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Abstract

This study uses micro data to measure three types of training gaps by gender and minority status in Oregon apprenticeship programs: probability of graduation, time to graduation, and the quantity of training acquired by quitters. Apprentices who started training between 1991 and 2002 are followed through 2007. Both raw and adjusted gaps, the latter controlled for individual, institutional, and occupational attributes, are reported. The duration of training was shorter for the few women who completed. We find that white women apprentices were substantially less likely to graduate than white men. White women drop-outs received a much lower quantity of skills than white men. Minority men were not observed to face any significant disadvantages relative to white men. Apprentices in union-management jointly sponsored programs were more likely to complete requirements. White women and minority men benefited disproportionately more from training in union programs. However, the time to graduation is shorter in nonunion programs, which suggests that the latter allocate resources more selectively across apprentices. Yet those who quit do not appear to have acquired a sufficient quantity of skills to be able to obtain high-skill jobs.

Keywords: Apprenticeship, Training, Gender, Race, Unions

JEL Classification: J15, J24, J51

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1. Introduction

Apprenticeship is the traditional route to acquire the occupational skills required to find employment in the crafts workforce. In the U.S. workers are attracted to apprenticeship programs because this route is a remunerated alternative to college that allows building a career with high wages and perhaps starting a business. The lack of access to training would explain in large part why non-traditional workers – women and ethnic/racial minorities – have been historically under-represented in the trades. The barriers are present both at the point of entry into and during apprenticeship. In this study we focus on the second stage of the process. Our objective is to evaluate the relative performances of white men, white women, and minority men in apprenticeship programs in the state of Oregon.

The newly available Oregon state apprenticeship database provides the most complete set of training quantity measures hitherto available for the U.S. Between 1991 and 2007, some 50,000 new workers joined the apprenticeship workforce in Oregon. They were distributed across 132 occupations in all major industries. Women made up 6% of all new registrations, and ethnic/racial minorities (henceforth minorities) accounted for 14%. We will use this database to define three kinds of training gaps by gender and race/ethnicity: the probability of completing training, the time to complete requirements for graduation, and the quantity of training received by terminated apprentices as measured by the number of on-the-job-credit hours accumulated at the time of exit. Jointly, these gaps provide a full picture of the relative performance of traditional and non-traditional apprentices in training. For each of these gaps, we will first provide unadjusted values. Next, we will adjust these figures by observable individual, institutional, and occupational characteristics. This exercise will show the magnitude of training gaps that are attributable to gender and minority status after accounting for workforce

characteristics. Among the institutional characteristics, we will pay special attention to the role of union-management cooperation in training because the literature has shown it to be a strong predictor of the apprentice performance.

2. Determinants of the Quantity of Training

Registered apprenticeship in the U.S. combines on-the-job training (OJT) and in-class related theoretical instruction (RTI) to provide general skills in an occupation. Apprenticeship programs have predetermined hours of formal OJT (typically ranging from 2,000 to 10,000 hours), and RTI (144 to 720 hours). Upon completion, the apprentice receives certification that recognizes him or her nationwide as a journey worker in the trade. Apprenticeship programs are sponsored either jointly by unions and signatory employers, or unilaterally by employers (henceforth union and nonunion programs). The costs of administration of training are borne by employers in non-union programs and are shared by employers and unions (generally through a training trust) in the union-management jointly sponsored programs. Apprentices also bear a portion of the training costs by working for training wages, which start at a fraction of the journey-level wage and rise over the course of training. In addition, apprentices may pay for tuition and books, either out of pocket or through a scholarship loan agreement. Apprentices can quit the program without penalty.

2.1 A Conceptual Framework

At any point in time, the apprentice has to decide between continuing training and acquisition of skills and quitting. Bilginsoy (2007) suggests that an apprentice will continue acquiring skills as long as the sum of expected discounted present values of two earnings streams – apprenticeship earnings up to the completion of the program and the subsequent lifetime

certified journey-level worker earnings – exceeds the expected discounted present value of lifetime income that would be generated if he/she were to quit apprenticeship at that point in time. Thus, factors that influence the expected (pecuniary and non-pecuniary) income streams of alternative career paths determine the quantity of training.

Bilginsoy (2007) identified three distinct types of exits from apprenticeship: (i) quitting due to dissatisfaction with the training or occupation; (ii) quitting because sufficient skills are acquired and additional skills do not justify the costs of additional training; and (iii) completion of apprenticeship and receiving journey-worker certification.¹

Case (i):

Apprentices are required to obtain training jobs in order to accumulate skills and training credit. The cost of training would be higher if the pace of skill acquisition is slow either due to the labor market conditions or the quality of the training program. In combination with low apprentice wages (relative to the wage in the alternative line of work), these conditions are likely to induce early quits from the program. An apprentice may also quit early if he/she finds the occupation or the training program disagreeable for any other reason. Other factors that may induce quits include high start up costs, including tools, transportation, clothing, initiation fees, union dues (where applicable), and RTI, which is on the worker's own time.

Case (ii):

The apprentice may quit training prior to completion once the “optimal” skill stock is accumulated. Three wages are going to be relevant to this decision: the training wage, the “outside” wage (what the apprentice can earn after dropping out), and the certified journey-level

¹ There is also the possibility that the program terminates the training agreement because the apprentice fails to meet the program requirements (e.g. absenteeism). This is formally the same as the quits in case (i).

wage. The training wage is predetermined by the program as a percentage of the journey-level wage, and rises as the apprentice progresses. The outside wage is expected to vary directly with the skill level attained during apprenticeship. The apprentice would quit training before the completion of the program if, given the journey-level wage, the gap between outside and training wages rises sufficiently in favor of the former so that the expected lifetime income in the outside career dominates the apprentice plus journey worker income stream. In neoclassical terms, this quit is an optimal separation. In addition, loose licensing requirements or the option of attaining a lesser license without completing the program (e.g., getting a low-voltage electrical license after quitting a general inside electrician training program) would also raise the likelihood of this kind of quit. This case recognizes that the optimal quantity of skills may be less than the total amount required by the program sponsor, an outcome emphasized by economists (who warn about the credentialing effect) and some nonunion apprenticeship program sponsors (who argue that high quit rates do not mean lackluster program performance).

Case (iii)

When the expected present value of the lifetime outside income falls short of apprenticeship plus journey worker income stream, training would continue until the program is completed. The likelihood of completing apprenticeship is expected to increase with the journey-level wage relative to the outside wage. The escalating apprenticeship wage schedule over the training period also offsets, at least in part, the pressure to quit. Union workers who seek to qualify for union wages and benefits, and nonunion workers who need to signal quality in a labor market characterized by asymmetric information are also more likely to complete training and receive certification.

These three cases suggest that expected income streams in alternative career paths will be a function of an array of factors, including the worker's pre-existing skills, knowledge, aptitude, job characteristics, availability and remuneration of work in and outside apprenticeship, the effectiveness of the training programs in delivering skills, expected value of acquired job skills, licensing requirements, journey worker certification premium, and the discount rate. The direction of the effects of these individual and institutional factors on alternative income streams are often theoretically ambiguous and therefore remain empirical questions.

2.2 Individual Factors

Among the factors that determine the expected present value of training, the neoclassical theory emphasizes the pre-existing levels of basic and job-specific skills (e.g. Altonji and Spletzer 1991; Lynch 1992; Lillard and Tan 1992; Barron, Black and Loewenstein 1993; Barron, Berger, and Black 1997). Much of the empirical evidence indicates that there is a positive relationship between the pre-existing skills and the quantity of training, explained on grounds that these are either complementary or are jointly influenced by other factors, such as aptitude or job characteristics. In the case of apprenticeship, it is plausible that a higher level of pre-existing basic skills would improve access to training jobs and therefore positively affect the quantity of training. A good high-school education would also keep apprentices on track by helping in the RTI, which has a heavy math component for most trades. However, the relationship between prior skills and the quantity of training is not necessarily linear because prior skills may substitute for training at sufficiently high levels of pre-existing basic skills (Altonji and Spletzer 1991). Following this line of reasoning, an interesting possibility is that a combination of high level of pre-existing skills coupled with sufficient amount of training can lead to high outside

wages and quits from apprenticeship prior to completion. In such a case, the preexisting skills-training profile would have an inverted-U shape.

Economic theory also suggests that the quantity of training would decline with age because lifetime returns to training are higher for the younger workers. However, to the extent that age serves as a proxy for life and labor market experience, prior skills, or commitment to the labor force, it is likely for the quantity of training to rise with age over a range. Therefore, the age-training profile, again, would have an inverted-U shape. Green (1991) argues that this profile would have a later peak for women because employers are less likely to offer training to younger women based on the expectation that their labor force attachment is weak.

2.3 Institutional Factors

Institutional factors influence the quantity of training both directly via the organization of training and indirectly by conditioning workers' demand for training. A program's success in delivering skills depends on its ability to match the prospective apprentices with occupations, and its effectiveness in organizing RTI and providing training jobs, paying better wages, and offering a higher overall quality of training. Institutional factors may include union involvement in managing the program, adequacy of the funding mechanism to support training, the number of participating employers, and whether the program has adequate training facilities.

In union programs, the apprenticeship committee is composed of the representatives of the employers and workers, whereas there is generally no worker representation in nonunion programs (Oregon nonunion programs is an exception). Previous comparisons of union and nonunion apprenticeship programs found that the retention rate in union programs is substantially higher (Bilginsoy 2003, 2007). This could be attributed to a host of factors, including mandatory participation of signatory employers, multi-employer cooperation,

entrenched tradition of apprenticeship and mentoring in the unionized trades, more strict observation of jurisdictional boundaries between trades, union grievance procedures, and unions acting on behalf of the apprentice. These factors ensure stable funding of the training programs and prevent exploitation of apprentices as cheap labor. Unions are more likely to provide better job rotation because they work apprentices on both private and prevailing-wage jobs, while the non-union contractors tend to rely heavily on helpers rather than use apprentices except for prevailing-wage jobs and in the licensed trades. Some union training trusts use scholarship loan agreements that require the apprentice to pay back the cost of training, unless they work a certain number of years for a participating contractor after program completion (with the loans forgiven after journey-level work begins). The higher retention rate in union programs can also be explained by the fact that union workers have higher incentives to complete the program in order to qualify for union wages and benefits, and be dispatched as a journey worker, which requires either program completion or other formal union recognition of journey status. Finally, non-union programs in construction may have lower retention rates due to prevailing wage laws, which permit hiring of only registered apprentices at below prevailing wages in public construction. Contractors may be merely recruiting helpers into apprenticeship programs for prevailing wage work, and then neglect their training.

2.4. Women and Minorities Training in the Crafts Workforce

Many researchers found a training gap against women (e.g. Lynch 1992; Knoke and Ishio 1998; Berik and Bilginsoy 2000, 2002, 2006). Neoclassical economic theory attributes the gender gap in training to women's preferences for taking care of household tasks, which arguably create a weaker attachment to the labor force and commitment to long-term training.

With the expectation that they will be working fewer years than men and therefore reaping smaller returns to investment in training, women are not likely to engage in training as much as men. In contrast, the poor showing that has historically been observed for minorities is attributed to the discriminatory tastes of the white union workers, with the corollary that rising competition in the labor market (weakening of unions) would eradicate factors hindering the entry of minority workers to the crafts workforce.

While they are often discounted by neoclassical theory in favor of subjective preferences, historical and institutional factors have played a very important role in the shortage of women and minorities in training programs. The trades workforce has been historically dominated by men of European ancestry with strong local networks. One Oregon program administrator characterized the trades workforce as the “FBI” (Friends, Brothers, and In-laws) (Oregon Consortium 1996, 171), which excluded outsiders from these well-paying careers. Since entry into the trades requires substantial front-loaded training, the control of the training programs, often by the trade unions, has been an effective device for exclusion of women and minorities.²

In recent decades, however, many unions have acted as vehicles of integration for minority workers, resulting from the push of the Civil Rights Act, affirmative action policies and the pull of the need to adapt to the changing ethnic composition of the labor force.³ The barriers that minorities faced largely have been removed (particularly in the trowel trades). Government agencies also made an historic push in the late 1970s to increase women’s participation in the trades, but there has been minimal government support since then, as affirmative action

² See, for instance, Marshall and Briggs (1967) on the exclusion of blacks. The exclusionary behavior of unions has, in turn, shaped the “choices” of minority and women workers not to seek entry to these programs.

³ Several studies have shown that women and minority workers now are better represented in the union apprenticeship programs than their non-union counterparts, suggesting a shift in union practices (Berik and Bilginsoy 2000, 2002, 2006).

programs have been reduced to equal opportunity pledges. The result has been a marginal level of integration of women that has not been sufficient to achieve a status for tradeswomen beyond being a “wedge in the door” (Berik and Bilginsoy 2006).

Nonetheless, problems persist even for those non-traditional workers who successfully navigate entry into a training program. An Oregon survey conducted in 1996, for instance, documents the refrains of nontraditional apprentices who endure shortage of meaningful work assignments and condescending or patronizing behavior on the job, which slow their progress or stop it altogether (Oregon Consortium 1996). These problems have been documented more frequently for white and minority women than for minority men, suggesting an ossified male culture of the crafts, which has created a work environment that is more hostile for women than for minority men. The 1996 Oregon survey records that sexual harassment, physical and emotional stereotyping, discrimination in job rotation, lack of sanitary facilities, and accusations of reverse discrimination are rampant. Such conditions undoubtedly make the integration of women into apprenticeship an ongoing challenge. In addition, women usually bear the burden of domestic work, and competing domestic responsibilities limit their ability to pursue training jobs. In construction where most of apprenticeships are, for instance, jobs are intrinsically temporary and workers are required to move from one site to another continuously, which requires considerable search and travel costs. Women’s choice sets may also be limited by their background: they are also less likely to have taken shop classes in high school, be familiar with tools and technical skills, and to have received advice from industry insiders of high school counselors about career opportunities in trades. Finally, the lack of a critical mass of women in the trades to provide mentoring and other kinds of support mechanisms have also limited larger numbers of women from participating in apprenticeship training and entering the journey-level

workforce. These findings are not unique to Oregon as they are experienced by tradeswomen across the U.S. (for example Eisenberg 1998; Bilginsoy and Berik 2000, 2006; Paap 2006).

3. Empirical Models

Most empirical studies of training focused on its incidence, estimated by a binary choice model (Altonji and Spletzer 1991; Lillard and Tan 1992; Lynch 1992). Knoke and Ichio (1998) utilized proportional hazard model to estimate the probability of entering a training program over a 15-year period. Training gap measures are then found by breaking down the incidence or hazard estimates by gender, race or other groups. In contrast to these studies our objective is to evaluate the skill level of the worker at the time of exit from training. Berik and Bilginsoy (2000; 2006) made this assessment by estimating the completion probability using the multinomial logit method. Bilginsoy (2003; 2007) measured the quantity of training acquired in terms of the duration between the entry and exit dates conditional on the type of exit.

Similar to other apprenticeship databases in the U.S.,⁴ the Oregon database reports the dates of entry into and exit from the program for each new registration, the mode of exit (e.g. completion, cancellation, transfer to another program), and a set of individual and program level attributes.⁵ Apprentices who are still in training as of the last date when data are compiled is reported as “active.” The Oregon database provides, hitherto unavailable, the OJT credit accumulated by each apprentice who quit. We use these pieces of information to construct three measures of training and compare each across gender and minority status: the probability of

⁴ The latter are the AIMS and RAIS of the U.S. Department of Labor, and the California Apprenticeship Agency Database.

⁵ Each registration does not necessarily refer to a unique apprentice because the same worker can register in different programs at different times. We are interested in the outcome of each registration and therefore use it as the unit of observation. Thus, in the following empirical work “apprentice” refers to a registration, which is not necessarily a unique individual.

completion of graduation requirements, time to graduate, and the OJT credit hours earned by apprentices who quit.⁶

We adjust training gaps for effects of individual and institutional factors on the measures of quantity of training. Individual level determinants of training are age, years of education at the time of entry into the program, trade school attendance, and veteran status. Age and education are the standard proxies for experience and pre-existing skills. Education ranges from nine to sixteen years of schooling.⁷ Initially we thought that the trade school attendance implied a higher level of pre-existing skills. Perusal of the apprenticeship files revealed that the trade schools are often “skills centers” that require 9th grade reading and 8th grade math, and hold classes in conjunction with the high schools. Thus, it is likely that the trade school provides preparatory programs in specialized training to help youth who face obstacles or demonstrate difficulties in formal education, and therefore trade school attendance may indicate an early deficiency in basic skills rather than a higher level of preparation. Veteran status may capture pre-existing skills in view of the likelihood that basic skills are acquired in the military. Both trade school attendance and veteran status are binary variables.

⁶ While these measures jointly provide a more complete account of the performance of apprentices than past studies, three shortcomings still remain. First, apprenticeship requirements include both OJT and RTI. Lacking RTI data, we are forced to ignore in-class instruction and therefore fail to capture this dimension of apprenticeship training. Second, our measurement of training assumes that the training hours are homogenous, i.e. an hour of training yields the same amount of skills at any point during apprenticeship. Strictly speaking, this is not accurate. The first phase of training, corresponding to around 1,000 hours in a 8,000-hour program for instance, is usually the probationary period during which the apprentices are assigned more menial tasks and probably learn fewer skills than in any other period of equal length. This source of non-homogeneity is time-specific and requires care in interpretation of results for workers who quit early. It is also conceivable that the training sponsor may schedule provisioning of skills strategically, e.g. saving the most valuable ones until the end of the training in order to raise retention. Such a scheme is not very likely in practice (at least in construction, where most of the apprentices are) because the sequencing of the skill acquisition is often dictated by the availability of the training jobs. Thus, our assumption of the uniformity of training hours is admittedly an approximation but not entirely unreasonable. Third, given the lack of quality measures, we will assume that the quality of training, i.e. the amount of skills delivered in each hour of training in each occupation, does not vary across programs and sponsors.

⁷ We entered 16 years for the 26 apprentices who reported longer years of schooling because our review of registration forms indicated that these figures were not reliable due to the questionnaire format. We counted GED as 12 years of schooling.

Program level variables are the percentages of women and minorities, program size, and program sponsor type, all defined at the program-occupation level.⁸ Shares of women and minorities are included to account for the possible threshold effects for these groups in training. Size is introduced to capture economies of scale in the delivery of skills. Both program size and female and minority shares are calculated for the year in which the apprentice started training. Program sponsorship is a categorical variable: union (base), nonunion, and mixed. Oregon apprenticeship system has two distinguishing features. First, in addition to the union and nonunion programs, Oregon also has “mixed” programs where both union and nonunion employers can be affiliated once they are registered as training program sponsors.⁹ Second, Oregon also requires all apprenticeship programs to have equal numbers of employer and employee representatives whether the training committee itself is union, nonunion, or mixed, whereas in other states this is true only for the union committees.¹⁰ Thus, the Oregon experience permits addressing the question of whether worker representation in the open shop committees closes the union-nonunion performance gap observed elsewhere in the U.S.

Unemployment rate captures the effect of demand for labor on the quantity of training. The direction of the impact is theoretically indeterminate. A higher rate of unemployment would imply a shortage of both outside and training jobs. The lack of attractive job offers from outside, on the one hand, may reduce the probability to quit from apprenticeship and increase the quantity of training (albeit credited hours of training are likely to accumulate over a longer duration). On the other hand, the shortage of training jobs may also force the apprentice out of the program and

⁸ We specify the training supplier as “program-occupation” because in some instances a single program provided training in several different occupations, and each of these occupations could have different standards of curriculum and wage progression in addition to the different occupational characteristics.

⁹ See Oregon Consortium (1996) and Byrd and Weinstein (2005) on the Oregon apprenticeship system.

¹⁰ In nonunion and mixed committees, the State Training Council generally approves any list of employees who are certified as skilled practitioners of the trade and who are not acting as supervisors.

pursue a different career path (such as college education). The data provide the entry and exit dates of each apprentice. We used these dates and monthly Oregon unemployment rates to calculate the average monthly unemployment rate each apprentice faced until he or she exited from the program.

In addition, we also added apprentice residence in the Portland metropolitan area, occupation, industry, and entry year dummy variables as control variables.¹¹

Each empirical model is applied separately to white men, white women, and minority men apprentices. Cell sizes for women and minority apprentices were relatively small and we omitted minority women, for whom this problem was most severe (0.6% of all apprentices). In all estimations we clustered observations by program-occupation-year considering that the error terms within these cells would not be independent.

4. The Data

The database includes all new registrations in the Oregon Apprenticeship system from January 1, 1991 to December 31, 2007. We made program requirements uniform by including only programs with 8,000-hour OJT requirement. These are by far the most popular programs, accounting for 57% of the total 49,468 new registrations. We narrowed observations by selecting apprentices who registered in the eight largest occupations (82 percent of the subtotal) before January 1, 2003 (in order to allow a time period long enough to complete apprenticeship requirements), and who did not receive OJT credit for prior experience at the time of entry (in

¹¹ We did not include licensing regulation as a separate control because it is highly correlated with occupational categories that pick-up the effect of licensing.

order to make their performances comparable).¹² Finally, we excluded three groups of apprentices: those who transferred to other programs or dropped out of the programs for observable “exogenous” reasons (e.g. medical condition, death, program termination); and those who quit within 30 days of indenture or with zero hours of credit, on grounds that they effectively did not start the program. After removing observations with missing or erroneous values, we have a total of 8,829 observations.

<Table 1 here>

Table 1 presents descriptive statistics of the selected sample. Non-traditional apprentices constituted 11% of all apprentices. Minority representation (7%) was smaller than their share in apprenticeship nationwide. The latter is attributable both to the smaller share of the minorities in the Oregon labor force (13%), and to the concentration of minorities, as in the rest of the U.S., in trades that have less than 8,000-hour OJT requirement.

Women were on average older and more educated. Non-traditional workers were more likely to have attended trade school, be located in the Portland area, and be registered in programs that are on average larger in size, and in construction.¹³ Electrical and carpentry jointly accounted for 55% of all apprentices. These two were also the largest trades for women and minorities.

Most of the apprentices were enrolled in nonunion programs (47%) followed closely by the union programs (42%).¹⁴ The organized sector accounted for 23% of the Oregon workforce in industries represented in the apprenticeship population, and therefore, relative to its size,

¹² There were no graduating white women apprentices in the next two largest occupations, drywall applicators and HVAC technicians.

¹³ Most non-construction apprentices were in the manufacturing sector.

¹⁴ Many programs that were reported as mixed were dominated by either union or nonunion apprentices. We re-categorized these cases as either union or nonunion accordingly.

trained a much larger share of the apprentices. White women and minority men were overrepresented in the union programs, which is consistent with the national patterns (Berik and Bilginsoy 2002).

5. Completion Probability Gaps

All apprentices in the sample exited training either through completion or cancellation. The upper panel of Table 2A reports raw completion probabilities and gaps. We define the gender completion gap as the percentage deviation of white women's completion probability from that of the white men's. The minority completion probability gap is also defined relative to white men. These gaps are reported for both types of sponsors under the "within-sponsor gaps" title. Since the literature found that program sponsor type is important predictor of the completion rate, we also report "across-sponsor gaps" for each demographic group, defined as the percentage deviation of nonunion completion rate from the union value.

<Tables 2A and 2B here>

White men had the higher raw completion probabilities, 73% in union and 69% in nonunion programs. Both white women and minority men were less likely to complete training than white men, and their deficits were wider in the nonunion programs. Gender gaps were -23% in union and -36% in nonunion programs. Minority gaps were smaller than gender gaps. Across-sponsor gaps indicate that apprentices in union programs had on average higher completion probabilities regardless of their gender or race. The largest difference is observed in the case of women. Nonunion women's completion probability was 22% lower than that of women in union programs.

Raw apprenticeship completion probability gaps may at least in part be attributable to differences in distributions of individual, institutional, and occupational characteristics across white men, white women, and minority men apprentice workforces. In order to adjust for these factors, we estimated logit regressions of completion probability on workforce characteristics and predicted the probabilities of completion for hypothetical apprentices who are identical except for their gender or minority status. The lower panel of Table 2A reports these predicted probabilities and the 95% confidence intervals. The hypothetical apprentice is defined as one who did not attend trade school, is not a veteran, resides outside the Portland metropolitan area, and is registered in a construction industry program; his/her values for continuous variables are set at the means for white men to determine the completion probabilities for white women and minority men had they displayed white men's characteristics; by the same token, values of occupation and starting year variables are set using the distribution of white men's across the values these variables take. Adjusted completion probabilities reported in lower panel of Table 2A show that raw within-sponsor gaps are indeed partially attributable to workforce characteristics. Adjusted gender gaps in union and nonunion programs are smaller than raw gaps by nine and six percentage points, respectively. Minority gaps change far more dramatically, turning in favor of minorities in the union and rising to -4% in nonunion programs. The narrowing of completion probability gaps suggests that the lower raw likelihood of white women and minority men to graduate may be due in part to labor market discrimination and greater access of white men to better training conditions and more attractive occupations.

Logit estimates of marginal effects reported in Table 2B underscore the importance of union sponsorship for completion probability. White male nonunion program apprentices were less likely to graduate by 16%. The corresponding figures were 24% for white women and 25%

for minority men. These marginal effects translate to adjusted across-sponsor gaps in the lower panel of Table 2A that are much wider than the raw gaps. Nonunion program completion rates were lower for the hypothetical apprentice by 35% in case of white women, 29% for minority men, and 20% for white men, which were higher than raw gaps by 13 to 20 percentage points.¹⁵

Table 2B also shows that age and education were important predictors of the completion probability, although at low levels of statistical significance for minority men and white women.¹⁶ Unemployment rate was also a strong predictor of the completion probability. Higher unemployment rates raised the likelihood to complete, which suggests that all apprentices who eventually graduated were more likely to keep at training as outside job opportunities declined. Completion of requirements in the face of higher unemployment, however, might have come at the cost of longer duration of training, which we examine in the next section.

6. Training Duration Gaps

¹⁵ Union effect estimates would be biased if unobserved attributes of the apprentices are correlated with the union status. However, the direction of this bias is not obvious. Anecdotally, union programs have the reputation of being better organized and more committed to training (Oregon Consortium 1996). They also provide better wages and benefits. On the down side, union dues may make union training unaffordable for a beginning apprentice especially when there is a shortage of jobs. If, on balance, more motivated and capable apprentices choose union(nonunion) programs, then the reported estimate of the union effect would be biased upward(downward). One may discern relative selectivity of union and nonunion programs by combining information on applicants and new entries to apprenticeship. Information on Oregon apprenticeship applications is available only for the 1991-1995 period and is limited in terms of the reported attributes of applicants. These data do not indicate a sharp difference between the rejection rates of union and nonunion programs (66% vs. 59%). Mixed programs rejected only 2% of the applications. Women and minority workers were more likely to be rejected by 14 percentage points each. Lacking information on individual attributes of the applicants (e.g. basic skills, education levels), it is difficult to assess relative competitiveness of union and nonunion programs from these figures. As an alternative, we identified the 1,788 apprentices with duplicate applications to both union and nonunion programs and examined the chances of an applicant, who is initially rejected by a union program, entering a nonunion program, and vice versa. Six percent of these apprentices were rejected by union programs but eventually admitted to a nonunion program; and 5% were rejected by nonunion programs but eventually admitted into a union program. Moreover, 25% were rejected by both union and nonunion programs. These findings do not suggest that one type of program takes the cream of the crop first and leaves the lesser qualified apprentices to others, and hence selection bias is probably not a serious problem.

¹⁶ Age is in quadratic specification because while it may serve as a proxy for experience initially, with advancement of age and shortening of the remaining work life, the marginal cost of continuing apprenticeship may eventually exceed the lifetime returns to additional training. Education is also in quadratic form in view of the possible substitutability between training and higher levels of education.

The pace of training is the second dimension of training gaps that we consider: the time it takes to receive a given quantity of training. If certain groups of apprentices are given priority in job allocation, others will take a longer period of time to complete an equivalent number of training hours and therefore face higher costs. Competing demands that constrain the time the apprentice can devote to skill formation would also extend the duration of training. In order to test whether there are any differences in the duration of training by gender and minority status, we selected the completed apprenticeships and measured the time to graduate. The expected duration of completion of an 8,000-hour program for a full-time employed apprentice is four years. There were a number of observations with completion durations of less than four years. One reason for a shorter period of completion is receiving credit for prior experience but most of these apprentices were already excluded.¹⁷ It is also possible, however, for the more motivated apprentices to collect credit hours at a faster pace at the discretion of supervisors. In recognition of this possibility, we included apprentices who completed in three or more years. We believe that observations of any shorter completion duration are more likely to be recording errors.

Table 3A reports observed average durations of completions and gaps. Duration is defined as the number of days that elapsed between the graduating apprentice's date of entry into and exit from the program. Similar to the completion probability gaps, we defined duration gaps as percentage differences from white men (for within-sponsor gaps) and from union (for across-sponsor gaps). Raw figures of the upper panel of Table 3A indicate that white men, on average, completed training the fastest. Women took the longest time to complete training, 3% (51 days) more in union and 7% (104 days) more in nonunion programs in comparison with white men.

¹⁷ Some programs may grant credit for prior experience at a time other than entry, e.g. at the end of the probationary period. We had observations only on credit received at the time of entry and therefore were able to exclude only these apprentices.

Minority men were only slightly behind white men in completion duration. Overall, raw gender and minority gaps are not substantial, except perhaps the gender gap in nonunion programs.

<Tables 3A and 3B here>

Larger gaps are observed in across-program comparisons. Nonunion apprentices completed training at a faster pace in all categories. Training duration of white men in nonunion programs was 8.5% (or 146 days) less than those in union programs. For nonunion white women and minorities, duration gaps were smaller.

Table 3B reports OLS estimates of completion durations for each group of apprentices. The dependent variable is the natural log of the duration of training. Age, education, and program size are also in natural logs so that the associated coefficients are elasticities. The lower panel of Table 3A reports predicted duration values for the hypothetical apprentice.

According to Table 3B, independent variables explain about a third of the variation in the duration. In line with raw statistics, hypothetical nonunion program apprentices completed training faster. Adjusted durations in nonunion programs were again shorter than those in union programs -- by 11% for white men, 10% for minority men (both statistically significant at the 1% level) and 5% for white women (statistically significant at the 10% level). Thus, while nonunion programs had lower retention rates than union programs, their completions came at a much quicker pace. This finding is consistent with the hazard analysis estimates of Bilginsoy (2007) who found that the probability of completion is lower in nonunion programs but the expected completion time is shorter. Jointly, these results suggest that union programs spread training resources more widely and allocate jobs among larger number apprentices so that the higher number of graduates comes at the cost of longer average duration of completion. Nonunion

programs, on the other hand, appear to allocate resources more selectively among the apprentices, graduate fewer but in a shorter period of time.

Minority duration gaps within programs were not affected by confounding factor controls but there were substantial changes in gender gaps. In nonunion programs, the gap shrank to less than 2% once individual and institutional factors are controlled for; in union programs, the hypothetical woman apprentice's predicted completion time was shorter than either white or minority man's. One important contributor to this outcome is the industry variable. Duration gap was in favor of white women only in the construction industry. As reported in Table 3B, outside the construction industry, white women's average completion duration was longer by 20% while white men's duration was shorter by 15%. Another variable of interest is the unemployment rate. Both white men's and women's durations varied countercyclically but the impact was much stronger on women. Duration to graduation for white women who faced an average one percent higher unemployment rate during their apprenticeship was longer by 18% while the figure was 8% for white men. The pro-cyclical gender duration gap indicates that men were in a relatively more favorable position in accessing apprentice jobs when these jobs were harder to find. In contrast, the impact on the duration for minority men was negative (although statistically significant at a much lower level), and therefore the race duration gap was in favor of minorities when unemployment was higher.

7. Training Quantity Gaps of Cancelled Apprenticeships

The Oregon dataset is the first data source to provide information on the actual number of OJT credit hours the apprentice has accumulated during training and permits direct measurement of the quantity of training received by apprentices who dropped out of the programs. This piece

of information can be of critical importance in evaluating program effectiveness. In the open-shop sector of the construction industry, for instance, nonunion program sponsors often attribute their lower retention rates to what they consider to be the needlessly long apprenticeship training requirements, instruction in skills that are of little use to individual employers or employees, and the ability of their apprentices to find well-paying outside jobs before the completion of apprenticeship. If these claims are correct, then the higher completion rate in union programs is a suboptimal outcome of perverse incentives created by institutional factors: Union workers are compelled to complete apprenticeship requirements fully in order to receive journey-level certification and qualify for union wage and benefits, whereas nonunion program apprentices, unburdened by the union membership requirements, can quit at the optimal hours of training prior to program completion.¹⁸ If these claims are true, then completion rate is a flawed measure of program effectiveness.

Ideally this hypothesis should be tested by comparing post-apprenticeship labor market outcomes of all apprentices, including the drop-outs and the graduates. In the absence of these data we looked into the quantity of training received by drop-outs for indirect evidence. First, if quits are optimal, then the training quantity of drop-outs should be sufficiently high so that they can get well-paying high-skill jobs. The second type of potential evidence is more circumstantial. If higher average training hours in union programs are attributable to incentives created by union membership requirements, then the nonunion program apprentices who dropped out should have received more training than union drop-outs.

The upper panel of Table 4A reports raw OJT credit hours and gaps of the sub-sample of apprentices who dropped out. We define within-sponsor gender (or minority) gap as the

¹⁸ Under conditions of asymmetric information, nonunion workers would also have the incentive to get certification to signal worker quality, but the issue is not raised in the debates among the industry observers.

difference between the numbers of hours of OJT credit received by white women (or minority men) and white men divided by 8,000 hours. Across-sponsor gaps for each group are defined as the difference between the nonunion and union hours divided by 8,000 hours. Overall, these figures show that the average hours of training acquired by the apprentices who dropped out were modest, regardless of the sponsor type. At best, white men in union programs earned 2,470 hours of training, or 31% of the 8,000-hour completion requirement. Since the first 1,000 hours of training is the probationary period during which apprentices perform more menial tasks, it is unlikely that apprentices who dropped out can find outside jobs beyond the semi-skilled level. Across-programs, nonunion apprentices received less training, although the difference is small. It was the widest for nonunion white women apprentices who received 5% (389 hours) less training than those in union programs. Within each type of program, gender and minority gaps were in favor of white men, but again they were relatively small. The largest gap was the gender gap observed in nonunion programs at -7%. However, quantity gaps convey only a partial picture. As a memo item, we reported in parentheses the average number of days that elapsed between the entry and exit dates of the drop-outs. These figures underscore that women received less training in spite of the fact that they remained in apprenticeship on average for a longer period of time than men. Thus, the quantity gender gap does not reflect earlier quits of women, but rather the disadvantages they face in accessing training jobs due to sponsors' preferences for men and/or competing claims on women apprentices' time.

<Tables 4A and 4B here>

Next, we adjust the quantity of training by predicting OJT credit hours by gender and minority status for apprentices who are otherwise identical in observed traits. Since the training quantity variable is bounded (between zero and 8,000 hours, non-inclusive), OLS estimation is

not appropriate. Therefore, we first expressed the quantity of OJT at the time of exit as a fraction of the completion requirement by dividing it by 8,000. We then applied Papke and Wooldridge's (1996) flogit method to estimate the fraction of OJT hours completed. The estimated marginal effects on the quantity of training for the hypothetical apprentice are reported in Table 4B. The coefficient of the nonunion variable, for instance, indicates that the percentage of OJT credit hours earned (as a share of 8,000-hours) by the hypothetical white man apprentice in a nonunion program who dropped out of training was on average lower than his union counterpart by 2.4 percentage points. These magnitudes are easier to interpret once converted to the number of hours of OJT training. The lower panel of Table 4A reports the adjusted predicted hours of training for hypothetical apprentices based on the flogit estimates. After adjustments, the terminated nonunion white men apprentice on average earned on average 191 fewer hours of training than the white men apprentice in the union program. Controlling for observed attributes, canceled union apprentices in all categories received more training than their nonunion counterparts, although the differences were small in magnitude. There were no significant differences between the raw and adjusted across-sponsor gaps, although the latter were more uniform. Low average hours of training received by the drop-outs and the persistent, albeit small, negative nonunion effect on the training quantity indicate that quits from apprenticeship were neither the outcome of the ability to acquire sufficient training prior to completion in the nonunion programs nor the perverse incentives created by the certification premium in the union programs.

Within-sponsor gender gaps were much wider after adjustments, dipping to -13% in union and -14% in nonunion programs, as seen on Table 4B, but the discrepancy is due primarily to the industry variable. In comparisons with their peers in construction, white women drop-outs

in non-construction industry received 70% more training. We do not observe as stark a difference for men. As in the case of raw figures, however, reported gender quantity gap severely understates the challenge women face in apprenticeship training in both union and nonunion programs, given that they remain a longer amount of time as apprentices. We use the duration model specification of the previous section to predict durations of cancelled apprenticeships and reported these in parentheses in the lower panel of Table 4A. These show that women drop-outs accumulated fewer hours of OJT credit in spite of the fact that they remained in apprenticeship programs about as long as men, underscoring once again the differential access to training jobs by gender. In union programs, for instance, on average, men received 4.4 hours of credit per day, while women received 2.6. Corresponding hours in nonunion programs were 4.3 and 2.1 hours, respectively.

The impact of unemployment also indicates that women's and men's experiences were quite different. Minority men apprentices, and to a lesser extent white men, received more training when they faced higher unemployment during their training. For women the effect is smaller in terms of both economic and statistical significance. This implies that men were more likely to hold on to training when overall job opportunities diminished. Conversely, men's OJT credit hours declined as the economy improved, indicating their ability to pursue non-apprenticeship jobs. Women's quantity of training was not as responsive to unemployment. Unlike men, they were not able to increase their training hours in the context of higher unemployment, although on average they remained in apprenticeship as long as the men did. Conversely, economic expansion did not provide as many outside job opportunities to women as it did to men.

8. Conclusion

This paper used the Oregon apprenticeship data to compare the training experiences of three groups of apprentices, white men, white women, and minority men. Historically, both white women and minority men have been excluded from the craft apprenticeship programs. Women's participation in apprenticeship programs in Oregon, as in the rest of the U.S., remains woefully low. While participation of minority men in apprenticeship is in line with their representation in the Oregon workforce, in the subset of the occupations considered in this study – commonly recognized as the more skilled trades – their representation lags behind. We used three metrics to measure gender and minority training gaps: completion probabilities, durations of completed apprenticeships, and the number of completed OJT hours for cancelled apprenticeships. Since observed differences may be attributable to individual characteristics and occupational and institutional features, we also used regression analysis to adjust for these factors and reported predicted values of the gaps for apprentices who had the reference white men's attributes. Among institutional factors we focused on program sponsorship type in light of the literature that has shown it to be a major predictor of apprentice performance.

We observe the largest adjusted gender gap in the probability of completion. White women were less likely to graduate than white men by 14% in union and 30% in nonunion programs. Experiences of white and minority men were similar. In union programs minority men were more likely to graduate than white men while in nonunion programs the reverse was true, but the gaps were nonetheless much narrower than gender gaps. In terms of time to graduate, differences were relatively small. White and minority men completed training within a month of each other. In union programs white women completed earlier than white men on average by as much as three months. Lastly, we compared the quantity of training received by the apprentices

who dropped out. Again the experience of white and minority men were very similar, with minorities receiving around 88 to 107 hours of fewer OJT training than white men, which is less than 2% of the total training requirement. In the case of women, however, the difference was very large. Total training received by white women drop-outs was lower than white men's (in construction) by 1,052 hours of OJT or 13% of the total required training. The average quantity of training received by the cancelled apprentices overall was relatively small and did not support the contention that the drop-outs could have acquired sufficient skills to be employed in jobs that require more than semi-skilled workers.

In addition to program sponsorship, unemployment rate and industry turned out to be of economic and statistical significance. A higher rate of unemployment raised the likelihood of completion as well as the quantity of training received by the drop-outs (although the latter is not statistically significant for white women). Training hours of minority men who dropped out increased the most in response to a higher unemployment rate, almost twice as much as that of the white men. For white men and especially women graduates, higher unemployment also raised the duration of training. Thus, there is strong evidence that apprentices tend to stick with training as job opportunities become scarce, at times at the cost of longer time spent as trainees.

Industry results are somewhat paradoxical. White women apprentices were statistically equally likely to complete training and, if in construction, they graduated in a shorter period of time. Among those who dropped out, however, women in non-construction industries received a much higher quantity of training. Thus, the experience of white women in construction industry is dichotomous: they either graduated in a relatively short period of time, or dropped out with few, if any, acquired skills. In the construction industry, employer-employee relationship is much looser than in the manufacturing sector, and workers are in constant flux between contractors and

jobs. In the manufacturing sector apprentices probably have more steady work. In Oregon, most of the manufacturing programs seem to have a more stable contract between the employer and the apprentice, as employers (particularly when there is a collective bargaining agreement) frequently recruit current line employees to be apprentices in their maintenance departments. Working conditions are also likely to be more adverse for women in construction since the constant search for new jobs as the previous one is completed and arranging transportation to changing job sites may be especially burdensome for those who are also more likely to bear greater responsibilities at home. Our empirical findings suggest that women apprentices in construction were either quickly terminated under these circumstances, or when they were able to overcome these difficulties, completed training efficiently. In the manufacturing sector, they stayed in training for a longer time period and acquired more skills, even if in the end they quit prior to the completion of all requirements. This is in sharp contrast to the white men in non-construction industries who completed training in a shorter time than those in construction and who were also more likely to graduate. Experiences of minority men apprentices in and outside construction industry, on the other hand, were barely different.

The effect of training sponsorship is one of the most prominent findings. Across the board the probabilities of completion were higher in union programs, and especially so for non-traditional workers. In union programs, white women and minority men were more likely to complete by 35 and 29%, respectively, compared to their nonunion counterparts. Differential completion rates demonstrate that white women and minority men benefited disproportionately more from training in union programs. In contrast, time to complete was shorter in nonunion programs, by 5% for white women and around 10% for both white and minority men. Thus, nonunion programs graduated relatively fewer apprentices but on average at a faster pace.

Nonunion programs appear to allocate resources more selectively, so that the few who graduate did so in a shorter span of time. Union programs were only slightly ahead of nonunion ones in terms of the quantity of skills imparted to terminated apprentices, but overall the quantity of training acquired by these workers is low and the evidence does not support the hypothesis that quits in the nonunion sector is an indicator of the acquisition of sufficient skills that would secure well-paying jobs.

Table 1: Descriptive Statistics

	All	White men	White women	Minority men
Earned OJT credit hours	6,327 (2,764)	6,432 (2,699)	5,139 (3,184)	5,699 (3,064)
Completions (%)	70.0	71.6	51.7	60.0
Age	29.3 (8.1)	29.3 (8.2)	31.3 (7.1)	29.0 (7.4)
Education	12.6 (1.3)	12.6 (1.3)	13.0 (1.5)	12.6 (1.4)
Attended trade school (%)	14.1	13.6	18.3	17.8
Veteran (%)	15.9	16.7	5.3	12.5
Program size	160.4 (146.3)	157.2 (145.1)	199.2 (157.1)	179.4 (149.8)
Portland (%)	38.2	36.5	54.4	50.2
Construction (%)	82.8	82.0	94.7	86.0
Union program (%)	42.2	41.3	56.9	44.9
Nonunion program (%)	46.5	46.7	38.9	47.3
Mixed program (%)	11.4	12.0	4.1	7.9
Unemployment (%)	6.0 (0.7)	6.0 (0.7)	5.9 (0.7)	6.0 (0.7)
Carpenter (%)	15.9	15.0	23.6	23.0
Communication tech. (%)	8.4	8.0	13.1	10.3
Electrician (%)	39.3	39.2	47.8	35.4
Maintenance electrician (%)	8.8	9.2	3.6	6.8
Maintenance mechanic (%)	5.5	5.9	1.1	4.0
Millwright (%)	2.4	2.5	1.4	2.1
Pipefitter (%)	6.0	6.0	6.7	5.8
Plumber (%)	13.7	14.3	2.8	12.7
N	8,829	7,847	360	622

Note: Standard deviations in parentheses.

Source: Oregon Apprenticeship System Database.

Table 2A: Completion Probabilities and Gaps

	Union	Nonunion	<i>Across-sponsor gaps</i>
Raw completion probabilities and gaps			
White men	73.2%	68.8%	-6.1%
White women	56.6	44.3	-21.7
Minority men	62.0	56.5	-9.0
<i>Within sponsor gaps</i>			
Gender gap	-22.7%	-35.6%	
Minority gap	-15.3	-17.9	
Adjusted completion probabilities and gaps			
White men	78.0%	62.1%	-20.3%
	[74.2-81.3]	[56.6-67.3]	
White women	67.0	43.4	-35.3
	[40.5-85.9]	[22.0-67.6]	
Minority men	84.6	60.0	-29.4
	[76.4-90.3]	[47.9-70.4]	
<i>Within sponsor gaps</i>			
Gender gap	-14.0%	-30.1%	
Minority gap	8.5	-3.9	

Notes:

Within-sponsor $gap_i = \text{Prob}(\text{Completion}_i) / \text{Prob}(\text{Completion}_{\text{white male}}) - 1$, where i = white women, minority men.

Across-sponsor $gap_i = \text{Prob}(\text{Completion}_{i,\text{Nonunion}}) / \text{Prob}(\text{Completion}_{i,\text{Union}}) - 1$, where i = white men, white women, minority men.

Adjusted completion probabilities are based on logit estimations of the likelihood to complete apprenticeship program and graduate (see Table 2B). The 95% confidence intervals are reported in brackets.

The hypothetical apprentice used in calculation of adjusted probabilities is a non-veteran union apprentice registered in a program outside the Portland metropolitan area, and works in the construction industry; continuous variables are set at the mean values for white male apprentices; values of occupation and entry year dummies are set at their shares of incoming white male apprentices.

Table 2B: Marginal Effects on the Probability of Completion - Logit Estimates
 Dependent variable: Probability(Apprentice completed 8,000 hours of OJT and graduated)

	White Men	White Women	Minority Men
Age	0.124 (3.97)***	0.318 (1.28)	-0.026 (0.26)
Age-squared	-0.015 (3.81)***	-0.044 (1.47)	0.002 (0.16)
Education	0.148 (2.90)***	0.287 (0.86)	0.233 (2.47)**
Education-squared	-0.005 (2.49)**	-0.009 (0.76)	-0.009 (2.36)**
Trade-schooled	-0.015 (1.17)	-0.038 (0.42)	-0.089 (2.31)**
Veteran	-0.005 (0.39)	0.146 (1.46)	-0.045 (1.15)
Nonunion program	-0.158 (8.07)***	-0.236 (3.55)***	-0.249 (5.85)***
Mixed program	-0.073 (1.31)	-0.243 (0.34)	-0.252 (1.35)
Female share in program	0.019 (2.36)**	-0.008 (0.20)	0.005 (0.37)
Minority share in program	-0.011 (1.58)	0.045 (0.91)	-0.004 (0.72)
Program size	-0.001 (0.99)	-0.007 (4.04)***	-1.5E(-4) (0.15)
Portland resident	0.028 (1.64)	0.001 (0.03)	-0.026 (0.72)
Unemployment rate	0.128 (4.68)***	0.195 (2.06)**	0.154 (3.80)***
Non-construction	0.116 (2.65)***	-0.090 (0.27)	0.022 (0.19)
N	7,847	360	622

Notes: z-values in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Observations are clustered by program-occupation.

Occupation and entry-year dummies are included in all regressions but not reported.

Marginal changes are calculated for eight year change age; one-year change in education; four percentage point change in female and minority shares; one percentage point change in unemployment rate; and 10 apprentices in program size.

Marginal effects are calculated for the hypothetical apprentice as described in notes to Table 2A.

Table 3A: Durations of Completed Apprenticeships

	Union	Nonunion	<i>Across-sponsor gaps</i>
Raw durations of completion and gaps (days)			
White men	1,721	1,575	-8.5%
White women	1,772	1,679	-5.3
Minority men	1,733	1,603	-7.5
<i>Within sponsor gaps</i>			
Gender gap	3.0%	6.6%	
Minority gap	0.7%	1.8	
Adjusted durations of completion and gaps (days)			
White men	1,752	1,561	-10.9%
	[1,705-1,800]	[1,525-1,597]	
White women	1,660	1,586	-4.5
	[1,586-1,737]	[1,519-1,656]	
Minority men	1,775	1,592	-10.3
	[1,707-1,846]	[1,541-1,646]	
<i>Within sponsor gaps</i>			
Gender gap	-5.2%	1.6%	
Minority gap	1.3	2.0	

Notes:

Within-sponsor gap_i=(Duration_i-Duration_{white men})/Duration_{white men}, where i=white women, minority men.

Across-sponsor gap_i=(Duration_{i,Nonunion}-Duration_{i,Union})/Duration_{i,Union}, where i=white men, white women, minority men.

Adjusted durations of completion are based on OLS estimations of the time to graduate (see Table 3B). The 95% confidence intervals are reported in brackets.

The hypothetical apprentice used in calculation of adjusted durations is described in the notes to Table 2A.

Table 3B: Determinants of Duration to Completion of Training – OLS Estimates
 Dependent variable: ln(Days to complete the requirements and graduate)

	White Men	White Women	Minority Men
ln(Age)	0.010 (1.07)	-0.029 (0.77)	0.085 (1.85)*
ln(Education)	-0.039 (1.88)*	-0.057 (0.90)	-0.156 (1.96)*
Trade-schooled	-0.001 (0.18)	0.012 (0.55)	-0.015 (0.71)
Veteran	-0.012 (2.55)**	-0.017 (0.29)	-0.020 (0.98)
Nonunion program	-0.116 (7.07)***	-0.046 (2.04)*	-0.109 (5.29)***
Mixed program	-0.022 (0.87)	-0.233 (3.70)***	-0.005 (0.08)
Female share in program	-0.002 (1.22)	0.008 (2.02)*	-0.004 (1.71)*
Minority share in program	0.001 (0.50)	-0.011 (2.20)**	0.000 (0.49)
ln(Program size)	0.002 (0.31)	-0.000 (0.01)	-0.008 (0.78)
Portland resident	-0.002 (0.20)	0.023 (1.53)	0.026 (1.72)*
Unemployment rate	0.081 (2.64)***	0.180 (2.39)**	-0.111 (1.35)
Non-construction	-0.147 (3.48)***	0.200 (5.78)***	-0.130 (1.81)*
Constant	7.299 (364.13)***	7.196 (126.44)***	7.377 (235.45)***
Observations	4,935	177	342
R-squared	0.27	0.37	0.29

Notes: t-values in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Observations are clustered by program-occupation.

Occupation and entry-year dummies are included in all regressions but not reported.

Units of measurement of variables are reported in notes to Table 2B.

Table 4A: Completed OJT Hours by Apprentices Who Dropped Out

	Union	Nonunion	<i>Across-sponsor gaps</i>
Raw OJT credit hours and gaps			
White men	2,470 (645)	2,359 (653)	-1.4%
White women	2,198 (703)	1,809 (700)	-4.9
Minority men	2,344 (664)	2,085 (636)	-3.2
<i>Within sponsor gaps</i>			
Gender gap	-3.4%	-6.9%	
Minority gap	-1.6	-3.4	
Adjusted OJT credit hours and gaps			
White men	2,429 (547) [2,257-2,608]	2,238 (516) [2,034-2,454]	-2.4%
White women	1,377 (526) [1,038-1,799]	1,142 (536) [886-1,458]	-2.9
Minority men	2,341 (530) [1,662-3,185]	2,121 (526) [1,589-2,754]	-2.8
<i>Within sponsor gaps</i>			
Gender gap	-13.2%	-13.7%	
Minority gap	-1.1	-1.5	

Notes:

Within-sponsor $gap_i = (\text{Hours}_i - \text{Hours}_{\text{white men}}) / 8000$, where $i = \text{white women, minority men}$.

Across-sponsor $gap_i = (\text{Hours}_{i, \text{Nonunion}} - \text{Hours}_{i, \text{Union}}) / 8000$, where $i = \text{white men, white women, minority men}$.

Numbers in parentheses are the actual (in the upper panel) and predicted (in the lower panel) durations (in days) between the entry to the exit dates.

Adjusted OJT credit hours are based on flogit estimations (see Table 4B) of the fraction of completion requirements credited prior to cancellation. 95% confidence intervals are reported in brackets.

The hypothetical apprentice used in calculation of adjusted OJT credit hours is described in the notes to Table 2A.

**Table 4B: Marginal Effects on Training Quantity of Apprentices Who Dropped Out
Flogit Estimates**

Dependent variable: (OJT credit hours of cancelled apprentices)/8000 hours.

	White Men	White Women	Minority Men
Age	0.005 (0.12)	0.108 (1.37)	0.132 (1.02)
Age-squared	0.001 (0.22)	-0.012 (1.19)	-0.020 (1.31)
Education	0.052 (1.75)*	0.019 (0.31)	0.125 (1.36)
Education-squared	-0.002 (1.79)*	-0.001 (0.29)	-0.005 (1.25)
Trade-schooled	5.0E(-4) (0.03)	-0.050 (2.06)**	-0.039 (0.99)
Veteran	-0.014 (1.19)	0.075 (0.89)	-0.028 (0.91)
Nonunion program	-0.024 (1.92)*	-0.029 (1.20)	-0.027 (0.56)
Mixed program	-0.018 (0.65)	-0.129 (3.95)***	0.328 (2.03)**
Female share in program	0.001 (0.15)	0.036 (4.05)***	0.009 (0.55)
Minority share in program	-0.005 (1.00)	-0.050 (2.98)***	0.008 (0.66)
Program size	0.001 (2.53)**	0.001 (1.37)	6.4E(-5) (0.05)
Portland resident	-0.003 (0.39)	0.050 (1.58)	-0.062 (3.00)***
Unemployment	0.087 (3.05)***	0.046 (0.95)	0.196 (4.16)***
Non-construction	0.135 (2.75)***	0.700 (22.23)***	-0.017 (0.13)
Observations	2,222	173	248

Notes: t-values in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Observations are clustered by program-occupation.

Occupation and entry-year dummies are included in all regressions but not reported.

Marginal effects are calculated for the hypothetical apprentice described in notes to Table 2A.

Units of measurement of variables are reported in notes to Table 2B.

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