3 + \varepsilon_2. \end{aligned} \quad (2)$$

The results are presented in Table 4.

There was a positive correlation between age and time spent earning the undergraduate degree. Each additional year of age when receiving first college credit increased the total time in school by almost one month. Students with high ACT scores spent about one semester longer (3.79 months). Controlling for other factors, successful completion of the cooperative education program (three or more semesters) added an additional 7.01 months to the student's time in school, compared to students who did not participate in coop. There was no significant difference in the time spent in school between non-coop students and coop students who spent less than three semesters in coop. This result is more informative than the comparison of means presented in Table 2. The three semester coop program does extend time in school, but the additional time spent in school is less than the time spent gaining work experience.

IV. Salary

Our final model seeks to determine the market effects of cooperative education participation as reflected in the starting salary of

Variable	Coefficient	t-statistic
INTERCEPT[#]	2.651*	12.360
BLACK	-0.340*	-5.665
FEMALE	0.143*	3.363
AGE	0.001	0.105
ACT	0.412*	11.329
ELIGIBLE	0.306*	6.773
COOP ≥ 3	0. 153*	4.374
COOP < 3	0.091	1.456
Adjusted R^2 = 0.314, F = 42.931		

* Statistically significant at the 95 percent level.

[#] Ordinary least squares regression estimates the equation of the line that best fits the data. This variable represents the intercept of that linear equation, i.e., it represents the value of the dependent variable when the independent variables are all zero. Since in many cases, as the one presented here, it makes no sense for the all the independent variables to be zero (e.g., AGE) the interpretation of this variable is of limited use. In some cases the value of the intercept may include the effects of important independent variables that were omitted from the estimation either as a result of identification error or data limitations.

Table 3. Regression Analysis: Determinants of GPA.

Variable	Coefficient	t-statistic
INTERCEPT[#]	70.368*	13.70
BLACK	1.967	1.48
FEMALE	-1.370	-1.48
AGE	0.889*	3.95
ACT	3.794*	4.28
GPA	-9.029*	-10.75
COOP ≥ 3	7.013*	9.17
COOP < 3	2.045	1.52
Adjusted R^2 = 0.2438 F = 30.56		

* Statistically significant at the 95 percent level.

[#] Ordinary least squares regression estimates the equation of the line that best fits the data. This variable represents the intercept of that linear equation, i.e., it represents the value of the dependent variable when the independent variables are all zero. Since in many cases, as the one presented here, it makes no sense for the all the independent variables to be zero (e.g., AGE) the interpretation of this variable is of limited use. In some cases the value of the intercept may include the effects of important independent variables that were omitted from the estimation either as a result of identification error or data limitations.

Table 4. Regression Analysis: Determinants of MONTHS.

Variable	Coefficient	Standard Error
INTERCEPT	-1.088*	0.267
WHITE	0.447*	0.153
FEMALE	-0.183	0.144
PERCENT AT MSU	-0.729*	0.272
COOP ≥ 3	1.603*	0.123
COOP < 3	0.461*	0.204

* Statistically significant at the 95 percent level.

Table 5. First Stage Heckman Model: Probit Model for Salary Reporting.

graduates. Our salary data come from exit surveys of employed graduates from December 2000 to May 2002, which were collected by the MSU Office of Career Services. Because the exit surveys and the cooperative education program are both run through the Office of Career Services, there may be potential selection bias in the survey results. Students who have ties to the Office of Career Services, namely cooperative education students, may be more likely to complete the surveys.

To correct for this potential bias we use the Heckman [4] two stage process designed to correct for sampling bias. First, a binary probit model for the likelihood of completing the survey is estimated. The results from this first stage are provided in Table 5. The coefficients from the probit estimation are used to calculate the probability that each student reports their starting salary. These calculated probabilities are included in the salary equation as the LAMBDA variable. As in the previous models, we posit that starting salary is affected by demographic characteristics (BLACK, FEMALE, AGE), intellectual ability and academic performance (ACT, GPA), and participation in the cooperative education program (COOP ≥ 3, COOP < 3). We also include a dummy variable for students who accepted employment in Mississippi (MS). Because Mississippi has the lowest per capita income in the country, we presume that staying in state will lower starting salaries. The estimated equation is given as:

$$\begin{aligned} \text{SALARY} = {} & \text{INTERCEPT} + B_{15}\text{BLACK} + B_{16}\text{FEMALE} \\ & + \beta_{17}\text{AGE} + \beta_{18}\text{ACT} + \beta_{19}\text{GPA} + \beta_{20}\text{MS} \\ & + \beta_{21}\text{COOP} \geq 3 + \beta_{22}\text{COOP} < 3 \\ & + \beta_{23}\text{LAMBDA} + \varepsilon_3. \end{aligned} \quad (3)$$

The results of this estimation are presented in Table 6.

Black engineering graduates earned starting salaries that were $2,989 higher than non-black engineers. Each point higher in GPA added $6,365 to starting salaries. Students who stayed in-state for their employment earned $5,247 less than those who located outside Mississippi. Successful completion of the cooperative education program added $2,620 to the engineering graduates' salaries. However, completing less than the requisite three semesters did not alter their pay outcomes.

Variable	Coefficient	t-statistic
INTERCEPT[#]	22,538 **	1.89
BLACK	2,989 *	2.39
FEMALE	-220	-0.08
AGE	158	0.60
ACT	447	0.08
GPA	6,365 *	6.12
MS	-5,247 *	-6.25
COOP ≥ 3	2,620 *	2.73
COOP < 3	-652	-0.30
LAMBDA	80	0.02

* Statistically significant at the 95 percent level; ** statistically significant at the 90 percent level.

[#] Ordinary least squares regression estimates the equation of the line that best fits the data. This variable represents the intercept of that linear equation, i.e., it represents the value of the dependent variable when the independent variables are all zero. Since in many cases, as the one presented here, it makes no sense for the all the independent variables to be zero (e.g., AGE) the interpretation of this variable is of limited use. In some cases the value of the intercept may include the effects of important independent variables that were omitted from the estimation either as a result of identification error or data limitations.

Table 6. Regression Analysis: Determinants of SALARY Second Stage of the Heckman.

V. Conclusion

Our study examined the impact of cooperative education on engineering graduates from Mississippi State University. The impact has been measured along three dimensions of the cooperative education experience—GPA, duration of time in school, and starting salary. Our results indicate that engineering students who completed the three-semester cooperative education program earned higher GPAs than non-coop students, earned more in terms of starting salaries, but took approximately two semesters longer (7 months) to complete their undergraduate program. Students who participated in cooperative education, but did not complete the full three semesters also earned higher GPAs than non-coop students. Their starting salaries and time in school were no different from their non-coop cohorts. These results will enable program administrators and academic advisors to more effectively inform students regarding the impacts of the cooperative education experience.

While our analysis was not designed to perform a rigorous cost-benefit analysis of the cooperative education experience, we have elucidated the effects that the experience has on dimensions which affect both the costs and benefits. Future research is needed to extend these results to a rigorous cost-benefit analysis that would examine impacts such as the costs and benefits of the additional time in school for both the students and the universities.

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References

[1] Gardner, P.D., D. Nixon, and G. Motschenbacker, "Starting Salary Outcomes of Cooperative Education Graduates," *Journal of Cooperative Education*, Vol. 27, No. 3, 1992, pp. 16–26.

[2] Lindenmeyer, R., "A Comparison Study of the Academic Progress of the Cooperative and the Four-Year Student," *Journal of Cooperative Education*, Vol. 3, No. 2, 1967, pp. 8–18.

[3] Wessels, W., and G. Pumphrey, "The Effects of Cooperative Education on Job Search Time, Quality of Job Placement and Advancement," *Journal of Cooperative Education*, Vol. 31, No. 1, 1996, pp. 42–52.

[4] Heckman, J. "Sample Selection Bias as a Specification Error," *Econometrica*, Vol. 47, 1979, pp. 153–161.

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