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Gender Differences in the Causes of Non-Completion Rates Among Oregon Apprentices: A Case Study of the Metro Electrical JTPC, Portland, Oregon

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GENDER DIFFERENCES IN THE CAUSES OF NON-COMPLETION RATES AMONG OREGON APPRENTICES

A CASE STUDY OF THE METRO ELECTRICAL JTPC, PORTLAND, OREGON

by

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I: INTRODUCTION

With government sponsored work force development programs being mostly insufficient in the United States, private industry is forced to secure its own labor supply of trained workers [Friedlander et.al (1997)]. In industries requiring especially high levels of occupation specific training, this is done by means of apprenticeships. Employers participating in such human capital development efforts typically spend substantial resources on training apprentices. With some programs incurring annual per apprentices training costs as high as $ 3,100 a year[1], all parties should have a strong interest in high program completion and success rates. As employers, unions, and other sponsors have to absorb monetary losses associated with an apprentice leaving the program before completion, high drop out rates therefore translate into an increase in operational costs and risk [Fry (1997 Interview)].

According to the Oregon Bureau of Labor and Industries (BOLI)(1997), the overall program cancellation rate during the 1995-96 fiscal year across all programs was about twenty-five percent or 1,694 given 6,813 total apprentices in the program during this year. The cancellation rate for women, who only made up about 6 percent of all apprenticeship programs in Oregon in 1996, was substantially higher and ran close to forty percent. Besides the loss of investment on the side of the sponsors and the loss of time and resources on the part of the apprentices, the high female drop out rate poses problems for employers trying to comply with equal-opportunity employment laws. This is especially true in the construction industry which is strongly dependent on government contracts that are tied to these laws and regulations.

This paper will address the question of why women drop out of apprenticeship programs at a higher frequency than men. I will examine if there are in fact substantial differences in human capital and social characteristics between female and male apprentices and whether the influence of these characteristics on the probability of finishing depends on the sex of the apprentice. I

1 Metro Electrical JTPC, 1997.

hypothesize that the reasons apprentices quit prematurely will differ significantly between sexes, especially in reference to educational background, experience, and family situation.

Using structural equations to calculate the different sample finishing probabilities, I will first test the validity of following hypothesis:

Hypothesis 1: The probability of finishing is greater for men than for women.

The second main hypothesis tested in this study will be the following:

Hypothesis 2: The probability of finishing an apprenticeship is a function of sex, age, race, experience, vocational education, college education, performance in the program, family situation, and future job expectations.

The following sub-hypothesis will be tested in order to establish which variables significantly influence a person's probability of finishing an electrical apprenticeship.

Hypothesis 2.1: The probability of finishing the program increases with the age of the apprentice.

Hypothesis 2.2: White apprentices have a greater probability of finishing an apprenticeship than non-white apprentices.

Hypothesis 2.3: Apprentices with more related work experience will be more likely to finish the apprenticeship program.

Hypothesis 2.4: The probability of finishing increases with the amount of vocational/technical training obtained by the participant prior to entering the program.

Hypothesis 2.5: Greater levels of college education increases the participant's likelihood of finishing the apprenticeship program.

Hypothesis 2.6: Good performance in related-training classes increases the apprentices' likelihood of finishing.

Hypothesis 2.8: Married participants are less likely to complete an apprenticeship than are similar unmarried participants.

*Hypothesis 2.8: Primary caretakers of small children are less likely to finish the program.

*Hypothesis 2.9: Favorable expectations in terms of future employment opportunities will encourage greater finishing rates.

*Due to lack of data, I was not able to test for these hypotheses.

If the specified variables do in fact prove to have an important impact on the probability of finishing an apprenticeship, I can thus determine how the impact of these variables on the probability of finishing varies by sex.

I will use a binary choice model and data collected from the Portland Metro Electrical Apprenticeship and Training Program[2] test the above hypotheses. Though of limited sample size, the results of the regression analysis shed light on some of the mysteries surrounding gender differences among apprentices.

The discussion of the topic will be presented in five parts. Following this introduction will be a brief summary of the case study and some background information on the Metro Electrical Apprenticeship program itself. In section three, I develop the theoretical model. Regression results for the different logit equations will be offered in section four, followed by discussion and evaluation of the results. I then proceed to summarize the results and findings in a brief conclusion.

II: CASE STUDY

I conducted a case based on numerous interviews with local officials, employers, and sponsors as well as on data collected from the Metro Electrical JTPC (Joint Apprenticeship Training Committee), a union sponsored electrical apprenticeship program located in the Portland Metro Area. Before discussing the Metro Electrical Training Program in more detail, I devote a brief discussion to the general set up and workings of the Oregon Apprenticeship Program as a whole.

The State of Oregon is one of the country's role models in apprenticeship training. During the 1995-1996 fiscal year, for instance, more than 4,600 employers were engaged in the training of 6,813 apprentices statewide [BOLI (1997)].

[2] The Metro Electrical Apprenticeship and Training Program is jointly administered and financed by the International Brotherhood of Electrical Workers (IBEW) Local 48 and the National Electrical Contractors Association (NECA), Oregon-Columbia Chapter, and governed by the Joint Apprenticeship and Training Committee, comprised of labor and management representatives. [Metro (1997)]

The regulatory backbone of any apprenticeship in Oregon is a legal contract that outlines the rights and responsibilities of all involved parties. This contract outlines all details of the program, including required qualifications, hours of employment, related training and on-the-job work schedules, wage and benefit schedules, duties of both employer and apprentice, and possible certification requirements. These details, as well as all other formalities and regulations concerning a specific apprenticeship, are set by local industry committees which represent the most basic unit in the administrative apparatus of the Oregon Bureau of Labor and Industries' (BOLI) Apprenticeship and Training program. Each committee is made up of employers and employee representatives who evaluate current and future training needs and set occupation-specific standards regarding selection requirements, the number of apprenticeship openings, wage scales, required course and training curricula, as well as certification and completion requirements. This allows for rapid changes in the curriculum and training schedule if required by the market situation.

A. The Metro Electrical Apprenticeship and Training Program

Even though over 400 different apprenticeship programs exist in the State of Oregon, the level of sponsorship, organization, and especially the size of the programs differ widely. One of the biggest and best-sponsored programs in the Portland Metro area is the union-sponsored Metro Electrical Apprenticeship and Training Program. Using Metro's program as a case study is appealing for the following reasons. First, with an average of 600 apprentices in the program, Metro's training program for electricians is one of the biggest apprenticeship programs in the State of Oregon as well as in the U.S.[3] [Fry (1997 Interview)]. Secondly, the substantial union sponsorship[4] guarantees a constant stream of resources available for the administration, organization, and operation of the program, including a comprehensive record system on all its

[3] States with apprenticeship programs of varying size and quality include: Arizona, California, Connecticut, Delaware, Florida, Guam, Kansas, Louisiana, Maryland, Massachusetts, Minnesota, New Hampshire, New Mexico, New York, North Carolina, Ohio, Oregon, Rhode Island, Vermont, Virginia, Washington, and Wisconsin [Department of Labor and Industries (1997)].

[4] The International Brotherhood of Electrical Workers funds these kinds of apprenticeship programs by collecting 30 cents per hour of wages from all journey-level workers nationwide. There are currently over 3,000 electricians working in Portland, Ore. alone. [Fry (Interview 1997)].

apprentices. Thirdly, Metro is one of the only three apprenticeship committees in the State to use the most strict selection method established and recognized in the State of Oregon for the screening of all applicants. Using the most stringent set of criteria available maximizes the probability of admitting only the most able and qualified applicants into the program. It should therefore follow that the variance in the newly admitted electrical apprentices' ability and skill levels is smaller than when other, less stringent admission standards were to be used. The fourth appeal of using the Metro Electrical JTPC as a case study is that it enjoys great popularity and credibility among apprentices and employers, making it the destination of apprenticeship 'hoppers', apprentices trying to switch to more prestigious and better paid apprenticeships, instead of losing apprentices to other programs as is the case for a large number of other apprenticeship programs in Oregon [Simms (1997 Interview)], [Fry (1997 Interview)], [Boyd (1997 Interview)]. Given that, I was able to eliminate 'apprenticeship hopping' from my analysis as a possible reason for high non-completion rates.

In terms of Metro's program graduation rates[5], Mason Tillman Associates(1996: 38-39) found that the graduation rate for males exceeded those of women and minorities, with minorities being less likely to graduated in either category. While the report found that fifty-eight percent of white males completed the program successfully, the graduation rate for minority males was fifty-one percent. For females, the statistics showed that white females graduated at a rate of thirty-six percent while only twenty-seven percent of minority females graduated. Put into numbers, only twenty-eight white and three minority females graduated between 1981-93. Even though these graduation rates might seem low by themselves, when compared to other programs, Metro's electrical apprenticeship program ranks first among all other programs in Oregon.

Another reason for selecting this program over others is the fact that, unlike in many other programs where apprentices take community college classes to gain related in-classroom experience, apprentices in Metro's program receive their training in a union owned and operated training facility that allows for a greater consistency in instruction and the monitoring of an apprentices' progress.

For the reasons outlined above as well as based on the opinions of administrators at the Oregon BOLI and other JTPC's , I am confident that the Metro Electrical JTPC represents the right choice for my case study. Not only was I able to eliminate several potential concerns merely by choosing one of the best apprenticeship programs in the area, its detailed historical personnel data superior to any other program in the State.

III: METHODOLOGY

As already stated, the main objective of this study is to estimate sex-related differences in human capital and social characteristics that might influence a given apprentice's probability of finishing the program. In order to analyze the relative importance of each variable on a person's probability of completing the apprenticeship, I employ a binary choice or dummy-dependent variable model. More specifically, I will use a logit function that is designed to determine the probability of an apprentice with a given set of attributes to make a certain choice, in this case to finish the apprenticeship [Pindyck and Rubinfeld (1998: 302-303)].

Partially based on the works of Gitter (1985) and Veum (1995) as well as on my own practical and theoretical research in form of a case study, I expect that the probability of finishing an apprenticeship is a function of the person's gender, age, race, education, experience, performance, family status, and expectations of future job opportunities. While data on an apprentices' gender, age, and race can easily be obtained and modeled, in the cases of education, experience, performance, family status, and expectations about future job possibilities I had to find variables that would best capture the effects of these variables on an apprentices' decision to finish or quit the program.

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[5] The graduation rate is the total number of graduates in each minority/non-minority group divided by the total number of current apprentices in those groups [Oregon Department of Labor and Industries (1996)].

For reasons explained later, I chose to break down the effect of education into two variables, VOC and COL, representing the amount of vocational/technical training and college education an apprentices had obtained before becoming an apprentice. The effect of experience(EXP) on the probability of completing an apprenticeship will be represented by the amount of industry-specific work experience acquired by the apprentice before entering the program. Performance, on the other hand, is a more difficult to model. While in the program, apprentices have to acquire a multitude of skills and knowledge, all of which are measured and evaluated in different ways. After collecting and analyzing my case study data, I found that the major reason for apprentices being cancelled from the program was repeated failure to progress in the required related-training classes. I therefore chose to compute the apprentice's average performance in all related-training classes as measured by semi-annual grades that are based on a one hundred percent rating scale.

In the case of family status, I deem it necessary to break down the total effect of differences in family status into two separate variables, one controlling for the apprentice's marital status (MAR) and one indicating number of children under six in the family (CHILD). However, due to confidentiality and anti-discrimination laws, I was unable to obtain data on either one of them and will therefore have to exclude these variables from my analysis. An apprentice's expectations of future employment opportunities following the successful completion of the apprenticeship could either be modeled by the percent of annual graduates having found jobs as electrician journeymen within some specified period of time after graduating from the program or by the unemployment rates for electricians in the greater Portland Metro area or in the whole State of Oregon. As with the case of the family variables, the lack of data forces me to exclude this variable from the actual regression equation.

A. Variable Definitions

Following is a list of definitions of the variables used in my model:

P - Probability of finishing the apprenticeship.

SEX - The sex of the apprentice. 1 if female, 0 if male

AGE - The apprentice's age at the beginning of the program.

RACE - Race of apprentice; divided into white and non-white. 1 if non-white, 0 if white.

EXP - Number of years worked in either the construction industry or in the electrician profession prior to entering the program.

VOC - The number of vocational/technical and mathematics courses above Algebra I level taken prior to entering the program.

COL - Number of full years completed at a two or four year college.

PER - The apprentice's graded performance in in-class training presented in an index ranging from 1 to 100.

MAR* - Marital status of the apprentice.

CHILD* - Number of children under six years of age.

FUTURE* - Annual unemployment rate of electricians, seasonally adjusted.

*Since I will not be able to include MAR, CHILD, and FUTURE as explanatory variables in the actual regression analysis, I will only use these variables in the theoretical model.

In theory the probability of an apprentice finishing the program can therefore be represented by the following function with the signs above the variables indicating the expected impact of that particular independent variable on the dependent variable P_i, the discussion and justification of which will follow hereafter.

$$\mathbf{P(finish) = f(\overset{-}{SEX}, \overset{+}{AGE}, \overset{-}{RACE}, \overset{+}{VOC}, \overset{+}{COL}, \overset{+}{PER}, \overset{-}{MAR}, \overset{-}{CHILD}, \overset{-}{FUTURE})}$$

B. Variable-Specific Methodology

1. Sex

Studies by Veum(1995), Lynch(1992), and Gitter(1985) have shown that males are significantly more likely to finish an apprenticeship than are women, all other things equal. In addition, just focusing on the actual training investment decision faced made by women, Blau, Ferber, and Winkler(1992: 168) argue that when adhering to traditional gender roles, women are in fact less likely to invest in training than are men. This conclusion is based on the work of many human capital theorists who found that women do in fact have shorter working lives than men, resulting in them receiving a relatively smaller return on their initial training investment. Theorists therefore expect women to choose occupations that require only moderate levels of investment in training and employers to prefer hiring men in jobs that are highly training insensitive [Ibid (1992: 171)]. A study done by Altonji and Spletzer(1991: 65) suggests that even though women are slightly more likely to obtain employer sponsored training than are men, the quantity of training obtained by women is significantly below that of men. The authors argue that the difference is greatest in occupations requiring high levels of job-specific training. Trying to explain their empirical findings, Altonji and Spletzer(1992) use the human capital model as well as the assumptions that women tend to work fewer hours and are less likely to be in the labor force. In light of that, they argue that the time during which women are able to collect returns on their training investments is shorter which makes women more likely to go into occupations requiring only moderate levels of training. Men, on the other hand, tend to have more regular labor force participation patterns and are therefore able to receive a greater overall return on their training investment, making high-levels of human capital investment more profitable for them [Altonji et.at. (1991: 65)].

By controlling for the sex of the apprentice, I hope to capture possible sex differences in the variables expected to influence the probability of completing an apprenticeship successfully. Since the majority of apprenticeship-trained occupations are typically concentrated in male-dominated occupations such as electricians, plumbers, and carpenters, I expect to find that sex-related barriers to entry, such as high physical demands, discrimination, and relative small amounts of relevant education and experience, may cause women to quit apprenticeship programs at a higher rate than men [Blau et.al. (1992:171)]. The variable itself will be in form of a dummy that equals 1 if the apprentice in question is female and 0 when the apprentice is male. I expect the sign the variable to be negative, indicating that the attribute of being "female" has a negative effect on the probability of finishing.

1.1 Decomposition of the Gender-related Probability Differential

What then causes this gender difference in finishing probabilities? Is it that people with different characteristics, such as education and work experience, simply have different probabilities of finishing an apprenticeship or is it that even if men and women had the same characteristics, they would still have different probabilities of finishing an apprenticeship? Similar to Blinder's (1973: 437) analysis of gender and race related wage differentials, it is interesting to ask exactly how much of the difference in finishing probabilities is due to, for example, the higher incidence of vocational training or related work-experience for men.

The decomposition of variables is a tool designed to break down the net difference or raw differential between two groups. Decomposition will allow me to break down the overall difference or raw differential (R) in the probability of finishing an electrical apprenticeship between males and females into its parts: the difference in the shift coefficients (U) and the portions of the differential due to either differences in endowments (E) or differences in the coefficients (C) [Blinder (1973: 438-439)][6]. In other words, the raw differential between the male and female probabilities of finishing is equal to the sum of U, E, and C.[7] I expect the results to this analysis to show that males have a strong overall advantage over female apprentices, especially in terms of their characteristics.

2. Age

The impact of age on the probability of finishing an electrical apprenticeship represents the sum of the following three impacts: changes in the family or social situation, changes in experience and skill levels, and changes in job mobility and tenure. First, let's consider the

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[6] Raw differential $R= \beta^M_o+\Sigma_j \beta^M_j \text{X-bar}^M_j - (\beta^w_o + \Sigma_j \beta^w_o \text{X-bar}^w_j) = E + C + U$
Portion due to differences in endowments $E= \Sigma_j\beta^M_j (\text{X-bar}^M_j - \text{X-bar}^W_o)$
Portion due to differences in coefficients $C= \Sigma_j\text{X-bar}^W_j(\beta^M_j - \beta^W_j)$
Unexplained portion of differential $U= \beta^M_o - \beta^W_o$
Source: [Blinder (1973: 439)].

impact of a change in family or social situation on a person's probability of finishing an apprenticeship. Lundberg's (1988) empirical work suggests that women's labor force participation rates are more sensitive to changes in family situation than are men [Lundberg (1988: 223)]. Despite the fact that more and more women find ways to combine their jobs and being a mother, with a multiple-year commitment like an apprenticeship it seems intuitive that a female's natural lifecycle should on average still play an important role. Borjas (1996: 65), analyzing the female labor supply decision, argues that only after women have passed their childbearing ages will they fully be able to concentrate on their careers and possibly consider a long-term training program such as an apprenticeship. The above discussion suggests that the impact of changes in the social situation differ in scale depending on the sex of the apprentice. According to this reasoning, a female's probability of finishing the program should therefore increase with age, assuming that older women will have a smaller incidence of childbirth or responsibility of young children. For men, on the other hand, this impact should be negligibly small.

The second factor impacting the probability of finishing for both sexes is the fact that the amount of acquired education and training increases with age. Whereas not all education or training obtained during a person's life will be applicable to requirements and tasks demanded of an electrician apprentice, that part of it that does will most likely improve the apprentice's performance in the program, hence increasing his or her probability of finishing the program. I therefore expect the impact of accumulated education and experience with age to be positively related to the probability of both female and male apprentices finishing the program.

Another aspect influencing the age variable are the different age-dependent levels of job mobility as analyzed by Buechteman et. al.(1993), Johnson(1978), and Viscusi(1980). According to Buechteman et.al.(1993: 105), American youths tend to exhibit very high levels of job mobility and job hopping resulting in higher quit rates during the first years of their professional life.

[7] For an example of the break down of the raw differential, refer to Appendix A.

Viscusi's(1980) argues that younger people but especially females, use the initial periods of employment as an experimental tool for career selection (388). Johnson's (1978: 261) analysis of the theory of job shopping suggest that job shopping is predominately used by young workers in search of an employer and occupation most suitable to their skills, interests, and habits. He argues that job shopping tends to occur especially frequently among workers who are unable to perfectly predict their performance or liking of the particular job or occupation without getting at least some actual employment experience. To transpose these ideas onto the case of apprenticeships, it seems plausible to argue that younger apprentices will be more likely to view an apprenticeship as part of his or her path of career exploration while older apprentices will be more dedicated to reaching journeyman status and the associated increase in pay rate. Even though human capital theory suggests that older workers should be more reluctant to give up large investments in specific human capital and the associated higher wage rates, electric ians represent an exception to the norm. With a relatively small portion of journey level electricians working for permanent employers, such as in an iron mill or a utility company, and all journeymen electricians having received a set of transferable but yet occupation-specific skills, the majority of electricians work for contractors who assign them to a variety of jobs and assignments.

Combining the above discussed influences of the age variable on the probability of finishing an apprenticeship, all of which I expect to be positive, I hypothesize that the sign of the estimated AGE coefficient will also be positive for both genders. Furthermore, I expect the positive relationship between the sex of the apprentices and the probability of finishing to be stronger in the case of females than in the case of their male counterparts.

3. <u>Race</u>

Analyzing nationwide data for finishing probabilities of apprentices Gitter(1985) concluded that race or ethnic background did not have a significant influence on a person's probability of finishing an apprenticeship program. Tillman Mason Associates(1996: 132-150) research based on interviewing apprentices in the Oregon construction industry, however, found evidence of occasional incidences of racial discrimination. With only 11 percent of all apprentices statewide describing themselves as non-white and the overall case study sample being of limited size, I do not expect the estimated coefficient to be statistically significant though I anticipate to find the coefficient to be of negative sign. The variable is a dummy equaling 1 if the apprentice is non-white and equaling 0 if the apprentice is white.

4. Industry Specific Work Experience

The basic logic behind including relevant prior work experience as one of the right-hand side variables rests on the assumption that a person who had had a chance to observe and evaluate the advantages and drawbacks of a given occupation will be able to make a more informed and rational decision about becoming an apprentice. The importance of this factor, especially in regards to female apprentices, has been observed by employers, sponsors, as well as by apprentices themselves, [Fry (1997 Interview)], [Mason Tillman Associates (1996: 100)]. Interviews with apprentices as well as employers indicate that apprentices who lack prior work experience in the electrical or construction industry are often shocked about high physical demands, working conditions, and the cyclical nature of employment. Also, apprentices may entertain wrong expectations regarding pay or the extent of classroom training [Mason Tillman Associates (1996: 104)].

Besides saving apprentices from wrong expectations and uninformed decision making, in-field experience tends to increase the potential apprentice's level of familiarity with occupation-specific work processes, tools, and safety regulations. By combining experience in the electrical field and the construction industry, I hope to capture two different aspects associated with obtaining prior work experience. While experience in the electrical field should have the greatest return in terms of greater levels of familiarity and skills for both genders, work experience in other occupations in the construction industry, in my opinion, still allows for a realistic picture of what an apprentice can expect in terms of working conditions and physical demands. I hypothesize that even a small amount of experience in the construction industry would keep a fair number of female apprentices from making uninformed decisions. With the construction industry entailing primarily male dominated occupations, I expect the influence of prior work experience in the field to be much more important for female apprentices than for their male counterparts. Either way, taking all the above into consideration, I expect the EXP to have a strong positive influence on the probability of finishing an electrical apprenticeship for both genders

5. Vocational Training and Educational Attainment

While the human capital model predicts that greater levels of education increase a worker's productivity, I expect the type of education received to matter in the case of an apprenticeship. Even though Altonji(1995) was not able to discover any significant relationship between different types of high school courses and wage rates, he did find indication that the types of classes taken in high school are positively related to performance in college. Although the author was more concerned with the impact of high school curricula on a student's performance in college, I feel that, at least in the narrow scope of this study, performance in an apprenticeship can be viewed as being influenced by greater levels of general but especially technical and vocational education. Building on Altonji's finding's, one can extrapolate, all other things being equal, that a student who took many vocational and technical courses while in high school will be better prepared for the work and knowledge required of an apprentice.[8]

With over 200 hours of in-class training per year being required of every apprentice, a strong background in both academic and vocational education and training is essential for an apprentice to master all tasks required in the class room as well as on the job. Given that the occupation of an electrician requires apprentices to understand and learn a lot of technical material, I will use the sum of all mathematics[9] and technical / vocational courses taken prior to entering the program as a proxy for the amount of relevant industry-specific education obtained by the apprentice.

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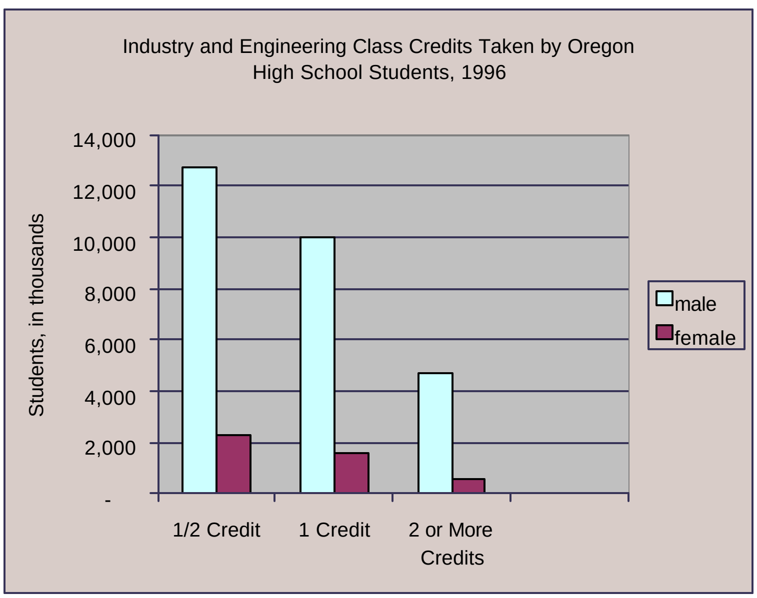
[8] In this argument, I'm specifically considering non-college bound youth of comparable merit and motivation, and interests.

Gitter(1995: 41), who chose to control for a slightly different set of high school courses than did I, discovered that trade and machine skill courses had a significant positive influence on a person's probability of finishing an apprenticeship while the number of mathematics courses failed to do so. While current statistics indicate that the traditional gender gap in formal education attainment rates has been closing over the last years[10], there are still significant differences in terms of the type of professional and technical education obtained by males and females [U.S. Department of Commerce (1997:158-159)]. Even though information on the average number of courses taken that meet the category 'Industry and Engineering' is not available, the following data suggests some interesting and very dominant trends. During the 1996 school year, only 4,476 female students took some Industry and Engineering courses versus 27,457 of their male peers [(Oregon Department of Education (1996)]. Figure 1 illustrates the

Figure 1. Number of Industry and Engineering Classes Taken in Oregon High Schools During, 1996 , by Gender



Source: Oregon Department of Education, Office of Professional and Technical Education. (1997) "1996 State of Oregon Annual Performance Report".

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[9] The completion of Algebra I is an admission requirement of the Metro Electric JTPC.
[10] Formal educational attainment rates are 12.7 % for females and 12.8% for males respectively. [Filer et.al. (1996: 20)].

magnitude of these differences. Even though the graph only represents a snapshot in time, the overall trends appear to be that females, on average, obtain less vocational and technical education relevant to an apprenticeship than do male students.

Thus, I hypothesize that an apprentice's probability of finishing the program will be positively related to the amount of vocational, technical, and related courses taken prior to entering the apprenticeship program. As for the gender difference implied by the above presented data, I furthermore expect that a woman's probability of finishing is more responsive to the attainment of vocational/technical education than is the case for male counterparts.

6. College Education

Based on Vuem's (1995) findings that people with a high school diploma and some college proved to be most likely to finish an apprenticeship, I will use the number of years in college in order to control for higher levels of education and more motivated and bright individuals. This variable, similar to that of age, has several aspects. First, obtaining some level of college education can deliver a signal about the person's motivation and learning ability. On the other hand, however, obtaining a college education could also be an indication of relatively low opportunity costs. Thirdly, if the person took any technical or analytical courses in college, the knowledge obtained in these courses would in most cases be of higher quality and greater depth than knowledge acquired in high school. The last aspect goes back to Buechteman's et.al. (1993) and Johnson's (1978) arguments of using job-hopping or shopping as a form of trial and error career exploration. If a person has attended college for some period of time and has been exposed to some career possibilities attached to a college education, he or she might be able to make more informed career decisions. If then a college student has made the decision to become an apprentice, I would expect this apprentice to have made a very conscious and informed decision. Furthermore, apprentices with prior college education also bring increased levels of general and specific knowledge as well as better study habits to the training program, all of which should help increase the apprentice's probability of finishing the program in a timely manner. Thus I expect the estimated coefficient of the COL variable to be of positive sign, suggesting that participants with higher education levels, especially when obtained in college, are more likely to finish their apprenticeships.

7. Performance During The Program

There are two reasons for an apprentice not finishing the program: the apprentice quits for personal reasons or the apprentice is cancelled from the program by his or her sponsor. Most apprentices, after a series of warnings and citations, are cancelled from the apprenticeship due to lack of performance in school or at the work place. In the case of the Metro case study, failure to meet school requirements was the most common cause for cancellations. Being limited to only a few measures of performance other than subjective employer provided progress reports, I decided to construct an index measuring the apprentice's average performance of all in-class work completed during their time of being an apprentice at Metro (PER) that is based on semester grades evaluated on a normal one hundred percent scale. With fifty percent of an apprentice's overall evaluation being based on his or her performance in school, I expect a strong positive relationship between PER and the probability of finishing.

IV: REGRESSION RESULTS

A. Data Discussion

Before discussing the regression results of the logit function, it will be necessary to highlight some of the data characteristics first. The data sample used for this analysis contains a total of 105 observations, with 50 female and 55 male apprentices. All apprentices sampled started, finished, or left the program between the years of 1990 and 1997. Among the 50 female apprentices, 28 finished the program while 22 did not. For men the ratio was 35 to 20 respectively. While acknowledging the fact that the reasons for not finishing the program can either be based on the apprentice's decision to quit or the employer/sponsors decision to cancel a given apprentice from the program, in light of the limited sample, I chose to combine both categories and looked at non-completion rates collectively. Below is a summary of the descriptive statistics for the full sample.

Table 1: Full Sample Descriptive Statistics

Variable Name	Sample Size	Variable Mean	St. Deviation	Sample Minimum	Sample Maximum
P (0=not finish, 1=finish)	105	0.60	0.49	0	1
SEX (0=male, 1=female	105	0.48	0.50	0	1
RACE (0=white, 1=non-white)	105	0.14	0.35	0	1
AGE (in years)	105	29.64	6.01	19	44
EXP (in years)	105	20.04	2.66	0	15
VOC (in classes)	105	5.01	4.14	0	21
COL (in years)	105	1.54	1.80	0	9
PER (on 100 pt. Scale)	105	87.09	7.89	59.1	98.05

It is interesting to note that while the average age differences between male and female completers and male and female non-completers are virtually negligible, non-completers in both categories were on average substantially younger than those having finished their apprenticeships.

Table 2. Average Age by Sex and Sex Sub-categories

Sample Set	Sample Size	Average Age	Youngest	Oldest
All	105	29.64	19	44
Total Women	50	30.84	19	44
Total Men	55	28.41	19	44
Women Comleters	28	31.39	19	40
Women Non-Completers	22	30.55	20	44
Men Completers	35	28.43	19	42
Men Non-completers	20	28.30	20	44

In terms of race, the sample indicated that of the fifty female apprentices in the sample only six apprentices or twelve percent were non-white. In the male sample, nine apprentices or almost seventeen percent were non-white. In terms of graduation rates, my sample showed that out of the nine non-white females only two graduated while nine of the seventeen non-white males graduated.

As for average experience in the subsamples, the data samples reinforced my hypothesis that on average male apprentices have more industry-related experience prior to entering the apprenticeship than do their female counterparts, even though the difference surprisingly only amounts to roughly one

In an attempt to measure relevant prior technical or vocational education, the averages of vocational variable for the different subsets revealed that the number of technical or vocational courses taken by men and women differs by only one course on average. However, when looking at completers versus non-completers, the gap widens significantly. In the case of female apprentices, for instance, that difference amounted to more than two courses. For men, the difference was greater still and made up more than three courses.

The descriptive statistics of the college variable indicate that there are substantial differences in the attainment of college education between males and females as well as and among completes and non-computers within each gender category. On average, non-completing female apprentices had spent only half the amount (1.1 years) of time going to college that women spent who ended up finishing their apprenticeship.

While the gender difference in apprentices' performance in the related classroom training was negligible, the difference between completers and non-completers was substantial especially for male apprentices[11].

B. Data and Model Limitations

Having collected the above-presented data, it is necessary to discuss some of the shortcomings associated with the data itself or with the data sources. I view the forced omission of three relevant variables, namely marital status, number of children below six years of age, and unemployment rates for electricians in Oregon as the primary limitation of the study. Omitting relevant variables will necessarily result in some level of bias in the regression results. The impacts of these two variables on female labor force participation rates have been observed to be strong and negative while male labor force participation rates have shown to react only insignificantly to these kind of changes [Lundberg (1988)]. Thus, I would expect the results of the female regression equation to contain more bias than the results of the equation for male apprentices. I believe that my model could be greatly improved by controlling for these variables.

A second major limitation of the model is its relatively small sample size. With many Oregon apprenticeship programs lacking detailed personnel files on their apprentices comparable to those of the Metro Electrical Training program, I found myself restricted to relying solely on Metro's data. logit analysis as well as all of the hypothesis tests and statistics used by myself in

[11] For a comprehensive summary of the descriptive statistics including graphs, please refer to Appendix B.

the latter part of this paper are designed for large sample sizes of five hundred or more, the nature of my question left me with only this option [Studenmund (1996: 512)]. Using large-sample statistics and functions on a small sample such as mine will inevitably cause the introduction of bias into my findings, which I will discuss in greater detail in the evaluation and discussion of my regression results.

C. Results

In order to analyze my data sample in the most efficient manner, four logit functions were specified: Equation A entailing all available specified variables; Equation B including sex interaction terms in addition to equation A; Equations C and D are gender-specific sub-sample equations. While equation B will yield a lot of information regarding actual differences in the probability of finishing an apprenticeship by gender, equation C and D will help as accuracy checks for equation B as well as provide the coefficients needed in the decomposition of gender differences in the coefficients themselves. Equation A for the full sample is specified as follows:

$$P_I = \beta_o + \beta_1 SEX + \beta_2 AGE + \beta_3 RACE + \beta_4 EXP + \beta_5 VOC + \beta_6 COL + \beta_7 PER + \varepsilon_I$$

Equation B will expand equation A to include gender interaction terms[12]. Using interaction terms is deemed appropriate when the change in the dependent variable with respect to one independent variable depends on the level of another right-hand side variable. A statistically significant interaction coefficient would indicate that the values of the coefficient in question are partially dependent on the sex of the apprentice [Studenmund (1997: 235-240)]. In the case of the age-sex interaction term(AS), for example, finding the interaction term to be statistically significant would mean that, all other things remaining equal, men and women do in fact exhibit very different response patterns during the course of their work-life cycles. Without interaction terms, the effect of age, for example, on the probability of finishing (P_I) would be measured solely by

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[12] AS=AGE SEX; RS=RACE SEX; ES=EDU SEX; VS=VOC SEX; CS=COL SEX ; PS=PER SEX

the estimated AGE coefficient instead of taking into account that effect of age on P_I is depended on the sex. If the estimator of the AS interaction term is positive and significant, the effect of age on P_I will increase as sex dummy switches from male to female [Pindyck et.al. (1998: 119-120)]. The equation will look as follows:

$$P_I = \beta_o + \beta_1 SEX + \beta_2 AGE + \beta_3 RACE + \beta_4 EXP + \beta_5 VOC + \beta_6 COL + \beta_7 PER + \beta_8 AS + \beta_9 RS + \beta_{10} ES + \beta_{11} ES + \beta_{12} VS + \beta_{13} CS + \beta_{14} PS + \varepsilon_I$$

In the case of the female and male sub-sample equations the SEX variable drops out resulting in both equations C and D looking as follows:

$$P_I = \alpha_o + \alpha_1 AGE + \alpha_2 RACE + \alpha_3 EXP + \alpha_4 VOC + \alpha_5 COL + \alpha_6 PER + \varepsilon_I$$

All four equations were estimated using maximum likelihood estimation (ML). A maximum likelihood estimation model is set up to choose "coefficient estimates that maximize the log of the probability (or likelihood) of observing the particular set of values of the dependent variable in the sample (Y_1, $Y_2 \ldots Y_n$) for a given set of Xs" [Studenmund (1997: 510-511)]. In other words, the ML function tries to estimate the maximum likelihood that the observed values of the dependent variable were generated by the empirical specification of the logistic function [Studenmund (1997: 510-511)]. Considering the difficulties associated with using a linear probability model when faced with qualitative choice models, it is more appropriate to use a logit function [Pindyck et.al. (1998: 299-312)]. The logit function is derived from transforming the linear probability function in such a way that all predictions for X_I will lie between 0 and 1. This can be done by using the probability function, F, in the form of $P_I = F(\alpha + \beta X_I) = F(Z_I)$.

The logit model can be specified as

$$P_I = \frac{1}{1 + e^{-Z_i}} = \frac{1}{1 + e^{-(\alpha + \beta X_1)}}$$

P_I represents the probability of an individual finishing the apprenticeship, with P_I=1 indicating successful completion and P_I=0 indicating an failure to compete the program. In this formula, e represents the base of the natural logarithms. The dependent variable represents the logarithm of the odds that a particular choice will be made. The general specification of the logit function used in this model takes on the following form:

$$\log \frac{\text{Prob(Finishing)}}{1 - \text{Prob(Finishing)}} = \beta_o + \beta_1 SEX + \beta_2 AGE + \beta_3 RACE + \beta_4 EXP + \beta_5 VOC + \beta_6 COL + \beta_7 PER + \varepsilon_i$$

Following are the summaries of the regression results of each of the three equations.

Full Sample

Table 3. Equation A, Logit Regression Results, Full Sample without Interaction Terms

Variable	Coefficient	Asymptotic T-Ratio	Mean	Slope	Elasticity At Means
SEX	-0.320	-0.601	0.476	-0.074	-0.055
AGE	-0.045	-1.034	29.638	-0.010	-0.483
RACE	-0.371	-0.392	0.143	-0.086	-0.016
EXP	***0.193**	**1.383**	2.038	0.045	0.142
VOC	***0.202**	**2.057**	5.010	0.047	0.365
COL	0.198	1.023	1.543	0.046	0.110
PER	***0.184**	**3.661**	87.094	0.043	5.782
Const	-15.6350				
n			105		
Y=1			63		
Y=0			42		
Log-Likelohood Function			-49.083		
Log-Likelihood (0)			-70.666		
Likelihood Ratio Test			43.166		
Maddala R-Square			0.337		
Cragg-Uhler R-Square			0.456		

*Inidcates statistical significance at the 10% level.

A R^2 or statistical fit of the specified equation between 0.337 (Maddala R^2) and 0.457 (Cragg-Uhler R^2) indicates that the equation explains between 34 and 46 percent of the variation of P_I around the sample mean. There are many different specifications used to measure the goodness of fit for logit models. In an effort to avoid possible misinterpretation of the results, I have chosen to report the Maddala and the Cragg-Uhler, the two extremes, in order to allow the reader and myself to obtain a picture of the approximate overall fit of the equation to the sample data.

To test the overall significance of the specified equation, I used the likelihood ratio test which, similar to the F-test used with OLS estimation, tests the null hypothesis (H_o) that all slope coefficients are equal to zero, meaning that none of the right-hand side variables have any impact on the depended variable, thus making their presence irrelevant to the explanatory power of the overall equation. The alternative hypothesis (H_a) is that the null hypothesis is not true, hence that the sum of the slope coefficients does not equal zero. Thus, if I were to be able to reject the null hypothesis and assume the alternative hypothesis by establishing that the calculated likelihood test ratio exceeds the appropriate Chi-square distribution critical value (χ^2)[13], I would be able to show that the specified regression equation significantly improves the fit of the equation [Studenmund (1997: 157-159)], [Shazam (1997: 280)]. Specific to equation A, the regression results offer a calculated likelihood ratio test value of 43.166. With 7 degrees of freedom (DF) and a desired level of significance of 5 percent, the associated χ^2 critical value is 14.07. This value clearly lies below the calculated value of 43.166, allowing me to reject the null hypothesis [Studenmund (1997: 647)].

In terms of the signs and the statistical significance of the coefficient estimates, the results indicated that all but one coefficient, RACE, exhibited the expected signs and significance. EXP, VOC, and PER were the only three coefficients that proved to be statistically significant at the 90 percent level of confidence[14].

Because the estimated coefficients obtained from ML on a logit function do not represent slope coefficients it is crucial to note that the slope coefficients had to be calculated independently[15] and are thus reported separately in the regression output. Logit function coefficients "represent the impact of a one-unit increase in the independent variable in question, holding the other explanatory variables constant, on the log of the odds of a given choice, not on the probability itself" [Studenmund (1997: 512)]. Looking only at the calculated slope

[13] "If all coefficients except the intercept are zero the likelihood ratio test statistic 2[L(β-hat)-L(0)] has an asymptotic $\chi^2_{(k-1)}$ distribution." [Shazam (1997: 280)].

coefficients of the equation, it becomes obvious that a one-unit change in any of the independent variables only has a relatively small impact on a person's probability of finishing the Metro apprenticeship.

Another helpful tool for analyzing the impact of each of the explanatory variables on the probability of finishing is the elasticity at the means. The elasticity measures the percentage change in the dependent variable that is caused by a one percent change in a given independent variable holding all other things equal. Looking at above reported regression results, PER appears to have the greatest impact on P_I when measured by the elasticity. A one percent change in the performance of the apprentices will increase the average apprentice's probability of finishing by 5.68 percent. Clearly this dwarfs the impact of all other variables on P_i all of which merely cause below a one percent change in P_I given a one percent change in the variable. Age and the amount of vocational training obtained by the apprentice are the only two other variables exhibiting a remote amount of influence on the probability of finishing. However, as in the case of GEN, RACE, EXP, and COL the economic significance of the findings for AGE and VOC appear to be limited.

2. Full Sample with Interaction Terms

Table 4. Equation B, Logit Regression Results, With Interaction Terms

Variable	Coefficient	Asymptotic T-Ratio	Mean	Slope	Elasticity At Means
SEX	5.447	0.507	0.476	1.26E+00	8.91E-01
AGE	-0.058	-0.774	29.638	-1.33E-02	-5.86E-01
RACE	0.552	0.444	0.143	1.28E-01	2.71E-02
EXP	0.018	0.131	2.038	4.27E-03	1.29E-02
VOC	***0.614**	**2.582**	5.010	1.42E-01	1.06E+00
COL	-0.062	-0.186	1.543	-1.44E-02	-3.31E-02
PER	***0.253**	**2.875**	87.094	5.86E-02	7.58E+00
AS	0.023	0.239	14.771	5.30E-03	1.16E-01
RS	-0.758	-0.434	0.057	-1.75E-01	-1.49E-02
ES	***0.449**	**1.526**	0.657	1.04E-01	1.01E-01
VS	***-0.577**	**-2.227**	2.210	-1.33E-01	-4.38E-01
CS	0.430	1.028	0.867	9.94E-02	1.28E-01
PS	-0.059	-0.500	42.038	-1.36E-02	-8.51E-01
Const	-22.6140				

*Indicates statistical significance at the 10% level.

n	105
Y=1	63
Y=0	42
Log-Likelohood Function	-45.012
Log-Likelihood (0)	-70.666

Likelihood Ratio Test	51.308
Maddala R-Square	0.387
Cragg-Uhler R-Square	0.523
Chow R-Square	0.411

[14] The critical value of the t-distribution with n-K-1 DF = 97 DF at a 10% level of significance for a one-tailed test is 1.289 [Studenmund (1997: 635)].

As discussed in the methodology section dealing with the usage and application of interaction terms, the purpose of constructing sex interaction terms was to see which variables were significantly dependent on the sex of the apprentice. The findings represented in Table 4 suggest that this is the case for both prior work experience and the attainment of vocational/technical education. Compared to the previously discussed equation A, the results for equation B show a slightly better fit. When testing the null hypothesis of the sum of the estimated coefficients equaling zero, the likelihood ratio test value of 51.308 allows me to reject this null hypothesis hence proving with 95 percent level of confidence that the sum of the right hand side variables do in fact influence P_i. In terms of coefficients the results indicate that VOC, PER, EG, and VG are statistically significant at the 90 percent level of confidence

In order to establish that there is in fact a significant difference between the male and the female regression, I will again employ the likelihood ratio test. The null hypothesis is that there is no difference in the coefficients of the two regressions. The alternative hypothesis states that the difference between the two regressions is not equal to zero. The likelihood ratio test is defined as equaling $-2[L_R - L_{UR}]$ with L_R representing the restricted version with all interaction terms being equal to zero and L_{UR} representing the unrestricted version with all interaction terms being present. With a calculated Chi-square statistic of 7. 321 (with 7 D.F.) and a associated χ^2 critical value of 14.07 I'm surprisingly not able to reject H_o. This means that the male and female regressions do not differ significantly from one another.

This finding represents a contradiction to statistical theory. Since the restriction of the chi-square test is that all interaction terms including the gender dummy equal zero, the fact that my

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[15] Slope of logit coefficient=bP(1-P) with $P(Y=1)=1/1+e^{-\beta x}$ [Maddalla (1988: 277)].

findings indicate that some of the individual coefficients differed significantly by gender would necessarily imply a significant chi-square statistic. However, that is not the case. The cause of these conflicting results are very likely due to a small sample problem typically caused when using large sample statistics such as the t-test and the chi-square statistic on small samples as in the case of my case study. The resulting bias in these two tests might therefore create a substantial amount of bias in hypothesis testing [Grant (1998 Interview)].

Female Model

The major purpose of dividing the data by gender and running a separate regression on each of them is to allow me to check the accuracy of my findings for the full model including gender interaction terms. As discussed earlier, the estimated values of the interaction coefficients represent the change in the dependent variable if the apprentice is female while the estimated coefficients for the normal variables represent the change in the probability of finishing given that the apprentices is male. Thus, I should be able to break down the sample by gender and receive similar estimations for the values of the coefficients as I did in the full sample regression including interaction terms. In other words, as long as the estimated values of the male and female coefficients from equation C and D are comparable to the estimated values of the variable and interaction term coefficients, I can conclude that the estimated general equation is equally well suited for both male and female apprentices. The following regression results will reveal that the coefficients of the male equation tended to be more accurately matching those of equation B than were the female model coefficients. More specifically, for equation C only 3 of the six variable pairs matched within a reasonable margin. The estimated coefficients representing race, vocational education, and performance in the program and the associated gender interaction terms are distinctly different in equation B and C.

Table 5. Equation C, Logit Regression Results, Female Model

Variable	Coefficient	Asymptotic T-ratio	Mean	Slope	Elasticity At Means
AGE	-0.035	-0.574	31.020	-8.35E-03	-3.27E-01
RACE	-0.206	-0.168	0.120	-4.97E-02	-5.85E-03
EXP	***0.467**	**1.813**	1.380	1.13E-01	1.78E-01
VOC	0.037	0.359	4.640	8.90E-03	4.78E-02
COL	***0.368**	**1.474**	1.820	8.86E-02	1.70E-01
PER	***0.194**	**2.468**	88.279	4.69E-02	5.19E+00
Const	-15.251				
n			50		
Y=1			28		
Y=0			22		
Log-Likelohood Function			-25.583		
Log-Likelihood (0)			-34.296		
Likelihood Ratio Test			17.428	with 6 D.F.	
Maddala R-Square			0.2943		
Cragg-Uhler R-Square			0.3943		

*Inidcates statistical significance at the 10% level.

Analyzing the above regression results, the first obvious feature is that the Maddala and Cragg-Uhler R^2s are only 0.294 and 0.394 respectively. One reasons for this relatively poor fit might be that the omission of marital status and number of small children in the household does in fact prove to be more important than for the a sample including both males and females. A likelihood test ratio value of 17.42 however still warrants the overall significance of the equation. The estimated coefficients of EXP, COL, and PER are statistically significant and positively related to a female's probability of finishing her apprenticeship at Metro Electrical. All other coefficients were statistically insignificant at the 90 percent level of confidence with AGE again indicating that a woman's probability of finishing the program in fact declines with age representing a contradiction to my hypothesized signs.

<u>Male Model</u>

Variable	Coefficient	Asymptotic T-Ratio	Mean	Slope	Elasticity At Means
AGE	-0.058	-0.774	28.382	-1.19E-02	-4.76E-01
RACE	0.552	0.444	0.164	1.14E-01	2.63E-02
EXP	0.018	0.131	2.636	3.81E-03	1.41E-02
VOC	***0.614**	**2.581**	5.346	1.27E-02	9.55E-01
COL	-0.062	-0.186	1.291	-1.29E-02	-2.34E-02
PER	***0.253**	**2.875**	86.017	5.22E-03	6.35E+00
Const	-22.614				
n			55		
Y=1			35		
Y=0			20		
Log-Likelohood Function			-19.43		
Log-Likelihood (0)			-36.051		
Likelihood Ratio Test			33.243	with 6 D.F.	
Maddala R-Square			0.454		
Cragg-Uhler R-Square			0.621		

*Inidcates statistical significance at the 10% level.

Table 6. Equation D, Logit Regression Results, Male Model

Compared to the other three proceeding equations, the one for male apprentices exhibits the highest average R^2, with values ranging from 0.454 for the Maddalla R^2 to 0.621 when using the Cragg-Uhler method of measuring goodness of fit of the equation. This indicates that the specification of the male model of measuring the probability of finishing the program can almost account for twice as much variation in the dependent variable than can the model for female apprentices. While the overall equation was found to be significant the individual coefficients and the probability of finishing, the results for male apprentices differ significantly from those of female apprentices. While PER is highly significant in both equations, VOC proved to be the only other significant variable at the 10 percent level of significance. The coefficient for the COL did not only not match the results of the female model but instead turned out to be of negative sign and insignificant.

VI: DISCUSSION OF RESULTS

Looking only at the ratio of males and females finishing the program at Metro Electrical, the sample suggests that males are in fact more likely to finish than are women. When testing this hypothesis using a structural equation and the coefficients estimated by the different logit analysis, my findings indicate that men are in fact more likely to finish than are their female counterparts. The average probability of finishing an apprenticeship at the Metro Electrical Training Center was found to be roughly sixty-six percent while that of women's was calculated to be just shy of sixty percent. Supporting my initial expectations, given mean characteristics, an average male's probability of finishing an electrical apprenticeship at Metro was estimated at seventy-one percent, almost ten percent greater than that for the average female apprentice.

Testing Hypothesis 2 the previously discussed chi-squared statistics outlined in the regression results allowed me to establish that in all four cases, overall significance was established with a ninety-five percent level of certainty. Testing hypotheses 2.1 though 2.7, and constructing t-statistics for all estimated coefficients of the full sample model, the results indicate that prior work experience, vocational/technical education, as well as good performance in the program were all found to be positive and highly statistically significant at the five percent level. Sex, race, and college education failed to have significant influences on a person's probability of finishing an apprenticeship at this level. The most surprising finding was that the age of an apprentice not only failed to prove significant at the five percent level but it was also surprisingly estimated to be of negative sign. The negative age coefficient suggests that younger apprentices are in fact more likely to finish than older apprentices. In the case of statistical significance, this result would contradict theory as well as the empirical findings of Viscusi (1980). A possible explanation might be found in the introduction of bias due to three omitted relevant variables as well as in the relatively small sample size used in the study.

Table 7. Summary of Statistical Significance at the 10% level by Equation and Coefficient

Coefficient	Equation A	Equation B	Equation C	Equation D
SEX	NO	NO	-	-
AGE	NO	NO	NO	NO
RACE	NO	NO	NO	NO
EXP	YES	NO	YES	NO
VOC	YES	YES	NO	YES
COL	NO	NO	YES	NO
PER	YES	YES	YES	YES

Table 7 summarizes the results of the t-tests for all equations by coefficient. Comparing variables shown to be significantly influencing the probability of finishing for equations C and D, it is obvious that the influence of different variables on the dependent variables varies by sex. While prior work experience, college education, and performance were shown to have significant influence on a female's probability of finishing an apprenticeship, the estimated coefficients for the male equation suggests that the relative importance of experience and college education is replaced by higher levels of vocational and technical training and good performance in the program.

Where, then, do these gender difference come from? Do males and females on average just have different characteristics or are their specific endowments simply valued differently within the framework of an apprenticeship? If the latter were true, would these differences in the treatment and evaluation of gender-specific characteristics be due to differences in preferences on the part of the apprentices or are they due discrimination?

By means of the already briefly discussed method of decomposing the overall difference in the probability of finishing between male and female apprentices into its parts, I develop some surprising findings. Table 8 shows a brief overview of these findings.

Causal Factor	Amount Attributable	Amount Attributable to Endowments	Amount Attributable to Coefficients
AGE	-0.5594	0.1518	-0.7112
RACE	0.1151	0.0241	0.0910
EXP	-0.5960	0.0232	-0.6192
VOC	3.1096	0.4330	2.6766
COL	-0.7498	0.0330	-0.7828
PER	4.6343	-0.5732	5.2076
Subtotal	5.9539	E = 0.0919 %	C = 5.8619 %
Shift Coefficient	U = -7.363 %		
Total	R = -1.409		

Table 8. Coefficient Decomposition Results

The negative raw differential of –1.4 percent indicates that combining all factors results in women having a slight advantage of finishing their apprenticeships. A possible explanation might be the presence of pre-existing bias in the sample. For instance, in order for females to pass all social and institutional hurdles connected with becoming apprentices in a traditionally male dominated occupation they might have to be more driven and motivated than their male counterparts. This greater degree of motivation might also allow the average female apprentices to overcome the typical gender related disadvantages in the amount of prior vocational and technical training as well as work experience. If one was to accept the premise that motivation is in part captured by the apprentices' performance in the program as well as by the amount of college education obtained before entering the program, the data sample did in fact attest to the fact that female apprentices on average did spent more time in college and performed better in the related training portion of the apprenticeship than did their male counterparts.

Taking a closer look, one can notice that the slight advantage for women was mainly due to the strongly negative value of the shift coefficients, hiding the fact that both E and C, the amount of the differential attributable to endowments and coefficients, are positive and therefore favoring male apprentices. When focusing in on E and C, it is very evident that nearly all of the raw differential (>98%) is almost entirely due to differences in coefficients while only a miniscule portion of the overall gender differential is due to differences in endowments. This suggests that the major difference in the probability of finishing between men and women is due to given characteristics being valued differently for male and female union electrical apprentices at the Metro Training Center and not to differences in endowments as I had expected.

While the differences in endowments between male and female apprentices are close to zero, it is interesting to note that when analyzing these minute differences, men have relatively better endowments in all but one case, PER. The negative sign for the shift coefficient or unexplained portion of the differential indicates that once all differences in endowments and coefficients are controlled for, females have a greater probability of finishing their apprenticeship at Metro Electrical than do males. This unexplained portion of the differential is commonly attributed to discrimination [Blinder (1973: 438-439)]. However, because including the omitted variables or even other relevant variables would most likely significantly reduce the size of the unexplained portion of the differential, I find it hard to determine whether the shift coefficient should actually be viewed in this conventional manner.

Analyzing the separate portions of the differential due to endowments and coefficients more closely, one can notice that good performance in related training classes is the only characteristic favoring female electrical apprentices over their male counterparts. All other variables favor males. Interestingly enough, even despite the small advantage by female apprentices, doing well in the program has a much greater impact on the probability of finishing for male apprentices than for their female counter parts. Vocational and technical training is another factor greatly influencing men's probability of succeeding in the Metro electrical apprenticeship program.

V: CONCLUSION

The purpose of this study was to establish and analyze sex differences in the finishing probabilities among Oregon apprentices. More specifically, this paper tried to determine whether and how these characteristics might vary with the sex of the apprentice. Based on previous studies and a review of relevant literature, a regression equation was specified to determine factors affecting the probability of completing an apprenticeship controlling for the apprentice's sex, age, race, prior work experience, attainment of vocational/technical and college education, as well as performance in the program.

Using case study data and logit models, prior work experience, attainment of vocational/technical education, and the performance in the program were all three found to have significant influence on the probability of completing an apprenticeship program while the sex, age, and race of an apprentice did not indicate significant influence on the probability of finishing. Experience, college, and performance in the program were especially important determinants of a female's probability of success while for males the most important characteristics were shown to be the attainment of vocational/technical education as well as good performance in the program.

Decomposition was used to examine sex differences in characteristics and returns to these characteristics. The results suggest that the sex difference in endowments is close to zero while the differences in the coefficients strongly favor male apprentices.

Sample size limitations and lack of data on three relevant variables posed significant problems in the estimation of the equations as well as in the evaluation of results. The accuracy of the model, especially for females, would greatly benefit from adding the missing variables and increasing the sample size significantly. Although plagued by several shortcomings, the findings offer state and industry officials initial insights into the differences in finishing probabilities by sex, and factors affecting them.

APPENDIX A

The Decomposition of the Raw Differential

1. A model for each sex was specified and estimated according to the equations below. (M denotes male and W denotes female.)

$$Y_i^M = b_0^M + \sum_{j=1}^{n} b_j^M \overline{X}_{ji}^M + u_i^M$$

$$Y_i^W = b_0^W + \sum_{j=1}^{W} b_j^W \overline{X}_{ji}^W + u_i^W$$

2. The Raw differential (R) is made up of three parts: the shift coefficient or unexplained portion of the equation (U), the part of the differential due to differences in endowments (E) , and the part due to differences in the coefficients (C). Thus, the following is true:

$$R = E + C + U = \left(b_0^M + b_{1i}^M \overline{X}_1^M\right) - \left(b_0^W + b_1^W \overline{X}_1^W\right)$$

3. In order to isolate the three different parts of R, the following steps were taken:

$$R = b_0^M - b_0^W + b_1^M \overline{X}_1^M - b_1^M \overline{X}_1^W + \overline{X}_1^W b_1^M - \overline{X}_1^M b_1^W$$

$$R = \left(b_0^M - b_0^W\right) + b_1^M\left(\overline{X}^M - \overline{X}^W\right) + \overline{X}^W\left(b_1^M - b_1^W\right)$$

4. E = proportion of differential attributable to differing endowments

$$E = \sum_j b_j^M\left(\overline{X}_i^M - \overline{X}_j^F\right)$$

5. C= proportion of differential attributable to differing coefficients

$$C = \sum_j \overline{X}_i^W\left(b_j^M - b_j^W\right)$$

6. U = unexplained portion

$$U = b_j^M - b_j^W$$

Appendix B

Descriptive Statistics

Table 1. Full Sample

Variable Name	Sample Size	Mean	St. Deviation	Variance	Min.	Max.
Y	105	0.60	0.49	0.24	0	1
GEN	105	0.48	0.50	0.25	0	1
AGE	105	29.63	6.01	36.06	19	44
RACE	105	0.14	0.35	0.12	0	1
EXP	105	2.04	2.66	7.09	0	15
VOC	105	5.01	4.15	17.20	0	21
COL	105	1.54	1.80	3.25	0	9
PER	105	87.09	7.89	62.30	59.1	98.05

Table 2. Female Apprentices

Variable Name	Sample Size	Mean	St. Deviation	Variance	Min.	Max.
Y	50	0.56	0.50	0.25	0	1
GEN	50	1.00	0.00	0.00	1	1
AGE	50	31.02	6.11	37.33	19	44
RACE	50	0.12	0.33	0.11	0	1
EXP	50	1.38	1.65	2.73	0	6
VOC	50	4.64	4.64	21.54	0	21
COL	50	1.82	1.88	3.54	0	9
PER	50	88.28	5.47	29.93	75.3	98.05

Table 3. Male Apprentices

Variable Name	Sample Size	Mean	St. Deviation	Variance	Min.	Max.
Y	50	0.64	0.49	0.24	0	1
GEN	50	0.00	0.00	0.00	1	0
AGE	50	28.38	5.67	32.20	19	44
RACE	50	0.16	0.37	0.14	0	1
EXP	50	2.64	3.22	10.422	0	15
VOC	50	5.35	3.65	13.34	0	16
COL	50	1.29	1.75	2.91	0	8
PER	50	86.02	9.50	90.33	59.1	97.27

Table 4. Female Apprentices, Non-Completers

Variable Name	Sample Size	Mean	St. Deviation	Variance	Min.	Max.
AGE	22	30.55	6.82	46.55	20	44
RACE	22	0.18	0.39	0.16	0	1
EXP	22	1.00	1.54	2.38	0	6
VOC	22	3.36	2.52	6.34	0	10
COL	22	1.09	1.27	1.61	0	4
PER	22	85.95	5.92	35.10	75.3	98.05

Table 5. Female Apprentices, Completers

Variable Name	Sample Size	Mean	St. Deviation	Variance	Min.	Max.
AGE	28	31.39	5.59	31.21	19	40
RACE	28	0.07	0.26	0.07	0	1
EXP	28	1.68	1.70	2.89	0	5
VOC	28	5.64	5.64	31.79	0	21
COL	28	2.39	2.10	4.40	0	9
PER	28	90.11	4.38	19.15	80	95.96

Table 6. Male Apprentices, Non-completers

Variable Name	Sample Size	Mean	St. Deviation	Variance	Min.	Max.
AGE	20	28.30	6.22	38.64	20	44
RACE	20	0.20	0.41	0.17	0	1
EXP	20	2.10	2.10	4.41	0	8
VOC	20	3.30	2.68	7.17	0	9
COL	20	0.70	1.08	1.17	0	4
PER	20	79.00	12.21	148.98	59.1	95.56

Table 7. Male Apprentices, Completers

Variable Name	Sample Size	Mean	St. Deviation	Variance	Min.	Max.
AGE	35	28.43	5.44	29.55	19	42
RACE	35	0.14	0.36	0.13	0	1
EXP	35	2.94	3.72	13.82	0	15
VOC	35	6.51	3.65	13.32	0	16
COL	35	1.63	1.91	3.65	0	8
PER	35	90.03	3.83	14.65	83.83	97.27

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