THE HAZARDS OF TRAINING: ATTRITION AND RETENTION IN CONSTRUCTION INDUSTRY APPRENTICESHIP PROGRAMS

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Apprenticeship programs in the United States, which provide workers with the broad-based skills required for practicing a trade via on-the-job training, are sponsored either unilaterally by employers or jointly by employers and trade unions. A comparison of the attrition and retention rates in these programs shows that program completion is more likely for apprentices in joint programs than for similar apprentices in unilateral programs. Rates of completion are lower for women than for men, and lower for ethnic and racial minorities than for whites. Apprenticeship duration rises with the unemployment rate.

Apprenticeship combines employment and training in a formal framework whereby a worker acquires broad-based skills required for practicing a trade via on-the-job training. The cost of training is shared by employers, who allocate resources to training, and apprentices, who accept low wages during training. Employers recoup their costs in the later stages of training when apprentices become more proficient in the trade, and apprentices receive returns to their investment over their lifetime of high-skill, high-wage work.

Academicians, policy-makers, and industry watchers have often viewed apprenticeship as an efficient training method that alleviates credit constraints faced by new entrants to the labor force. In order for the system to be workable, it is necessary for apprentices not to quit training before employers receive a positive return on their investment, and for employers not to treat apprenticeship as a source of cheap labor and fail to deliver the promised training. In light of these observations, the fact that less than half of the registered apprentices in the United States complete training may be a cause for concern. If the high rate of attrition is symptomatic of unfulfilled expectations of suppliers or demanders of training, the consequent disincentives could result in a socially suboptimal stock of skilled labor.

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At present there is no information on the post-training labor market experience of apprentices in the United States or the reasons for noncompletion of training by some apprentices. There do exist nationwide data, however, that permit an exploration of how the characteristics of apprentices and apprenticeship programs are related to the likelihood that a participant will complete the program. The dataset, collected by the Bureau of Apprenticeship Training of the Department of Labor, provides information on each apprentice's status by the last date of data collection and, in cases of cancellation or completion, the date of the exit. In this article, I employ survival analysis techniques to estimate the impact of individual and training program–level factors on the duration and type of training, conditional on the exit type, for a sample of workers who started training in 1989.

A program-specific explanatory variable of special interest in this study is trade union involvement in training. A unique feature of U.S. registered apprenticeship programs is the co-existence of unilateral employer-sponsored programs and joint union-management-sponsored programs. In the latter programs, training is organized under the aegis of the collective bargaining agreement and the apprentice is indentured to a union-employer joint apprenticeship program. Trade unions have an active role in determining the curriculum and requirements, admitting apprentices, locating training jobs, assigning apprentices to experienced journey workers for on-the-job training, and monitoring their progress. While the trade union is frequently included as an explanatory variable in regressions of the incidence of training, its impact on apprenticeship has attracted little attention in the empirical literature. This article presents a dedicated comparative analysis of completion and cancellation rates in apprenticeship programs organized with and without the participation of trade unions.

A second variable of interest is the unemployment rate. There has been some debate concerning the relationship between the level of economic activity and completion and cancellation rates in apprenticeship programs, but the issue remains unresolved theoretically and empirically. I address this question empirically by estimating the impact of the annual state unemployment rate on the completion and cancellation hazards over the tenure of an apprentice.

Also examined in this paper is the participation of women and ethnic/racial minorities, relative to men and whites, respectively, in skilled trades training programs—a subject of lively debate since the days of the Civil Rights Movement and the legislative changes associated with it.

Apprenticeship Programs in the Construction Industry

The essence of the apprenticeship system is that the worker is indentured to an employer for a predetermined period of time during which he or she learns a wide range of skills required in a trade and agrees to work for low wages. Historically, this arrangement has achieved efficiency in the acquisition and provision of training by eliminating liquidity constraints for workers, both by shifting the training costs to the firm and by giving workers access to jobs and allowing them to earn training wages. Firms recoup training costs they incur in the later years of apprenticeship through the increased productivity of the trainees. In the past, when such arrangements have been incentive-incompatible, the system has required socially or legally enforceable mechanisms—legally binding indenture agreements, certification requirements for entry into jobs, or sanctions imposed by trade unions on quitters and by the employer associations on poachers, for example—to ensure that the firm would not fail to deliver the promised training and the apprentice would not quit before the end of the indenture period.

In the United States, these mechanisms have been historically either weak or absent, and apprenticeship has played a much smaller role in the training of the crafts labor force than it has in European countries (Gospel 1994; Elbaum 1995). A very high rate of apprentice desertion was the major reason for the decline of apprenticeship in the United States in the nineteenth century. Apprenticeship survived on a significant scale in the construction trades, which are traditionally crafts-based and more heavily unionized than other occupations. In 1990, the last year for which cumulative figures are available, the GAO estimated that there were 283,000 apprentices in civilian programs, about 65% of whom were training in the construction industry. Researchers and industry watchers agree that even in this industry, the majority of the workers, especially in the open-shop sector, receive training informally on an ad hoc basis.[1]

While less structured forms of training (such as helpers, task-training, cross-training, and modular training) and informal "catch-as-catch-can" training continue to be the primary routes for entry into the construction trades, it is widely recognized that the maintenance of a core of highly skilled workers is critical for the industry, and formal training is the best method to train these craftspeople. The Business Roundtable, voicing the concerns of the large industrial construction owners, for instance, has commended union-management apprenticeship programs and called for expansion of formal training across the whole industry as the means to alleviate its chronic skills shortage, improve the quality of construction, reduce cost overruns, and prevent schedule delays (Business Roundtable 1997).

Apprenticeship programs that agree to meet the federal standards register either with the Bureau of Apprenticeship Training (BAT) of the Department of Labor or the BAT-recognized State Apprenticeship Councils (SACs). These programs are organized either jointly by trade unions and employers signatory to a collective bargaining agreement in the organized sector, or unilaterally by employers in the open-shop sector.

In the organized sector of the construction industry, training provisions have historically been a component of the collective bargaining agreements. The collective bargaining agreement specifies the role and responsibilities of union and management in the administration of the apprenticeship program, per-labor-hour training fees paid by the employers, apprentice-journey worker ratios, and apprentice wages. The joint apprenticeship committee, composed of representatives of unions and employers (in equal numbers), determines the requirements, curriculum, and admissions, and monitors the progress of apprentices. The apprenticeship coordinator, who is a union member, carries out the day-to-day management of the program. This setup provides an institutional framework that distributes costs and risks of training among the stakeholders in training, coordinates their activities, and enforces the training "contract."

Apprenticeship training, in Becker's terms, delivers "general" skills. The key to the returns to contractors on investment in training is transformation of what are general skills from the perspective of an individual firm to skills that are specific to the local industry; in effect, contractors pay not for the training of a specific worker, but for the maintenance of a steady supply of similarly trained workers.[2] Apprentices covered by the collective bargaining agree-

[1]Construction industry employment increased on average by about 160,000 per year between 1990 and 2000 (Berman 2001). According to the data used in the present paper, during the first five years of this period the average number of workers entering apprenticeship was not more than 40,000 per year (and many of them dropped out before completing training). Two early surveys, which used different samples of trades, found that 49% (Marshall and Glover 1975) and 37% (Silver 1986) of union workers entered construction trades via apprenticeship.

[2]An additional incentive for employers is the fact that registered apprentices are paid below the government-mandated wage in federal and state projects subject to the prevailing wage laws.

ment can make use of union grievance procedures and collective bargaining rights in order to ensure proper job rotation and acquisition of requisite skills. Finally, trade unions have a stake in training because it allows control over the quality of labor and helps protect jurisdictional boundaries between trades.[3]

In the open-shop sector of the construction industry, apprenticeship programs are established unilaterally either by a group of employers or by a single employer. Multiple employer non-joint programs can be viewed as an attempt to create a structure similar to that of the joint programs whereby the costs and risks of employer investment in training are distributed across participants. Thus, these programs may also mitigate under-investment in training by eliminating the distinction between the current and future employers and internalizing the externalities that would be enjoyed by the third parties. They are usually organized under the leadership of a contractor association and financed collectively by the participating employers. Single-employer non-joint programs, on the other hand, are a highly diverse set, including a great many programs with very few trainees (often a single one) and a few large programs with new enrollments as high as several hundred.[4]

Apprenticeship training is highly structured. Apprentices who enroll in registered programs follow a curriculum to acquire manual, mechanical, and technical skills for the trade and are certified as skilled journey workers only upon the successful completion of a predetermined number of hours of supervised on-the-job training (OJT) and related theoretical instruction in the classroom (RTI). Programs in construction occupations generally have 6,000 hours of OJT and 432 hours of RTI, or 8,000 hours of OJT and 576 hours of RTI requirements. These are often referred to as three- and four-year programs, respectively, since an apprentice working 40 hours a week and 50 weeks a year would complete 2,000 hours of OJT in a year. The actual time to completion, however, often differs from these term lengths. Duration of apprenticeship may lengthen due to the unavailability of training jobs or temporary separation of the apprentice from training for any other reason. Completion of the program in a shorter time is also possible if the apprentice works overtime or receives OJT credit hours for prior experience. Regulations also allow an apprentice with outstanding aptitude and practical experience to be put on a fast track at the program sponsor's discretion.

Data

The data for the empirical analysis come from the Apprenticeship Information Management Systems (AIMS) compiled by the BAT. This database, the most comprehensive one on apprenticeship training in the United States, provides apprentice-level information on demographic characteristics, occupation, industry, program type, apprenticeship start and exit dates, type of exit (completion or cancellation), and the apprentice's status as of November 30, 1995 (the last date for which data are available) for about 70% of all registered apprentices. Not all states report to the system, and the 14 states (and Washington, D.C.) that do not participate fully in the BAT/AIMS database are not included in the analysis.[5]

For the purposes of this study, I first identified the five largest occupations (measured in terms of the total number of apprentices enrolled) in the construction in-

[3]Mills (1972:189) argued that the frequently mentioned labor supply control motive is an unimportant factor because only a minority of workers enter the trades via apprenticeship and therefore it cannot be an effective tool for this purpose.

[4]For further information on training programs, see Mills (1972), Northrup and Foster (1975), Bourdon and Levitt (1980), and Business Roundtable (1990).

[5]These states are California, Connecticut, Delaware, Hawaii, Louisiana, Maryland, North Carolina, New Hampshire, New York, Oregon, Virginia, Vermont, Washington, and Wisconsin.

Table 1. Exit Status and Duration by Program Sponsor Type.

Description	*All Programs*	*Joint Programs*	*Non-Joint Programs*
Number of apprentices	12,715	7,764	4,951
% Canceled	38.8	30.5	51.8
% Completed	47.4	58.4	30.2
% Still Active	13.8	11.1	18.0
Mean Duration (in months)			
Exit by Cancellation	26.9	27.3	26.5
Exit by Completion	49.1	51.1	43.0

Source: BAT/AIMS.

dustry—carpenters, electricians, pipefitters, plumbers, and sheetmetal workers. Second, I deleted the small number of apprentices who were not enrolled in programs with 8,000 hours of OJT and 576 hours of RTI, which is the norm in these occupations. Finally, I selected apprentices enrolled in the calendar year 1989 in order to minimize the number of apprentices still in training by the last date of data recording.

After clean-up of the data and deletion of observations with missing values, the sample included 12,715 apprentices (Table 1). The majority of the apprentices (61%) were trained in joint programs. Table 1 also presents information on the exit status of apprentices. According to these figures, 39% of all apprentices graduated, 47% canceled, and the remainder were still in training (right-censored).[6] There are, however, important variations between the sponsor types. The percentage of completions is higher by a substantial margin in the joint programs than in the non-joint programs (58% versus 30%). Symmetrically, relative to the non-joint program apprentices, a smaller fraction of joint program apprentices canceled.[7]

In addition to the program sponsor type, the BAT/AIMS dataset provides information on various factors that may influence the attrition and retention rates: the apprentice's age at induction, gender, ethnic/racial origin, veteran status, and OJT credits received at the time of entry into training. While the program size in terms of the total number of apprentices in training is not available, the number of new apprentices entering each program in 1989 may be used as a proxy for this variable. I expanded this set of potential explanatory variables by adding the state occupational licensing requirement and state construction industry unemployment rate. Table 2 reports the mean values and standard deviations of these variables by program type and data sources.

Attrition and Retention Rates

The lower panel of Table 1 reports the mean values of the duration of canceled

[6]The category of cancellation warrants some explanation. The data recorded an apprentice's exit status as cancellation for a variety of reasons, including quitting, being laid off, being fired for disciplinary action, injury or death, transfer to another program, closure of the training program, or correction of clerical errors. Information on the cause of cancellation is given for only a fraction of the apprentices, and these remarks are often ambiguous. Nevertheless, cancellations due to transfers to another program or the closure of the training program can be identified from the data. Similarly, cancellations that occur within the first week of apprenticeship appear to be attributable primarily to clerical errors. These cases, which constitute less than 2% of all cancellations, are excluded from the following analysis.

[7]These cancellation rates are substantially higher than those observed in Western Europe. Cheallaigh (1995) reported that 21% apprentices in the European Union countries left training without qualification.

Table 2. Descriptive Statistics.

	Means (Standard Deviations)		
Variable	*All Programs*	*Joint Programs*	*Non-Joint Programs*[a]
Apprentice of Color (%)	14.6	15.8	12.7
Female Apprentice (%)	3.5	4.5	1.8
Veteran Apprentice (%)	10.8	9.6	12.6
Age at Induction	24.8	24.6	25.3
	(5.4)	(5.1)	(5.7)
OJT Credit	28.4	21.2	39.7
	(292.8)	(224.2)	(375.7)
Program Size	10.1	19.3	5.8
	(26.5)	(38.4)	(16.7)
Licensed Occupation[b] (%)	17.9	13.6	24.7
State Unemployment Rate[c] (%)	12.2	12.4	11.9
	(2.3)	(2.3)	(2.2)

Source: BAT/AIMS, except for Licensed occupation (Bianco 1993) and State unemployment rate (CPS Outgoing Rotation Files 1989–1995).

[a]The test for equality of means between joint and non-joint programs is rejected at the 1% level for each variable.

[b]Weighted by the number of apprentices.

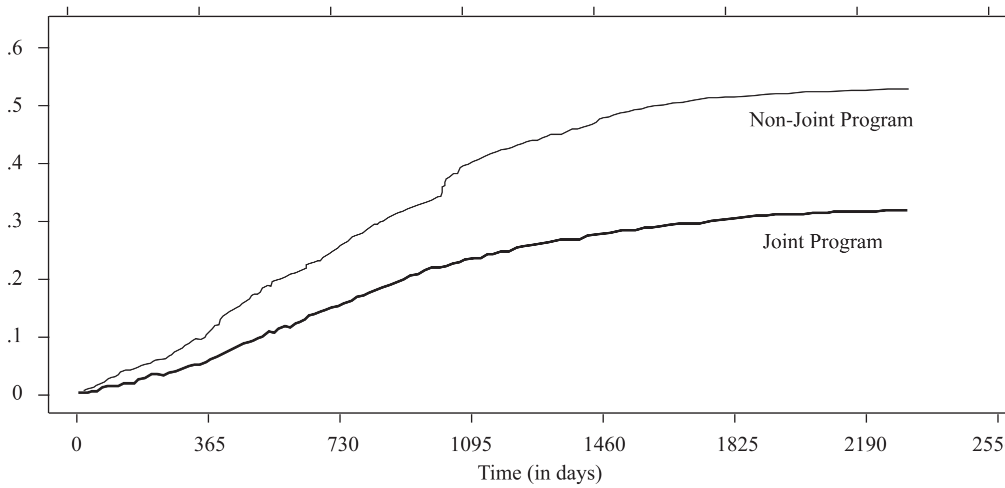
[c]The mean of annual construction industry unemployment rates over the 1989–95 period, weighted by the number of apprentices.

and completed apprenticeships. The average duration of a canceled apprenticeship was about 27 months. This period was longer among joint program apprentices than among non-joint program apprentices only by two-thirds of a month. The mean length of completed apprenticeship was 49 months. Non-joint program apprentices, on average, completed training eight months earlier than joint program apprentices.

Figures 1 and 2 plot the cumulative incidence (CI) rates of cancellation and completion over time in joint and non-joint programs. These are the cumulative probabilities of exit via each competing risk.[8] Before considering the differences between the program types, however, note the unexpected shape of the completion plots. Completion of a program with an 8,000-hour OJT requirement takes four years under the assumption of continuous employment, which implies that the probability of completion is zero during the first four years. However, the data include a substantial number of observations with completion durations that are shorter than four years. These observations are attributable, in part, to the OJT credit hours granted to workers with previous experience in the trade. As observed in Table 2, while the number of credit hours is very low on average (less than 1% of the requirement), for some workers it can be substantial and can

[8]In the competing risks framework, the CI rate is the counterpart to the ordinary exit probability, defined as one minus the Kaplan-Meier (KM) product limit estimator. Each CI rate is based on an overall survival function estimate that combines the cancellation and completion hazards. The more familiar KM estimator or the associated exit probability assumes a single cause of failure and therefore is inappropriate in the context of competing risks. For instance, in the presence of the completion risk, the KM estimator underestimates the instantaneous risk of exit via cancellation by censoring completions (or 1-KM overestimates the probability of exit via cancellation). For the derivation of the non-parametric CI plots of Figures 1 and 2, as well as the regression-based estimates of the CI rates discussed in the next section, see Kalbfleisch and Prentice (1980:168–70).

Figure 1. Cumulative Incidence of Cancellation.



Source: BAT/AIMS.

appreciably reduce the completion period. In order to factor OJT credit hours into the duration, I converted these to days at the rate of eight hours per day and added them to the duration of the apprenticeship prior to the calculation of the CI rates. Figure 2 shows, however, that even after this adjustment there remain many "early" completions. These early completions—which may be attributed to overtime work, advancement at a faster pace due to outstanding aptitude, recording errors in data, or some combination thereof—necessitate further modifications in the estimation process presented in the next section.

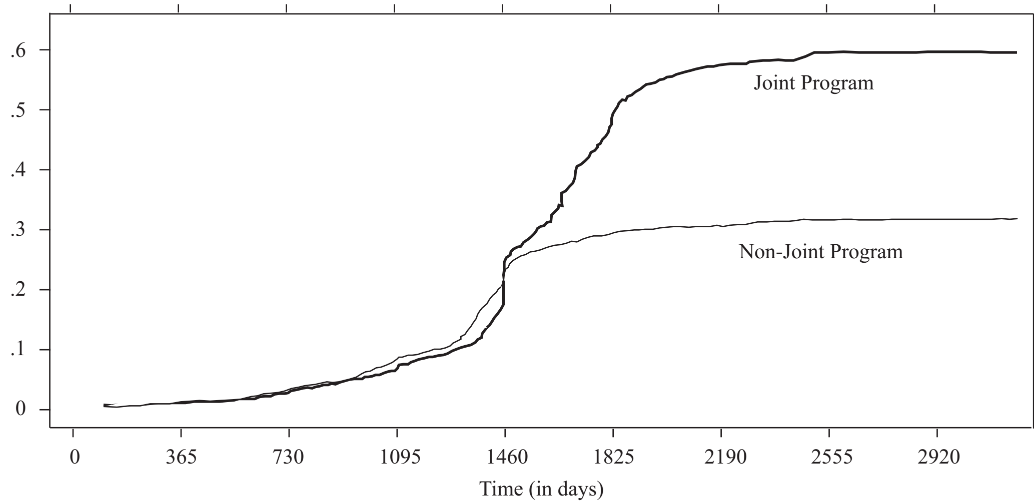
Figures 1 and 2 suggest that there are important differences between the joint and non-joint programs in cancellation and completion rates. The cumulative probability of cancellation in non-joint programs is uniformly higher than that in joint programs (Figure 1). In both types of programs, it rises fastest during the second and third years of apprenticeship and levels off after the end of the fourth year, to around 30% in the joint programs and 50% in the non-joint programs.

According to Figure 2, the cumulative probabilities of completion between the programs are quite close until the end of the fourth year but diverge afterward. The completion probability of non-joint program apprentices is initially higher, and the margin is at its widest, by as much as five percentage points, during the second half of the fourth year. Almost one-half of the non-joint program completions take place during the latter period. Relatively few non-joint program apprentices graduate in the fifth year, after which hardly any apprentices complete the program. The cumulative completion probability of joint programs surpasses what is observed in the non-joint programs by much higher margins after the end of the fourth year, reaching a level almost twice as high by the eighth year.[9] The largest number of joint program completions occurs around the end of the fourth year and during the fifth year of training.

These differences in completion and cancellation behavior may be attributable to differences in apprentice-specific char-

[9]The completion probability plot goes beyond the seven-year time horizon of this study because of the addition of OJT credit hours into the completion duration.

Figure 2. Cumulative Incidence of Completion.



Source: BAT/AIMS.

acteristics, or the distribution of program types across occupations or labor markets. Indeed, Table 2 reports statistically significant differences between joint and non-joint programs in the mean values of these variables. Shares of minorities and women, for instance, are significantly higher in the joint programs. If these groups are also less likely than white men to complete training, then the completion differentials reported in Table 1 and Figure 2 will understate the joint program effect. Hence, it is necessary to control for these variables in assessing the impact of program type on the completion and cancellation rates through multivariate analysis.

Competing Risks Estimates of Completion and Cancellation Hazards

In this section, I estimate the impact of program sponsorship on the completion and cancellation rates using the Cox proportional hazard model in a competing risks framework. This popular model provides easily interpretable estimates of the impact of explanatory variables on the span of time that elapses between the entry into apprenticeship and the exit. Explanatory variables are assumed to affect an unspecified hazard function multiplicatively: estimated coefficients measure the impact on the relative risk of exit, while the underlying hazard function is left unchanged. Thus, the proportional impact of an explanatory variable on the conditional probability of exit is assumed not to depend on duration.

As mentioned in the previous section, I adjusted the duration of apprenticeship by converting the OJT credits to days and adding it to the observed period. There is, however, an additional complication concerning the measurement of the apprenticeship period, because a certain minimum period of training must go by before the completion hazard becomes positive. Kalbfleisch and Prentice (1980:30) suggested that when it is known that the exit cannot occur before a specific length of time, this information should be incorporated into modeling by subtracting the known threshold from the observed duration. The obvious candidate for this threshold is four years. Assuming that the apprentice works continuously at the rate of eight hours a day, the completion hazard should be zero during the first four years. This four-year threshold for completion hazard,

Table 3. Cox Regression Competing Risks Estimates of Completion and Cancellation Rates.[a]

	Cancellation		*Completion*[b]	
Variable	β	*z-value*	β	*z-value*
Joint Program	–0.72***	19.57	0.38***	10.44
Woman Apprentice	0.15*	1.92	–0.31***	4.62
Apprentice of Color	0.12***	3.08	–0.39***	9.47
Veteran Apprentice	0.05	1.05	–0.09*	1.89
Age at Induction	–0.03	1.62	0.02	1.14
Age at Induction-Squared/100	0.05	1.39	–0.00	1.08
Ln(Program Size)	–0.06***	5.27	0.08***	7.66
Licensed Occupation	0.11**	2.56	–0.06	1.23
State Unemployment Rate[c]	–0.22***	7.71	–0.58***	22.30
Log Likelihood	–29,341		–34,742	
Number of Events	4,932		5,774	
N		12,460		

Source: BAT/AIMS, except for Licensed occupation (Bianco 1993) and State unemployment rate (CPS Outgoing Rotation Files 1989–1995).

[a]Stratified by occupation and geographic region.

[b]Completion hazard is assumed to be zero during the first two years of apprenticeship.

[c]Time-varying covariate.

*Statistically significant at the .10 level; **at the .05 level; ***at the .01 level.

however, is too stringent, because, as mentioned above, early graduation is possible through overtime work or fast-track training. Unfortunately, no information is available on either of these factors, and therefore it is not clear after which period the completion hazard becomes positive. As a compromise between no threshold and the four-year threshold of completion, I carried out the estimation under three alternatives: one-year (365-day), two-year (730-day), and three-year (1,095-day) thresholds.[10]

Explanatory variables are the program sponsor type (= 1 if joint), the apprentice's gender (= 1 if woman), ethnicity/race (= 1 if apprentice of color), veteran status (= 1 if veteran), age at induction (in quadratic form), program size (in logarithm), state occupational licensing requirement (= 1 if licensing is required), and the annual state construction sector unemployment rate. Unemployment rate is a discrete time-varying covariate measured annually over the duration of apprenticeship. It is measured in five percentage point units. Continuous variables (age, program size, and unemployment rate) are measured as deviations from their mean values. Finally, regressions are stratified by four geographic regions (following the U.S. Bureau of Census classification) and five occupations, which allows baseline functions specific to each of the 20 strata but restricts regression coefficients to be equal across groups.

In estimations reported in Table 3, the completion threshold is set at 730 days. Reported estimates confirm that there are statistically significant differences between the joint and non-joint programs in terms of the cancellation and completion rates of apprentices even after controls for other variables are included. The cancellation hazard is smaller in the joint programs than in the non-joint programs. Symmetrically, the completion hazard is higher in the joint programs, although by a smaller margin. These results are consistent with the bivariate findings reported in Table 2.

In order to gauge the magnitude of the

[10]Adoption of the four-year threshold would have led to the deletion of 2,369 apprentices who completed training at a shorter period of time. One-year, two-year, and three-year thresholds reduced observations by 43, 255, and 786, respectively.

Table 4. Percentage Point Differences between the Cumulative Incidence (CI) Rates of Joint and Non-joint Programs.

	Electricians—South		*Electrician—North*	
End of Year:	*Cancellation*	*Completion*	*Cancellation*	*Completion*
1	–5.6	—	–1.5	—
2	–12.7	—	–8.6	—
3	–19.8	1.3	–14.8	2.2
4	–22.1	6.1	–23.0	7.8
5	–22.8	13.8	–26.5	21.9
6	–23.1	15.9	–27.1	25.7
N	980	723	1,114	383

Notes: The differential is CI(joint program) – CI(non-joint program). CI rates are calculated using estimates from Table 3 under the assumptions that the apprentice is white, male, and non-veteran, occupation is unlicensed, and all continuous variables are at their mean values.

sponsorship effect, I estimated the CI rates for joint and non-joint programs (assuming that the apprentice is white, non-veteran, and male, the occupation is unlicensed, and all continuous variables are at their mean values). Full reporting of these estimates is unwieldy, since there are 20 strata by region and occupation. For illustrative purposes, differences in CI rates between the joint and non-joint programs at yearly intervals are reported in Table 4 for the two largest groups of apprentices—electricians in the South (N = 2,334) and the North (N = 1,594).

The first column of the table shows that the cumulative probability of cancellation in the joint programs is lower by 5.6 percentage points at the end of the first year and by 12.7 points at the end of the second year. The cancellation rate differentials increase rapidly until the end of the fourth year and stabilize afterward at a level exceeding 20 percentage points. Overall, the non-joint program apprentices are roughly twice as likely to cancel. In the case of completions, the differentials show a similar pattern, with a slight difference in timing. Initially the completion rate is higher in joint programs than in non-joint programs by a small margin. After the middle of the fourth year, the differential begins to widen as the joint program completion rate progressively exceeds the non-joint completion rate. After the beginning of the sixth year, the completion rates even out and the differential stabilizes at around 16 percentage points for the southern and 26 percentage points for the northern electrician apprentices.[11]

While these estimates demonstrate that there is a statistically significant difference

[11]The estimate of the completion hazard should be interpreted with caution. Under the assumption of proportionality, the hazard of exit in joint programs is a constant multiple of that in non-joint programs. This assumption fared well in the cancellation regressions. Intersecting CI curves of Figure 2 suggest, however, that proportionality is suspect in the case of exit via completion. Further tests also rejected the hypothesis of proportionality of the program effect in the completion regression. To address this issue, I experimented by including a joint program-time interaction variable that permitted the impact of the sponsorship dummy to change over time. This estimation showed that the effect of joint programs on the completion rate is positive until about the beginning of the fifth year of training and is negative thereafter. The estimated CI of completion again is higher in joint programs than in non-joint programs, but the differentials were implausibly higher than those reported in Table 4 (by a factor exceeding four in the first two years), shedding doubt on the appropriateness of this specification. According to Allison (1984), given the generality of the model, the violation of the proportionality assumption may not be of great concern. Allison suggested that where the proportionality hypothesis is rejected, the estimates should be interpreted only as the *average* effect over the period considered.

in exit rates between joint and non-joint programs, they do not give any information about the process through which apprentices eventually complete or quit training. Furthermore, they are compatible with competing explanations. The decision to cancel or complete an apprenticeship can be conceptualized in terms of the cost-benefit analysis. Cancellation, as the outcome of a voluntary quit decision, is predicted to take place when the opportunity cost of training on the margin exceeds expected discounted returns to additional training. One hypothesis that is consistent with the observed completion and cancellation rates reported above is that the marginal benefit-cost differential is higher for union apprentices than it is for non-union workers due to union rules. If union workers are required to complete apprenticeship and receive certification in order to qualify for journey-level wages and benefits while open-shop apprentices are less likely to be bound by such rules, then the latter are expected to be more responsive to outside job offers that may materialize prior to the completion of training and more likely to quit.

One fact that weakens the force of this hypothesis is that apprenticeship is not an exclusive port of entry into trades for union workers either. A worker can get a union card without any apprenticeship training if he or she has the necessary skills to practice the trade. It is also the case that a union apprentice can take journey-worker exams without completing apprenticeship.[12] An alternative hypothesis is that voluntary quits are attributable to the apprentice's discontent with the occupation or the training program. Incoming apprentices are more likely to quit if they are not properly informed, selected, or matched with the occupation, or if they are dissatisfied with the quality or quantity of skills delivered by the program.[13] The higher cancellation rate could then be the outcome of a program's inability to inform candidate apprentices about the nature of the occupation and the training program, to supply higher-quality training by access to more job sites and better job rotation, to pair apprentices with qualified journey-level workers, to arrange in-class instruction, or to ensure that apprentices are not exploited as cheap labor. Joint programs may be better suited to perform these functions due to multi-employer collective bargaining and the trade union operating as an institution to collect and disseminate information and to look after the interests of apprentices.

One early study based on a survey of 190 apprentices in Wisconsin concluded that cancellations in non-construction occupations are attributable to dissatisfaction with the employer. In the construction trades, in contrast, it was found that apprentices quit primarily either for personal reasons ("changing one's mind about working in the apprenticeship job") or to find a job "as good as they would have found had they completed the program" (Barocci 1972:171). There are, however, no recent studies on the reasons for leaving apprenticeship programs. The paucity of informa-

[12]One may also anticipate that the likelihood of quitting will vary positively with the outside wage relative to the apprenticeship wage. According to the U.S. national apprenticeship guidelines, the apprenticeship wage should start at 50% of the journey-worker wage and increase gradually over the period of training, reaching 90% by the last six months. Collective bargaining agreements often specify apprenticeship wages that conform with the national guidelines, but I do not have any information showing whether joint and non-joint programs differ in their degree of compliance with the national guidelines. In any case, the opportunity cost of continuing training for more advanced apprentices does not appear to be very large in the United States. By way of comparison, in Germany, where the dropout rate is only 15%, the final year apprentice wage is about 30% of the unskilled wage (Soskice 1994:41; Cheallaigh 1995). Even taking into account that the apprenticeship entry age in Germany is much lower (16–19 years) than in the United States, and that many apprentices in Germany live with their parents during training, the difference is substantial.

[13]This hypothesis assumes that prior to entry an apprentice has incomplete or imperfect information about the nature of the occupation and the quality of the program.

tion on post-apprenticeship wages and careers makes it difficult to evaluate the relative usefulness of these hypotheses for explaining the observed differences between joint and non-joint programs in completion and cancellation rates.

Another interesting finding concerns the impact of the business cycle. Farber (1967) hypothesized that apprentices respond to lower rates of unemployment by quitting training and taking semi-skilled jobs that pay higher than the apprenticeship wage, and he offered bivariate statistical evidence on the counter-cyclical behavior of completion rates. Others have been skeptical of this argument on the grounds that apprenticeship is a long-term investment decision unlikely to be influenced by short-term fluctuations (Belitsky 1967), and that statistical support is insufficient (Mills 1972:224). Estimates reported in Table 3 show that the unemployment rate has statistically significant negative effects on the completion and cancellation hazards, and indicate that the relationship is more complex than suggested by Farber. Specifically, a unit (five-percentage point) increase in the construction industry unemployment rate causes the CI of cancellation and completion to decline by 5 percentage points each by the end of the fifth year of apprenticeship. Lower hazards of both outcomes imply that the duration of apprenticeship rises with the unemployment rate. The pro-cyclical behavior of the cancellation rate is consistent with the idea that cancellations are voluntary quits rather than an outcome of layoffs. During periods of expansion and labor shortage, it appears that apprentices with adequate skills receive better outside job offers and leave training. The impact on the completion hazard, on the other hand, indicates that training jobs also become more available during the upswing, helping apprentices complete the training requirements at a faster pace.

Table 3 also shows that, relative to men, women face a lower risk of completion and, symmetrically, a higher risk of cancellation (although the latter difference is only marginally statistically significant). The experience of apprentices of color is similar to that of the women. Relative to whites, their risk of completion is lower and their risk of cancellation is higher. Both estimates are highly statistically significant.

Union-management cooperation appears to improve women's and minorities' odds of advancing in skilled trades as evidenced by the substantially higher representation of these groups in joint programs than in non-joint programs. Participating women and minorities presumably pick up valuable skills even when they do not complete the program. Still, to the extent that these groups' high rates of attrition evince their inability to successfully complete training, they may spell trouble for the demographic integration of the skilled labor force. Observers have often noted that the bond between the employer and employee is loose in the construction industry, and informal networks are vital in entering the industry and locating jobs for workers who are in constant flux between jobs and contractors. For women and minorities, who were traditionally excluded from the trades and who, despite gains made over the past three decades, may still be disadvantaged in participating in networks, formal training and certification as a journey worker may be an especially important way to establish a foothold in the industry.

Finally, a larger program size increases the completion risk and, in the case of joint programs, reduces the cancellation risk. The impact of program size on the attrition rate may be due to internal and external economies of scale. Larger programs may find it easier to organize in-class instruction, access various construction projects (presumably of different types and sizes), and find qualified journey workers to match with apprentices on the job, which would allow not only a less interrupted training experience but also better job rotation to acquaint apprentices with different aspects of the trade. These factors may increase the returns to the time spent in apprenticeship and make continuation of training more attractive.

In order to check the sensitivity of estimates to the completion threshold, regressions were re-estimated after changing the threshold to 365 and 1,095 days. These changes had a statistically significant impact on the estimated coefficients of the program sponsorship variable. With the 365-day threshold, estimated coefficients were lowered to (–0.84 in the cancellation and 0.17 in the completion regressions. In the case of the 1,095-day threshold, they rose to (–0.54 and 0.77, respectively. In terms of the CI plots, across program types, the cumulative probability of cancellation increased with the threshold while the probability of completion declined. There was no statistically significant effect, however, on the differential between the program types, which lay slightly below the figures reported in Table 4, especially after the end of the fourth year. The magnitudes of the percentage point differences between the CI rates of the joint and non-joint programs were virtually identical across all estimations. Thus, estimated rates of exit were sensitive to the threshold, but the impact of union participation in training programs was not.[14]

Conclusion

Chronically high rates of attrition in U.S. apprenticeship programs may indicate the inability of the suppliers of training to collect returns on investment, or the dissatisfaction of workers with the quality of training provided. The consequent disincentives for provision or acquisition of training have potentially serious social costs via shortages of skilled labor. These shortages are already widely observed and commented on within the construction industry. The available empirical work on the subject, however, is thin, mixed, and dated. There is little systematic evidence on the relationship between the attrition and retention rates, on the one hand, and the characteristics of apprentices and programs, on the other.

This paper adds to the knowledge base on this issue by presenting evidence from the experience of the 1989 incoming class of apprentices in the five largest construction trades. In addition to analyzing bivariate relationships, I have used the proportional hazards model in a competing risks framework to estimate the impact of an array of individual, program, occupation, and local labor market variables on the completion and cancellation hazards during the six years following the entry into training. The estimations show that apprentices in unilateral employer-only programs were roughly twice as likely to cancel out of the training program as were their peers in union-management joint programs. Apprentices in joint programs are also found to have been more likely to complete training and receive certification. Combined with the fact that more apprentices were enrolled in the joint programs than in the non-joint programs, these results suggest that joint programs made a larger contribution to the maintenance of the crafts labor force. Second, both completion and cancellation hazards varied directly with the business cycle in the construction industry, which suggests that recessions lengthen the time spent in apprenticeship and expansions shorten it. Third, relative to white and male apprentices, ethnic/racial minority and female apprentices were more likely to cancel training and less likely to complete it.

The cost-benefit framework helps interpret the observed differences in cancellation and completion rates across program types. At any point during training, it is reasonable to suppose that an apprentice will quit training when expected discounted returns to continuation fall below the costs of training, and the higher cancellation rate in employer-only programs indicates the higher incidence of this situation in these programs. Yet, it is not possible to determine definitively with the available data the underlying reasons for this outcome. The higher cancellation rate may be due to the ability of the non-joint programs to equip apprentices with skills enabling them to get good job offers prior to completion, thus creating higher opportunity costs for continuing training. Alternatively, it

[14]These results are available from the author on request.

may reflect the workers' dissatisfaction with the training or occupation, and their downward revision of the expected benefits of staying in apprenticeship. The observed outcome could also be an artifact of union rules, which require apprentices to receive certification in order to qualify for union wages and benefits. In view of this unresolved question, this paper stops short of working out implications of the observed attrition and retention rate differentials for the maintenance of an optimal stock of skilled labor force. Before drawing public policy lessons, it is necessary first to collect information on workers' post-apprenticeship experience and to discriminate among these competing explanations.

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