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Apprenticeship Program Requirements and Apprenticeship Completion Rates in Canada

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Apprenticeship Program Requirements and Apprenticeship Completion Rates in Canada*

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Abstract

Over the past two decades there has been considerable growth in the number of new apprenticeship registrations in Canada. However, this has not been matched by a corresponding increase in the number of apprenticeship completions. As a result Canadian apprenticeship programs have seen declining completion rates over this period. Across provinces, trades and time there is considerable variation in apprenticeship completion rates. In Canada apprenticeship programs are provincially regulated and there are differences in requirements across trades and provinces and, to a lesser extent, over time. Therefore, this paper asks to what extent the differences in completion rates are related to differences in the structure of apprenticeship programs, as well as differences in demographic variables and unemployment rates. Results suggest that apprenticeship programs for which certification is mandatory have completion rates that are about ten percentage points higher than those without mandatory certification. There is little evidence to support the view that either the length of the work experience term or the technical training requirement act as a barrier to completion. However, there is some evidence to suggest that the format in which technical training is delivered is related to completion rates. While the decline in completion rates during the 1990s coincided with the raising of education requirements, accounting for the trend in completion rates implies a positive relationship between these two variables across trades and provinces. On average, trades with a higher fraction of female apprentices and apprentices with a younger average age tend to have higher completion rates. Finally, in general the results are consistent with high unemployment rates acting as a barrier to completion.

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Executive Summary

In this paper I explore the relationship between apprenticeship completion rates and apprenticeship program requirements using data from 40 different trades and nine provinces over the period 1991 to 2007. The objective is to ask to what extent variation in completion rates is related to variation in apprenticeship program requirements and therefore provide information that might prove useful in the design of apprenticeship programs.

To do this I take data from the Registered Apprenticeship Information System (RAIS) for 111 trade-province combinations that cover approximately 75% of new apprenticeship registrations in Canada from 1991 to 2007. For each year and trade-province combination I then calculate a completion rate. That is, the ratio of apprenticeship completions in a given year divided by the number of lagged new apprenticeship registrations. The length of the lag is determined by the nominal duration of the program which is obtained from the Ellis Charts. Using the Ellis Charts for 1990, 1997, 1999, 2004 and 2007 and the RAIS I then collect data on variables that describe the length and structure of the apprenticeship program for each of these 111 trade-province combinations. These variables are whether or not certification is mandatory to work in the particular trade and province, the length of the work experience term of the apprenticeship program, the number of hours of technical training required to complete the program, the format of delivery for that technical training and the level of education required to enter the apprenticeship. I also collect data in the average ages of apprentices in each trade and province as well the proportion of apprentices who are female. Finally, I also collect unemployment rates for all workers in the province and those in the National Occupational Classification that covers each trade for each province. Using this data I estimate the relationship between apprenticeship completion rates and the structure of the apprenticeship program as well as the variables age, sex and unemployment rates.

In general the results reveal that apprenticeship programs for which certification is mandatory have completion rates that are about ten percentage points higher than those without mandatory certification. This suggests that a policy shift towards more mandatory certification could raise completion rates. However, if workers who have begun but not completed an apprenticeship are at least partial substitutes for qualified journeypersons then moving

to mandatory certification could exacerbate any perceived skills shortage, particularly in the short-term. There is no evidence that longer apprenticeship programs, either in terms of technical training hours or work experience hours have lower completion rates. Consequently the results do not provide an argument for shortening apprenticeship programs as a way to improve completion rates. However, the results do not speak to the question of whether a long duration discourages workers from entering a program in the first place. Some of the existing survey evidence suggests that block release can be a barrier to completion as it involves a period of income interruption. However, if anything the results in this paper find that on across province-trade combinations the delivery of technical training via block release is associated with higher completion rates than training delivered by other methods. There is some evidence that higher education requirements to enter an apprenticeship are associated with higher completion rates. However, the predicted effect is relatively modest, a one year increase in the grade of education is associated with an increase of 2 - 2.5 percentage points in the completion rate. Given this and the fact that higher education requirements may prevent some people from entering apprenticeship programs, a policy recommendation to raise education pre-requisites should be treated with caution. Overall the results are supportive of a negative relationship between the average age of apprentices in a trade and that trade's completion rate, and a positive relationship between the proportion of apprentices who are female and the completion rate. However, the parameter estimates describing these relationships are consistent with a movement towards apprentices who are younger on average and more female apprentices being associated with only a relatively modest effect on completion rates. Finally, the majority of the results using unemployment rates in this paper are consistent with most previous findings and suggest that issues of employment instability may be a problem for completions.

1 Introduction

In recent years there has been much media attention devoted to the apparent shortage of skilled trades workers in Canada. For example in 2006 the Globe and Mail reported:

> "Two-thirds of Canadian employers said they're having difficulty filling positions due to the lack of suitable talent available." (Globe and Mail 21/02/06).

In 2008 the Financial Post reported that this shortage is not likely to end soon:

> "The expectation of throngs of Baby Boomers retiring has, in part, triggered a shortage of skilled tradespeople, with the problem in many industries being so dire that any available trades are quickly being scooped up." (Financial Post 27/08/2008).

The main path into the skilled trades in Canada is through an apprenticeship program. Therefore, those concerned by the possibility of a skilled labour shortage in Canada should be at least partly comforted by the strong growth in the number of new apprenticeship registrations over the past two decades. Figure 1 shows that the total number of new apprenticeship registrations in Canada has increased from approximately 30,000 per year in the early 1990s to over 80,000 per year in 2007.[1] However, this rise in new registrations has not been matched by a corresponding increase in apprenticeship completions. Figure 1 also plots the number of completions between 1991 and 2007.[2] It shows a steady decline through the 1990s, a slight hump-shape from 1998 - 2002 and a steady increase only beginning in 2002. Even then, this upturn in completions that begins in 2002 has not kept pace with the growth in new registrations.

Needless to say, these different trends imply a decline in completion rates for apprenticeship programs in Canada. Sharpe and Gibson (2005) report that in 1982 the completion rate for all apprenticeships in Canada was around 64%, and that by 2002 it had fallen to approximately 39% (Sharpe and Gibson, p44).[3] They also report 2002 completion rates for the 25 largest apprenticeship programs. These figures show that across trades there is a fair amount of variation in completion rates with the highest completion rate being 65.8% for industrial

[1] Registered Apprenticeship Information System.

[2] Ibid.

[3] Sharpe and Gibson use two different definitions of the completion rate. Both of these involve dividing current completions by a measure of prior registrations. They obtain similar trends for both definitions.

electricians and the lowest a mere 14.5% for plasterers. (Sharpe and Gibson, appendix table 16). Similarly there is variation in completion rates across provinces. Manitoba leads the way with 62%, while Newfoundland brings up the rear with only 11% (Sharpe and Gibson p55). This variation in provincial completion rates is not merely due to differences in the composition of apprenticeship trades across provinces. There is also variation in completion rates across provinces for the same trade. For example, the completion rate in 2002 for bricklayers in Alberta was 50% while the figure for the same trade in British Columbia was only 14%.[4]

Sharpe and Gibson offer a number of reasons for low apprenticeship completion rates. These include costs to both the apprentice and the employer, poor math and literacy skills of apprentices, family commitments, employment instability and the structure of the apprenticeship program. Much of the existing evidence to support these reasons is based on survey responses. Examples of these include the Canadian Apprenticeship Forum's (2004) survey of apprenticeship training in Canada and Ménard et al's (2007) study using the National Apprenticeship Survey. The focus of this paper is the relationship between apprenticeship completion rates and the structure of apprenticeship programs. I compile data on the requirements of apprenticeship programs by trade and province and over time. I then seek to add to the existing literature by providing empirical evidence on the extent to which differences in apprenticeship completion rates across trades, provinces and time are related to differences in the structure of apprenticeship programs. I also ask to what extent completion rates are related to differences in the average age of apprentices, the proportion of apprentices who are female and unemployment rates across provinces, trades and time.

The unit of analysis for this paper is not the individual apprentice but rather an individual apprenticeship program, for example hairdressers in Ontario. Therefore, I do not ask to what extent an individual's likelihood of completing a program is related to the characteristics of his or her program. Instead I ask to what extent the completion rate for a particular trade in a particular province is related to the characteristics of the apprenticeship program for that trade in that province. To the extent that these relationships exist, the information in this paper may be useful in the design of apprenticeship programs.

[4]Registered Apprenticeship Information System.

Both across provinces and across trades there are differences in the requirements to enter and to complete an apprenticeship program. Not surprisingly, given that these trades are regulated by provincial governments there are also differences in the accreditation process across provinces for the same trade. For example, to become qualified as a cook in Alberta in 1999 required a grade 9 education to enter the apprenticeship program and 5400 hours of work experience to graduate from the program. However, in Nova Scotia in 1999 the program for the same trade had an entry requirement of a grade 12 education and work experience requirement of 6000 hours.[5] Not surprisingly given the differences in competencies across trades there are also differences in accreditation requirements across trades, within each province. For example, in Alberta certification as a carpenter in 1999 required 32 weeks of technical training while becoming a roofer required only 18 weeks.[6]

It is not difficult to imagine how such variation in apprenticeship program requirements might lead to variation in completion rates. Most obviously, all else equal, apprenticeship programs with longer durations are likely to have lower completion rates as the difficulties of employment stability and foregone income are exacerbated. However, while one might expect programs with higher duration to have lower completion rates, both Prasil (2005) and Morissette (2008) find no evidence of this from apprenticeship programs in New Brunswick, Ontario and Alberta.

Technical training is often cited as a barrier to apprenticeship completion, with the cost of tools, tuition and foregone income (although employment insurance payments may partially offset this) reported as a substantial financial burden by the Canadian Apprenticeship Forum. In particular, block release training is reported as being particularly burdensome. The Canadian Apprenticeship Forum's report cites a study of apprentices in Prince Edward Island which reported the number one barrier to completion as reduced income while on block release training. Ménard et al (2007) also report a commonly cited problem among apprentices is insufficient income, or a delay in employment insurance payments or training allowance while undertaking periods of technical training. On the other hand, using data from the Registered

[5] 1999 Ellis Charts.
[6] Ibid.

Apprenticeship Survey, Laporte and Mueller (2010) find that Canadian apprentices who undertake technical training by block release are more likely to complete than those undertaking technical training by other methods.

It is also possible that higher educational requirements to begin an apprenticeship program may improve completion rates. The Canadian Apprenticeship Forum's survey points to employer concerns over the literacy and mathematical skills of apprenticeship candidates, suggesting that inadequate preparation might be a factor in low completion rates. This point is also raised by Prasil.[7] If this conjecture is correct, and assuming that the level of high school education is a reasonable proxy for mathematical and literacy skills, we might expect to see a positive relationship between the level of education required to enter an apprenticeship program and the program's completion rate. On the other hand apprentices with higher levels of education may have better labour market options outside the apprenticeship system and so a lower incentive to complete. All else equal, this would imply a negative relationship between schooling requirements and completion.

Finally, certification is not mandatory to work in all occupations in Canada that have apprenticeship programs. Indeed, there is variation across trades within a province, and across provinces for a given trade, in whether or not certification is mandatory. Clearly we would expect to see higher completion rates in trades and provinces for which certification is mandatory as a partly trained apprentice cannot be substituted for a qualified journeyperson. As a result, the incentive to complete an apprenticeship program will be stronger.

Surveys also report that family circumstances can also be a barrier to completion. For example, older apprentices are perhaps more likely to have financial commitments that make them more susceptible to outside job offers, and the costs of block release training more burdensome. Consistent with this Prasil reports that there are fewer completions among older apprentices. On the other hand, Laporte and Mueller find that age is positively related to completion with the probability of completion peaking at an age of 41.[8] Ménard et al report

[7]Laporte and Mueller (2010) find that apprentices who have not completed high school are less likely to complete, while Mangan and Trendle (2008) find that a one year increase in schooling is associated with a fall in the risk of apprenticeship cancellation of around 8% for apprentices in Queensland.

[8]Similarly, Mangan and Trendle find that the probability of cancellation is negatively related to the age at which the apprentice starts their program. This is not necessarily inconsistent with the findings of Prasil as Mangan

that while females make up 10% of all apprentices they account for 11% of all apprenticeship completions. On the other hand Bilginsoy (2003) finds that females are less likely to complete and Laporte and Mueller find that the likelihood of completion is positively related to being male when they control for trade.[9] Therefore this paper also explores the relationship between apprenticeship completion rates and the average age of apprentices, and between completion rates and the proportion of apprentices who are female across trades, provinces and time.

Finally, a common obstacle faced by apprentices is that they are subject to periods of unemployment while accumulating the work experience required for graduation. Sharpe and Gibson cite a national survey of apprentices in Canada that reports 37% of apprentices had suffered periods of unemployment, with the figure much higher for construction apprentices. On the other hand a relatively high aggregate unemployment rate may indicate that current apprentices will a have relatively low opportunity cost of completing their program as alternate employment prospects are weak. Brunello (2009) surveys the empirical literature on apprenticeships and the business cycle. He finds that the ratio of apprentices to employees is mildly procyclical suggesting that perhaps it is the first effect that dominates when looking at enrollments. Looking at completion rates in the construction industry in the United States, Bilginsay (2003) finds that they are negatively related to the state unemployment rate, again suggesting that it is the problem of job instability that also dominates for completions. Similarly, Matalla and Matalla (1976) find that completion rates for electricians and plumbers in Detroit are negatively related to the state unemployment rate but positively related to hours worked in construction. One exception to this pattern is reported by Mangan and Trendle (2008). They find that for 20-24 year olds in Queensland overall employment growth is positively related to the cancellation of apprenticeships, consistent with the possibility that these apprentices are being lured away by other labour market opportunities.[10] In order to try to uncover the two separate effects I use two unemployment rates. To capture the negative effect

and Trendle confine their attention to apprentices aged 15-24. However this cohort does account for over 70% of apprenticeship commencements in Queensland, Australia.

[9]Without these controls they find completion to be positively related to being female and argue that this is a result of the high numbers of female apprentices in hairdressing programs which typically have high completion rates.

[10]Their study focuses on 15-24 year olds and they do not find such a relationship for younger apprentices. They speculate that the lack of such a relationship for these apprentices may be due to insufficient experience to make informed decisions.

that periods of unemployment can have on completion I use National Occupation Classification (NOC) specific unemployment rate for each province. The idea being that when unemployment rates are high for a particular occupation the problems of job instability are greater and so completion rates are lower. To capture the negative effect associated with alternative labour market opportunities tempting apprentices away from their program I use the aggregate unemployment rate for the province. Here the idea is that when unemployment as a whole is high the average apprentice will have less alternative labour market options and so a greater incentive to complete his or her program.

The remainder of the paper is divided into three sections. Section two describes the data and reports some summary statistics. Section three reports results based on pooled OLS estimates and section four concludes.

2 Data and Summary Statistics

2.1 Sample

The data on apprenticeship registrations and completions used in this paper are taken from the Registered Apprenticeship Information System (RAIS). The RAIS provides counts of the number of newly registered apprentices in each trade, for each province for the period 1991-2007. While the system lists a total of 329 trades, many of these have zero or close to zero new registrations for the whole of the 1991 and 2007 period. I restrict my attention to trade-province combinations with at least 1000 new registrations over the 1991-2007 sample period.[11] There are also a few trade-province combinations that do have over 1000 new registrations over this period, which are excluded from the sample for one of two reasons. The first is that some trades are relatively new and therefore only a few years towards the end of the sample period

[11]It is important to note that I am selecting the trade-province combinations on the basis of the number of new registrations and not the number of completions. The latter would clearly lead to a sample selection bias. Selecting on the number of new registrations means that the sample will include apprenticeship programs that are larger than the Canadian average. If these larger programs have systematically different completion rates than the apprenticeship programs as a whole then sample selection bias is also a possibility. However, as the appendix shows the levels and trends in the completion rates for the trade-province combinations included in the sample and for all Canadian apprenticeship programs are very similar.

have new registrations. This means that completion rates cannot be calculated for these trades. The second reason is that they either have no clear match with the trades reported in the Ellis Charts which describe the requirements of the apprenticeship programs, or the Ellis Charts do not report requirements in sufficient detail. Further details of which trades are included in the sample appear in the data appendix. Table A1 of that appendix reports the total number of new registrations for the trade-province combinations that are included in the sample.

There are a total of 40 different trades included in the sample. For 15 of these there is just one province that meets the criteria for inclusion in the sample.[12] Two trades are represented by nine provinces. These are carpenters and construction electricians. The next two most frequently represented trades in the sample are automotive service technicians and hairstyling with eight and six provinces respectively. Not surprisingly the province with the most trades represented in the sample is Ontario with 24. Alberta and B.C. are both close behind with 23 trades and Quebec is next with 14. What might appear to be a relatively low number for Quebec is largely due to the fact the reporting of apprenticeship requirements in the Ellis Charts has been less comprehensive for Quebec than it has been for other provinces. The Prairie provinces of Manitoba and Saskatchewan are represented by eight and six trades respectively. Finally, the three Atlantic provinces with some trades that have enough new registrations to appear in the sample are Newfoundland and Labrador, Nova Scotia and New Brunswick. These are represented by five, five and three trades respectively. The other Atlantic province, Prince Edward Island has no trades with 1000 or more new registrations between 1991 and 2007.[13]

Overall there are 111 trade-province combinations included in the sample. While this might seem a low number given that there are 329 trades listed in the RAIS and 10 provinces, these combinations cover approximately 75% of all new apprenticeship registrations in Canada. Figure 2 contains a plot of the number of new registrations and the number of completions for 1991-2007 for these 111 trade-province combinations. A natural question is whether the trends in new registrations and completions in the 111 trade-province combinations included in the

[12]These criteria are over 1000 new registrations between 1991 and 2007 and sufficient data on accreditation requirements.

[13]This is also the case for the Yukon, the Northwest Territories and Nunavut.

sample are similar to those for all trades in Canada. A comparison of figure 2 with figure 1 indicates that this is indeed the case with new registrations growing steadily from 1992 and completions relatively stagnant from 1991 - 2001 but then picking up after 2002.

2.2 Completion Rates

Using counts of newly registered apprentices and successful completions by trade and province I am able to calculate completion rates for cohorts beginning apprenticeships in the years 1991-2006.[14] I calculate three different completion rates. The first is for the cohort of apprentices that were new registrations in trade i and province j in year t and is calculated as:

$$cr1_{ij,t} = \frac{comp_{ij,t+d_{ij}}}{nreg_{ij,t}} \tag{1}$$

where $comp_{ij,t+d_{ij}}$ is the number of successful apprenticeship completions in trade i in province j in year $t + d_{ij}$ and $nreg_{ij,t}$ is the number of new registrations in trade i in province j in year t. The duration of the apprenticeship program (in years) for trade i in province j is given by d_{ij} and is taken from the Ellis Charts.[15] To account for the fact that not all apprentices will finish their program in the intended number of years I also calculate two alternative completion rates. The first follows Sharpe and Gibson (2005) and uses a three year moving average of the number of new registrations as the denominator. This allows for the possibility that some apprentices may take an extra year to complete their requirements and some may complete a year ahead of schedule. In this case the completion rate is given by

$$cr2_{ij,t} = \frac{comp_{ij,t+d_{ij}}}{(nreg_{ij,t-1} + nreg_{ij,t} + nreg_{ij,t+1})/3}. \tag{2}$$

[14]Not all apprenticeship programs have the same nominal duration and so I do not calculate completion rates for all trades and provinces for all years. As an obvious example, with the sample ending in 2007, I am only able to calculate completion rates for apprentices who begin one year programs in 2006.

[15]For most cases the Ellis Charts reports the duration of the work experience term of each apprenticeship program in both years and hours of work experience and so can be used to obtain d_{ij}. In a few cases just total hours of work experience are reported. In these cases the duration in years is inferred using the total number of hours and reference to other issues of the Ellis Charts. For example it is common that one edition of the Ellis Charts will report the work experience term for a trade as being 4 years and 2000 hours per year while another will just report 8000 hours for the same trade.

In the second alternative completion rate the number of completions is divided by the average of the number of new registrations lagged by d_{ij}, $d_{ij}+1$ and $d_{ij}+2$ years. This is motivated by the possibility that apprentices may often take longer than the intended number of years to complete their program, but rarely complete ahead of schedule. Morissette (2008) shows that for the 1993 cohort of new apprentices the median time to completion was longer than the nominal program duration for the majority of trades. Therefore, this third completion rate is given by:

$$cr3_{ij,t} = \frac{comp_{ij,t+d_{ij}}}{(nreg_{ij,t-2} + nreg_{ij,t-1} + nreg_{ij,t})/3}. \tag{3}$$

Table 1 gives the average completion rates for the 1991-2006 cohorts across the 111 trades included in the sample. These show a downward trend through the 1990s and then a slight upturn after 2001.[16]

2.3 Other RAIS Variables

The RAIS also reports numbers of apprentices by sex as well as in various age groups for each trade and province. Table 2 reports that across the trades and provinces in the sample an average of just under 9% of apprentices are female. Hairdressing has by far the largest share of female apprentices with the average over provinces and the sample period being 88%. There are four other trades in the sample for which an average of over 10% of apprentices are female. These are Baker (45%), Cook (29%), Horticulturalist (27%) and Partsperson (21%).[17]

Using apprenticeship counts by age group I create an estimate of the average age of apprentices for each trade, province and year in the sample.[18] Table 2 reports that across trades, provinces and time the average age of apprentices is around 29. The lowest average age is just under 22 and the highest is just over 40. Figure 3 contains a histogram of the average ages of apprentices for each trade-province combination and year. This figure shows that for over half the observations in the sample the average age of registered apprentices is between 26 and 30.

[16]Note the number of trade-province combinations used to calculate the average completion rates for 2004 to 2006 are relatively low as only programs with relatively short durations are scheduled to finish before the end of the sample in 2007.

[17]These figures are all taken from the RAIS.

[18]Details are in the data appendix.

There is a sharp drop-off in the histogram below age 26 and very few observations for which the average age in a trade-province is below 24. The decline in frequency is more gradual for average ages above 30.

The RAIS also reports the type of technical training that the apprentice is enrolled in. That is, whether the training is full-time or part-time and whether it is by block release, by day release or by some other format. Using this information I create a dummy variable for the various types of training. For the trade-province combinations included in this sample the training is always full-time. Given this I create four dummy variables. The first takes on the value one when training is primarily through full-time day release, and zero otherwise. The second is one when training is primarily full-time block release, the third is one when training is primarily full-time modular and the fourth is one when training is primarily full-time by some other method.[19] Table 2 reports the means of these four dummy variables and indicates that the vast majority of apprentices (nearly 69%) take their training via block release. Of the other three methods, around 5% of apprentices take training either via day release or some other method and only 2% take modular training. Note, these figures do not add up to one as the RAIS does not report the type of technical training for Quebec and Saskatchewan. With the exception of three trades in New Brunswick these dummy variables do not vary over time, only by trade and province.[20]

2.4 Apprenticeship Program Requirements

The Ellis Charts report the requirements for apprenticeship programs in Canada as well as whether or not certification is mandatory to work in a trade in each province. The most recent issues of the Ellis Charts were published in 2007, 2004, 1999, 1997 and 1990. I use these charts to put together a time series of apprenticeship requirements for each trade-province combination in the sample.[21] Table 2 contains summary statistics for the four variables taken from the Ellis Charts. The mandatory certification dummy takes on the value one if certification was

[19] Again, further details are available in the data appendix.

[20] See appendix for full details.

[21] Conversations with the Trades and Apprenticeship department at HRSDC and an inspection of some of the variables reported in the RAIS both suggest that changes in requirements tend to coincide with the publication of a new Ellis Chart. The data appendix contains more details on these variables.

mandatory to work in trade i in province j in year t, and zero otherwise. The mean of 0.49 for this variable in table 2 indicates the certification is mandatory in approximately half of all cases in the sample. The second variable taken from the Ellis Charts is the length of the work experience term required to complete an apprenticeship. This is reported in number of hours. Across sample trades, provinces and years the average is just under 6500 hours with the range being 2000 hours to 9000 hours. Figure 4 is a histogram of these requirements across trades, provinces and time and shows that in about 50% of cases the work experience term is between 6000 and 8000 hours, with less than 20% of observations below 5000 hours. The next variable from the Ellis Charts is the length of the technical training period required to complete an apprenticeship. Again this is measured in hours. Table 2 shows that the mean of this variable is 767 hours while the range is zero to 2290 hours.[22] The final variable taken from the Ellis Charts is the required level of education required to enrol in an apprenticeship program. This ranges from grade 8 to grade 12, with an average of 10.58. Figure 6 presents a histogram of this education requirement.

Table 3 looks at changes in these requirements over time. It documents that fact that while apprenticeship requirements are mostly unchanged from one Ellis Chart to the next, some variation in requirements over time does exist. In particular there is a net movement to mandatory certification between 1990 and 2004. However, between 2004 and 2007 there is a net movement away from mandatory certification. The cases that see a relaxing of the certification requirement are typically construction trades located in British Columbia. The suggests the possibility that apprenticeship requirements could be endogenous to labour market conditions as British Columbia was often cited as being particularly affected by the shortage of skilled construction tradespeople in the run up to the 2010 Winter Olympics. For example, in a 2006 article entitled *Worker shortage glows red in run up to 2010* discussing the construction industry in the period before the 2010 Winter Olympics, the Globe and Mail reported that in British Columbia:

"Employers estimate they will need 20,000 construction workers during the next

[22]Hairdressing is the only trade for which the Ellis Charts report zero training hours. For some trade-province combinations (most commonly in Quebec) the number of training hours is not reported in some editions of the Ellis Charts.

> three years to add to the 167,000 currently on the job across the province." (Globe and Mail 10/04/06)

Therefore, it is not inconceivable that if there is a perception of an extreme labour shortage, certification requirements could be relaxed to allow non-certified workers to substitute for certified journeypersons.

The second column of table three refers to the total work experience requirement for the entire program measured in hours. With the exception of the period between 1997 and 1999 there has been a general trend towards a lowering of the work experience requirement for the apprenticeship programs in the sample. The large number of cases in which the work experience requirement has been lowered between 2004 and 2007 are mostly in Alberta and British Columbia. Again this is consistent with the structure of apprenticeship programs responding to local labour market conditions. While there has been a downward trend in the amount of work experience required to complete an apprenticeship the opposite is true for the amount of technical training required. Table 3 reports that with the exception of the period between 1999 and 2004 there were considerably more trades that saw an increase in the formal training requirement than saw a decrease between each publication of the Ellis Charts. This pattern and that in the work experience column suggest a substitution away from work experience and towards classroom training in the accreditation process. To the extent that this classroom training typically requires the apprentice to take a break from employment this could be a potential factor in the declining completion rates.[23]

Finally the education requirement is the grade of school that must be completed in order to start an apprenticeship. There were increases in the minimum level of education required to start an apprenticeship for a number of trades during the 1990s. Between 1990 and 1997, 44 of the 111 trades-province combinations that are in the sample experienced an increase in the level of education required to start an apprenticeship. There were 11 further increases between 1997 and 1999. Between 2004 and 2007 there were 20 increases in the education requirement and 20 decreases. A large fraction of the increases were in Ontario which had previously tended to have lower requirements than many of the other provinces. Again, consistent with

[23]Offsetting this is the fact that Employment Insurance benefits are available for apprentices while attending technical training if they satisfy eligibility requirements.

requirements responding to labour market conditions the lowering of requirements took place in British Columbia.[24]

2.5 Unemployment Rates

The unemployment rates used in this paper are for both sexes aged 15 and over and are taken from the Canadian Labour Force Survey (LFS) as reported in the CANSIM II database. I use both the aggregate provincial unemployment rate and the provincial unemployment rate by National Occupational Classification (NOC). The NOC specific unemployment rate is included to capture the possibility that some apprentices may have trouble completing their requirements due to spells of unemployment. The aggregate unemployment rate is included to capture the possibility that when the labour market as a whole is booming apprentices maybe lured away from their programs by other opportunities and therefore will not complete their requirements. The LFS reports unemployment rates by NOC at a fairly aggregated level rather than at the individual trade level. This means, for example, that instead of using the unemployment rate for bricklayers in Ontario I use the unemployment rate for the construction trades in Ontario. Further details on this are available in the appendix. It is well known that there is variation in unemployment rates across Canada's provinces with those provinces to the east of Ontario typically having higher average unemployment rates than Ontario and those to the west. This is documented in figure 7 which shows average unemployment rates by province over the sample period. Figure 8 shows that average unemployment rates also vary with National Occupational Classification. This figure shows the average unemployment rate for the period 1990-2007 for Canada for each NOC used in this paper. By far the highest average unemployment rate is that for the construction occupations which stands at over 13%. The next highest is that for chefs, cooks and other occupations in the food industry at 9%.

[24]The reporting of the minimum level of education required to enrol as an apprentice in a trade in B.C. has always been somewhat vague. Prior to 2007 for most trades the Ellis Chart states that an entry assessment will be performed and that "Secondary school students are encouraged to complete Grade 12 with appropriate English, Applied Mathematics and Science courses." In 2007 this is weakened to "Recommended education: Grade 10 or equivalent...(list of mandatory courses).... Preferred: Grade 12" for most trades. However, for a few trades Grade 12 is still listed as "recommended" in the 2007 Ellis Charts. These are automotive service technician, construction electrician, plumber, refrigeration and air-conditioning mechanic and steel fabricator.

The average rates for the other five NOC groups are all below Canada's average aggregate unemployment rate for this period which stands at 8.4%. The lowest rates are for clerical workers and workers in the natural and applied sciences at just over 5% and 4% respectively.

3 Results

In this section I estimate the relationship between completion rates and accreditation requirements, the format of technical training, the age and sex variables, and unemployment rates using the data described in the previous section. Results for all three completion rates are very similar and therefore I focus my discussion on the results where the dependent variable is the number of completions in year $t + d_{ij}$ divided by the number of new registrations in year t, that is the completion rate in equation (1).

The variables describing the structure of the apprenticeship program are those in place at the beginning of the program, that is those in place in year t. There are two reasons for using the requirements at this point of the program. First these are likely the requirements that applied to apprentices starting programs in year t. The second is that using these requirements at time t reduces concerns about endogeneity. The decline in apprenticeship program requirements in B.C. in 2007 is consistent with requirements responding to labour markets conditions. It is also not inconceivable that those designing apprenticeship programs might take completion rates into account when setting program requirements. By using requirements in place at the beginning of programs the intent is to limit endogeneity issues. The implicit assumption that is being made here is that accreditation requirements that are in place in year t do not respond to completions in year $t + d_{ij}$.

This paper uses five variables describing the structure of the apprenticeship program. The first is a dummy variable that takes on the value one when certification is mandatory to work in trade i in province j in year t, and zero when certification is voluntary. The second is the total work experience required to complete the apprenticeship program in thousands of hours for trade i in province j in year t. The third is the total training requirement of the apprenticeship program in hundreds of hours for trade i in province j in year t and the fourth is a dummy

variable that takes on the value one when technical training is delivered via block release, and zero otherwise. I focus on block release training as this is the format that is reported as being problematic in survey evidence. Finally, the last requirement is the grade of education needed to enrol in the program for trade minus eight. Therefore, this variable is measured as the number of years of high school that must be completed prior to registering in the program.[25] The proportion of apprentices that are female and the average age of apprentices are measured as means over the duration of the program. That is they are the averages over the period from t to $t + d_{ij}$. Similarly, the two unemployment rate variables are measured as means over the duration of the apprenticeship program.

As mentioned before, only trade-province combinations with over 1000 new registrations over the period 1991 - 2007 are included in the sample due to the sensitivity of completion rates to small changes in the number of new registrations. For the same reason the results contained in tables 4 through 6 are pooled OLS results where for each trade-province a year is included in the sample only if it had at least 50 new registrations.[26]

Table 4 reports regression results for which the dependent variable is the number of completions in year $t+d_{ij}$ divided by the number of new registrations in year t, that is the completion rate given by equation (1). In the first column this completion rate is regressed on only the accreditation variables and an intercept, in the second column the age and sex variables are added and in the third column the two unemployment rates are added. The fourth column includes the dummy variable for block release training.[27] The last four columns report the results of regressions that contain dummy variables for years, provinces or trades.[28] The estimated coefficients on the accreditation variables are essentially unaffected by the inclusion of the age, sex and unemployment rate variables and so I focus my attention on columns three to eight.

[25]Across trades, provinces and years the lowest grade of schooling required to enter a program is eight and the highest is twelve. Therefore this variable ranges from 0 to 4.

[26]I obtain similar results when only years with at least 100 new registrations are included. These results are available on request.

[27]The sample size is different for this column as format of technical training is not reported in the RAIS for Quebec and Saskatchewan.

[28]For each specification that includes dummy variables an $F-$test for the null hypothesis that the coefficients on a set of dummy variables are all equal to zero is comfortably rejected. This is, the trade, province and time dummies are jointly statistically significant when present.

Not surprisingly the presence of mandatory certification is associated with a higher completion rate for a given trade-province-year. The estimated coefficients suggest a move from voluntary to mandatory certification is associated with an increase in the completion rate of approximately 11 percentage points. Given that the average completion rate between 1991 and 2006 is typically in the range of 40 to 55% this is a significant difference. However, while moving from voluntary to mandatory certification will likely increase the incentive for an individual apprentice to complete his or her program it is not necessarily the case that such a move would help alleviate the alleged shortage of skilled trades persons. It could be the case that in trades for which certification is voluntary apprentices who withdraw from their program before completion, but with some training, are at least partial substitutes for certified tradespersons. Therefore, while making certification mandatory may increase the completion rate it may not lead to a large increase in the number of workers with the skills the labour market requires. The fifth column also shows that when trade dummies are added mandatory certification is no longer significant. This reflects the fact that the presence of mandatory certification is not randomly distributed across trades. For example, for the trade-province combinations included in the sample to work as a construction electrician almost always requires mandatory certification while to work as a horticulturalist never does. The presence of time and province dummies does not change the inference regarding the relationship between mandatory certification and completion rates.

The length of the work experience term is positively related to the completion rate. An increase in the work experience requirement of 1000 hours is associated with an increase in the completion rate of between three and five percentage points. This is the case both in the specifications without dummy variables and those with province and time dummies. At first glance this might appear odd as problems of employment instability, forgone income etcetera are likely to be greater for apprentices in longer programs and so we would expect a negative relationship. A possible explanation for this positive relationship is that the workers who choose apprenticeship programs with high work experience requirements have unobserved characteristics that also cause them to be more highly motivated to complete an apprenticeship. Column five explores this possibility by including dummy variables for each trade. When

these dummies are added the coefficient on the work experience term falls to less than a half of its previous magnitude and becomes statistically insignificant. This is consistent with the interpretation above. However, it is also worth noting that the addition of trade dummies does not generate a negative coefficient on the work experience variable. Therefore, there is no evidence consistent with the hypothesis that longer work experience terms serve as a barrier to the completion apprenticeship programs.

There is also little evidence to suggest that the amount of technical training required to complete an apprenticeship program is related to the completion rate. Across the eight specifications reported in table 4 this variable is statistically significant in only one, the specification with the trade dummies. In this case the estimated coefficient is -0.0074 suggesting that an increase in the technical training requirement of 100 hours is associated with a decline in the completion rate of less than one percentage point. Therefore, as with work experience there is little evidence to suggest that the length of apprenticeship programs, as measured by the amount of technical training, acts as a barrier to completion.

It is possible that it may not be the amount of technical training that serves as a barrier to completion but rather that certain methods of delivery of that training are associated with lower completion rates. For example, the Canadian Apprenticeship Forum (2004) cites survey evidence which suggests that by requiring an apprentice to give up income for an extended period of time, block release training acts as a barrier to completion. I explore this issue by including a dummy variable that takes on a value of one when technical training is delivered by block release, and zero when it is delivered via some other method. These results appear in the fourth column of table 4. Far from suggesting that block release training is a barrier to completion the data indicate that the completion rate is 12 percentage points higher than when training is delivered via alternative formats. Adding in trade dummies has a negligible effect on the estimated coefficient, although adding in province dummies does cause the coefficient to become negative, much smaller in absolute value and statistically insignificant.[29] Therefore,

[29]Note, the number of observations for the specification including the block release dummy is less than in the other specifications and this variable is not available for Quebec or Saskatchewan. This is also the case for the results with the block release dummy and the trade and province dummies, which are available on request. Adding dummy variables for day release training, modular training and other full-time training yields similar results to those in column (4). That is, the estimated parameters for these variables in the regression are all negative indicting a lower

while the positive relationship is sensitive to the inclusion of dummy variables, there is no evidence to support the view that block release training contributes to lower completion rates.

The first four columns of table 4 report a negative relationship between the completion rate and the level of education required to begin an apprenticeship, with an increase of one grade in the level of education being associated with a decline in the completion rate of two and a half percentage points. Adding trade dummies does not remove this relationship. In fact, the estimated coefficient roughly doubles absolute value to -0.0475. This result is at odds with the Canadian Apprenticeship Forum (2004) survey that reported employer concerns that poor literacy and mathematical skills of apprenticeship candidates are a barrier to completions. If these are a contributing factor to low completion rates and assuming that the level of high school education is correlated with mathematical and literacy skills, we would see a positive relationship between education requirements rather than a negative one. One interpretation is that apprenticeship candidates with higher levels of education are likely to have more or better alternative labour market options. For example, an apprentice with a grade 12 education may be able to earn a higher wage outside the skilled trade than one with a grade 10 education. Alternatively, he or she could quit an apprenticeship to take up a university education, something that is not open to an apprentice with only a grade 10 education.

Columns six to eight of table four show at the effects of introducing province and time dummies on the relationship between completion rates and education requirements. Adding these dummy variables does change the inference regarding the relationship between education requirements and completion rates. Adding province fixed effects causes the parameter estimate to become much smaller and statistically insignificant while adding time fixed effects causes it to become positive and statistically significant. The figures in tables two and three shed some light onto why this is the case. Table two shows that in the first half of the 1990s average completion rates for the trades in the sample are in the neighbourhood of 50%, however by 1999 the average completion rate was down to 41%. Table three shows that between

average completion rate in these programs than in programs with block release training. Unfortunately, it is not possible to estimate a model with these three dummy variables and province dummy variables. This is because day release training is used for all trades in Newfoundland and Labrador that are present in the sample but not in any other trades.

1990 and 1997 the education requirement to begin an apprenticeship increased in 44 of 111 trade-province combinations and between 1997 and 1999 it increased in a further 11 cases. Adding time dummies allows for the possibility that this downward trend in the completion rate is accounted for by factors not otherwise included in the empirical model rather than by the increase in education requirements. The fact that the estimated relationship is now positive is consistent with the Canadian Apprenticeship Forum survey's concerns about poor literacy and mathematical skills being a factor in low completion rates. However, it is worth noting that the size of this effect is quite small. An increase of one grade in the education requirement is associated with an increase in the completion rate of only 2.5 percentage points.

The proportion of apprentices who are female is positively related to the completion rate. The equations estimated without dummy variables imply that a switch from an all male to an all female apprenticeship population would be associated with an increase in the completion rate of around seven percentage points. Adding province and time dummies increases this effect to between 12 and 15 percentage points. In each of these cases the parameter estimate is also statistically significantly different from zero. Over the period 1991 - 2007 the average proportion of apprentices that are female in the 111 trade-province combinations in the sample has increased from 7.5% in 1991 to over 10% in 2007. This is encouraging as this trend coupled with the positive relationship between the fraction of apprentices that are female implies an improvement in Canada's apprenticeship completion rate. On the other hand, this positive relationship could be the result of some unobserved factor that causes trades which attract a higher proportion of women to also have higher completion rates. If this is the case, then when trade specific dummy variables are added we would expect to see the coefficient on percentage female drop to zero. Laporte and Mueller find that adding trade dummies causes the effect of being male on the likelihood of completing to switch from negative to positive. Column five of table 4 provides mixed evidence on this point. While the specification with trade dummies now implies an even bigger effect for proportion female, the parameter is now much less precisely estimated and the null hypothesis that it is zero cannot be rejected at conventional significance levels.

The parameter estimates associated with age and age-squared imply that for average ages

below approximately 60 an increase in the average age of apprentices is associated with lower completion rates. For the specifications without dummy variables these effects are economically very small. For example, moving from the sample average age of 29 to an average age of 30 is associated with a fall in the completion rate of less than 0.1 percentage points. On the other hand when province or year dummies are included this effect increases to around half a percentage point. Again, it is the specification with trade dummies that implies the greatest effect, but again the parameter estimate is much less precise in this case.

Table 4 also looks at the relationship between unemployment rates and completion rates. In column three the coefficient for the NOC specific unemployment rate is -0.0043 and statistically significant. This implies that a one percentage point increase in this unemployment rate is associated with a fall in the completion rate of around 0.4 percentage points. Put another way, it implies a difference in completion rates between the clerical trades (with an average unemployment rate of about 5.5%) and the construction trades (with an average unemployment rate of just under 14%) of approximately five percentage points. This result is consistent with high unemployment rates acting as a barrier to completion. However, the third column provides little support for a relationship between aggregate provincial unemployment rates and completion rates. The estimated coefficient is positive, consistent with the average apprentice having a greater incentive to complete when outside job prospects are weak, however it is economically small and statistically insignificant.

Not surprisingly when trade specific dummy variables are added the coefficient on the unemployment rate by NOC is no longer statistically significant. This is most likely because the NOC specific unemployment rates reported in the LFS are relatively aggregated and so cannot capture any variation that might be present at the individual trade level.[30] The introduction of time and province dummy variables does not have much of an effect on the estimated relationship between the NOC specific unemployment rates and the completion rates, which remains negative and statistically significant.

The inclusion of province and time dummies leads to mixed inference on the relationship

[30]It is also statistically insignificant in the specification that includes the block training dummy which is estimated using data that excluded Saskatchewan and Quebec. Again, these results are available on request.

between the aggregate unemployment rate and the completion rate. Figure 7 shows the well known pattern of variation in provincial unemployment rates in Canada. It shows that between 1991 and 2007 unemployment rates were on average highest in the Atlantic provinces and Quebec and lowest in Ontario and the West. Figure 9 shows that downward trend in the aggregate Canadian unemployment rate from 1991 to 2007 is shared by all the provinces covered in the sample. Adding just province dummies leads to a positive and statistically significant estimate of the relationship between the aggregate provincial unemployment rate and the completion rate. However, adding just time dummies leads to a large negative and statistically significant estimate. Finally, when both are added the estimated parameter is 0.02 implying a one percentage point increase in the aggregate unemployment rate is associated with a two percentage point increase in the completion rate. However, this estimate is not statistically significant. Overall the variation on the estimated parameter on the aggregate unemployment rate across the specifications does not suggest a robust relationship.

Finally, tables five and six report regression results using the two alternative completion rates described by equations (2) and (3).[31] These tables imply very similar inference to that of table four. That is, with the exception of the specifications with trade dummies the presence of mandatory certification is associated with an increase in the completion rate of approximately 10 percentage points and an increase in the work experience requirement of 1000 hours is associated with an increase in the completion rate of around three percentage points. There remains little evidence of a relationship between the length of the training requirement and the completion rate and the block release dummy remains positive and statistically significant. The estimate of the relationship involving the education requirement remains sensitive to the presence of time dummies. Average apprenticeship age remains negatively related to the completion rate and the proportion of apprentices who are female remains positively related to the completion rate. Finally, the NOC specific unemployment rate continues to have a negative relationship with the completion rate and the estimate for the aggregate unemployment rate remains dependent on the which dummy variables are included in the empirical model.

[31] In these cases the samples begin in 1992 and 1993 due to the averaging of the new registrations in the construction of the completion rates.

4 Conclusions

This paper looks at the relationship between apprenticeship completion rates and the characteristics of apprenticeship programs as well as measures of the average age and sex of apprentices, and unemployment rates. It attempts to exploit variation across trades, provinces and time to ask to what extent variation in apprenticeship completion rates is related to variation in the variables describing the apprenticeship programs. To the extent that such relationships exist the results of this paper provide insights that might be useful to those designing apprenticeship programs.

In general the results reveal that apprenticeship programs for which certification is mandatory have completion rates that are about ten percentage points higher than those without mandatory certification. If the sole interest is in raising completion rates then these results suggest that a policy of moving towards mandatory certification for more trades would have desirable effects. However, if the aim is to solve the apparent shortage of skilled workers in the trades then the policy recommendation is not so clear. If workers who have begun but not completed an apprenticeship program are at least partial substitutes for qualified journeypersons then moving to mandatory certification could exacerbate any skills shortage, particularly in the short-term.

While the amount of work experience required to complete an apprenticeship may appear to be quite high for some trades, this paper finds no evidence of a negative relationship between the length of the work experience term and apprenticeship completion rates across trades and provinces. Therefore, the results do not support a reduction in the length of apprenticeship programs with a view to raising completions. That is not to say that a reduction in the terms of apprenticeship programs could not help reduce a perceived labour shortage. If long apprenticeships discourage workers from beginning a program then a reduction may encourage more workers to undertake apprenticeship programs in the skilled trades. However, the results in this paper do not speak to the question of whether the duration of a program acts as a barrier to entry. They just say that across provinces and trades there is no evidence to suggest that programs with longer duration have lower completion rates for the apprentices that do

enrol.

There is also no evidence that the length of the period of technical training is related to the completion rate. Some of the existing literature argues that it is not so much the amount of technical training that matters as the form of the delivery of that technical training. In particular, block release is often reported as being problematic as it involves a period of income interruption. However, the results in this paper do not support this conjecture. Instead, when there is a statistically significant relationship, I find that across province-trade combinations the delivery technical training via block release is associated with a higher completion rate than training delivered by other methods.

The relationship between completion rates and education requirements for entry in an apprenticeship are dependent on the inclusion of year dummy variables. When these are excluded the relationship is negative, reflecting the coincidence of declining completion rates and rising educational requirements in the 1990s. However, when year dummies are included the relationship between these two variables becomes positive which is consistent with the employers concerns over poor math and literacy skills of apprentices. Taken at face value this would suggest that an increase in education requirements may help improve completion rates. However, what must be counted against this is the fact that higher education requirements may prevent some people from entering an apprenticeship program. Given that the predicted effect is relatively modest, a one year increase in the grade of education required is associated with an increase of 2 - 2.5 percentage points in the completion rate, it may be the case that while completion rates might increase the number of apprenticeship completions will actually fall.

The average age of registered apprentices in the trade-province combinations in the sample is 29, suggesting that for a significant number of apprentices registering in an apprenticeship is not the first thing they do after high school. Indeed, in the sample the average fraction of apprentices who are under 20 is just 6.25%, the same fraction as are between the ages of 40 and 44. This average age of 29 also suggests that a significant fraction of apprentices in Canada are at an age where they will be starting to have more family and financial responsibilities.[32]

[32]In 2004, 54% of women in Canada and 52% of men in Canada had their first marriage prior to age 30. These

The fact that the results show completion rates are negatively related to the average age of apprentices across trades and provinces suggests a potential role for policies that would encourage people to start apprenticeships at a younger age. However, the parameter estimates in table three suggest that a reduction in average age from 29 to 24 would have only a fairly modest effect. This change in average age is associated with a completion rate that is only approximately 2.5 percentage points higher.

The results indicate that a higher proportion of female apprentices is associated with a higher completion rate. The order of magnitude of this effect is such that moving from an all male to an all female apprenticeship population for a given trade would lead to an increase in the completion rate of between seven and 15 percentage points. However, this could be driven by the fact that on average women choose trades which also happen to have higher completion rates and that if we hold trade constant males and females have similar completion rates. When trade specific dummy variables are added the parameter for percentage female actually increases suggesting a difference in completion rates of 23 percentage points. However, the parameter is much less precisely estimated. Given the small numbers of female apprentices in most trades a more satisfactory answer to this question will likely require the use of individual level data.

Overall, the results in this paper on the effect of the business cycle on completions are consistent with those of Bilginsay (2003) and Matilla and Matilla (1976). That is, completion rates are typically negatively related to NOC specific unemployment rates suggesting that issues of employment instability could be a problem for completions. However, the data does not consistently reveal a pattern that could be interpreted as being consistent with apprentices having a greater incentive to complete when outside labour market options are relatively weak. That is, there is no consistently positive relationship between completion rates and the aggregate unemployment rate.

One factor that has often been cited as important for a successful apprenticeship is the mentoring that the apprentice receives from qualified journeypersons, as well as how well

figures are calculated using CANSIM II series V29497329-V29497331 and V29496829-V29496831. These series give age specific first marriage rates for females and males for the age groups of under 20, 20-24 and 25-29.

their progress is monitored in general. Bilginsay (2003) points out that in the United States apprenticeship programs are either unilaterally sponsored by employers or jointly sponsored by employers and trade unions. A survey of Department of Labor officials by the United States Government Accountability Office (2005) found that jointly sponsored programs are more established and also more likely to provide mentoring and job placement services to apprentices. Bilgansay looks at the completion rates of construction apprentices in the United States and finds that average completion rates in joint programs are almost twice that of non-joint programs. The figures being 58% and 30% respectively. Coupled with the results of the Department of Labor survey, this is consistent with the view that mentoring is important for apprenticeship completions.[33] The RAIS contains counts of the number of apprentices of different types of indenture (union, employer, provincial labour boards etc) for each trade, province and year. In theory this might allow an investigation of the relationship between completion rates and the type of apprenticeship indenture. However, in practice for a large number of trades and provinces the highest count is in the "not reported" category and so exploring the relationship between indenture type and completion rates using this data is not feasible. It maybe the case that looking at individual level data from the RAIS will shed some light on this issue. This remains a possibility for future research.

The primary objective of this paper was to ask to what extent the variation in apprenticeship completion rates across trades, provinces and time is related to differences in the structure of apprenticeship programs and therefore to shed light on the optimal design of these programs. Overall, there is little evidence to suggest that lowering the length of work experience or technical training terms will lead to higher completion rates. There is some evidence to suggest that mandatory certification and higher education requirements are associated with higher completion rates. However, as noted above a policy shift in this direction may have offsetting effects that could end up lowering the number workers with the necessary skills despite an increase in completion rates. Finally, there is some evidence to suggest that policies aimed to

[33]Toner (2008) makes a similar point when comparing construction apprenticeship systems in the United Kingdom and Australia. He argues that strong apprenticeship systems rely on strong employer associations and strong trade unions. He attributes the relative decline of the United Kingdom's apprenticeship system relative to Australia's as at least partly due to the "decollectivizing" of industrial relations. Toner argues this lead to a decline in unions' role in apprenticeship systems and increased weight on employers' concerns.

lower the age at which workers enter an apprenticeship may have a small positive effect on completion rates.

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Table 1: Mean Completion Rates for Sample Trade-Province Combinations

Year	$cr1_{ij,t}$	$cr2_{ij,t}$	$cr3_{ij,t}$	K
1991	0.542			95
1992	0.575	0.530		91
1993	0.526	0.504	0.525	88
1994	0.498	0.499	0.546	90
1995	0.510	0.521	0.557	91
1996	0.516	0.501	0.532	92
1997	0.463	0.455	0.489	97
1998	0.442	0.435	0.494	105
1999	0.418	0.412	0.463	105
2000	0.385	0.389	0.424	109
2001	0.385	0.392	0.405	110
2002	0.447	0.422	0.425	108
2003	0.433	0.424	0.423	93
2004	0.419	0.383	0.426	35
2005	0.493	0.458	0.495	9
2006	0.350		0.354	3

Source: These figures are calculated using new registration and successful completion counts from the Registered Apprenticeship Information System.

Notes: For a definition of $cr1_{ij,t}$ etc see equations (1) to (3) in the text of the paper. K indicates the number of trade-province combinations used to calculate the mean completion rates for each year. These numbers are not equal to 111 as only trade-province combinations with at least 50 new registrations in that year are used to calculate the mean. The decline in K from 2002-06 is due to the fact that only trades with short enough apprenticeship programs can be used to calculate completion rates towards the end of the sample. For example, the 2006 completion rates are for programs of only one year in duration.

Table 2: Summary Statistics

Year	N	Mean	Min	Max
Proportion Female	1868	0.086	0	0.986
Average Age	1731	29.0	21.7	40.3
Training Type				
Day Release Dummy	1887	0.045	0	1
Block Release Dummy	1887	0.687	0	1
Modular Dummy	1887	0.016	0	1
Other Training Dummy	1887	0.054	0	1
Mandatory Certification Dummy	1880	0.49	0	1
Work Experience Requirement (thousand hours)	1870	6.45	2.00	9.00
Training Requirement (hundred hours)	1637	7.67	0	22.9
Education Requirement (grade-8)	1780	2.58	0	4.00
Aggregate Unemployment Rate (%)	1887	8.20	3.4	20.1
NOC Unemployment Rate (%)	1887	9.98	1.6	45.5

Notes: These summary statistics are means (etc) over trade-province combinations over the period 1991 - 2007. N refers to the total number of observations for each variable in the sample.

Table 3: Changes in Apprenticeship Requirements Between Ellis Charts

	Mandatory Certification	Required Work Experience	Training Requirement	Education Requirement
1990 - 1997				
Increases	5	2	17	44
Decreases	1	12	4	0
1997 - 1999				
Increases	2	19	16	11
Decreases	1	7	6	1
1999 - 2004				
Increases	1	6	4	0
Decreases	0	14	6	1
2004 - 2007				
Increases	1	14	13	20
Decreases	7	38	4	20

Source: 1990, 1997, 1999, 2004 and 2007 Ellis Charts.

Notes: This table reports the number of increases and decreases in the apprenticeship requirements between editions of the Ellis Charts for the 111 trade-province combinations included in the sample. For mandatory certification an increase refers to the case when a province switches from voluntary to mandatory certification and a decrease refers to a switch in the other direction. Both required work experience and the training requirement are reported as number of hours. The education requirement is reported at the grade of schooling that must be completed in order to enter an apprenticeship program.

Table 4: Completion Rate Regressions: Completion Rate 1

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Mandatory Certification	0.1093 (0.014)	0.1097 (0.014)	0.1085 (0.014)	0.1110 (0.014)	0.0253 (0.021)	0.1136 (0.014)	0.1083 (0.013)	0.1123 (0.013)
Experience Requirement	0.0306 (0.005)	0.0354 (0.006)	0.0347 (0.006)	0.0426 (0.006)	0.0158 (0.008)	0.0461 (0.007)	0.0338 (0.006)	0.0460 (0.007)
Training Requirement	-0.0003 (0.003)	0.0015 (0.003)	0.0035 (0.003)	0.0030 (0.003)	-0.0074 (0.003)	0.0008 (0.003)	0.0101 (0.003)	0.0006 (0.003)
Education Requirement	-0.0263 (0.006)	-0.0259 (0.006)	-0.0248 (0.006)	-0.0157 (0.007)	-0.0475 (0.006)	0.0056 (0.008)	0.0248 (0.007)	0.0210 (0.009)
Proportion Female		0.0688 (0.040)	0.0705 (0.040)	0.1282 (0.044)	0.2295 (0.158)	0.1236 (0.040)	0.1506 (0.038)	0.1287 (0.040)
Age		-0.1775 (0.045)	-0.1467 (0.047)	-0.1035 (0.048)	-0.0687 (0.062)	-0.1193 (0.044)	-0.1105 (0.045)	-0.0822 (0.045)
Age^2		0.0030 (0.001)	0.0025 (0.001)	0.0018 (0.001)	0.0010 (0.001)	0.0021 (0.001)	0.0020 (0.001)	0.0015 (0.001)
NOC Unemployment Rate			-0.0043 (0.002)	-0.0019 (0.002)	0.0043 (0.003)	-0.0063 (0.002)	-0.0162 (0.004)	-0.0070 (0.002)
Aggregate Unemployment Rate			0.0009 (0.004)	0.0075 (0.004)	-0.0107 (0.005)	0.0612 (0.006)	-0.0047 (0.002)	0.0201 (0.017)
Block Release Training Dummy				0.1209 (0.032)				
Intercept	0.2893 (0.035)	2.8330 (0.673)	2.3906 (0.700)	1.4596 (0.722)	1.8087 (0.894)	1.2640 (0.672)	1.9519 (0.668)	1.0983 (0.682)
Trade Dummies	No	No	No	No	Yes	No	No	No
Province Dummies	No	No	No	No	No	Y es	No	Yes
Time Dummies	No	No	No	No	No	N o	Yes	Yes
N	1103	1103	1103	1032	1103	1103	1103	1103
R^2	0.101	0.119	0.128	0.142	0.354	0.249	0.250	0.283

Notes: Estimates are from pooled OLS regressions where N is the sample size. Only years with at least 50 new registrations are included in the sample. The figures in parentheses are standard errors. When dummy variables are included the excluded trade is Welders, the excluded province is Ontario and the excluded year is 1991.

Table 5: Completion Rate Regressions: Completion Rate 2

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Mandatory Certification	0.1034 (0.013)	0.1054 (0.013)	0.1034 (0.013)	0.1047 (0.014)	0.0034 (0.019)	0.1095 (0.013)	0.1019 (0.013)	0.1074 (0.013)
Experience Requirement	0.0311 (0.005)	0.0348 (0.006)	0.0344 (0.005)	0.0411 (0.006)	0.0135 (0.008)	0.0461 (0.006)	0.0334 (0.005)	0.0458 (0.006)
Training Requirement	-0.0006 (0.002)	0.0010 (0.002)	0.0032 (0.003)	0.0022 (0.003)	-0.0097 (0.003)	0.0001 (0.003)	0.0088 (0.002)	-0.0002 (0.003)
Education Requirement	-0.0218 (0.006)	-0.0210 (0.006)	-0.0178 (0.006)	-0.0112 (0.006)	-0.0422 (0.005)	0.0037 (0.008)	0.0254 (0.007)	0.0185 (0.009)
Proportion Female		0.0574 (0.037)	0.0640 (0.037)	0.1060 (0.042)	0.3085 (0.139)	0.1056 (0.037)	0.1371 (0.036)	0.1125 (0.037)
Age		-0.1664 (0.042)	-0.1410 (0.043)	-0.1027 (0.044)	-0.0474 (0.055)	-0.1210 (0.041)	-0.1227 (0.042)	-0.0943 (0.042)
Age^2		0.0029 (0.001)	0.0024 (0.001)	0.0018 (0.001)	0.0007 (0.001)	0.0022 (0.001)	0.0022 (0.001)	0.0018 (0.001)
NOC Unemployment Rate			-0.0034 (0.002)	-0.0016 (0.002)	0.0068 (0.002)	0.0567 (0.007)	-0.0035 (0.002)	-0.0063 (0.002)
Aggregate Unemployment Rate			-0.0028 (0.004)	0.0022 (0.004)	-0.0166 (0.004)	-0.0058 (0.002)	-0.0178 (0.004)	-0.0243 (0.016)
Block Release Training Dummy				0.0850 (0.031)				
Intercept	0.2634 (0.033)	2.6294 (0.629)	2.2753 (0.652)	1.4910 (0.674)	1.4722 (0.794)	1.2999 (0.625)	2.1240 (0.628)	1.2183 (0.640)
Trade Dummies	No	No	No	No	Yes	No	No	No
Province Dummies	No	No	No	No	No	Y es	No	Yes
Time Dummies	No	No	No	No	No	N o	Yes	Yes
N	1029	1029	1029	958	1029	1029	1029	1029
R^2	0.110	0.129	0.142	0.151	0.424	0.268	0.250	0.292

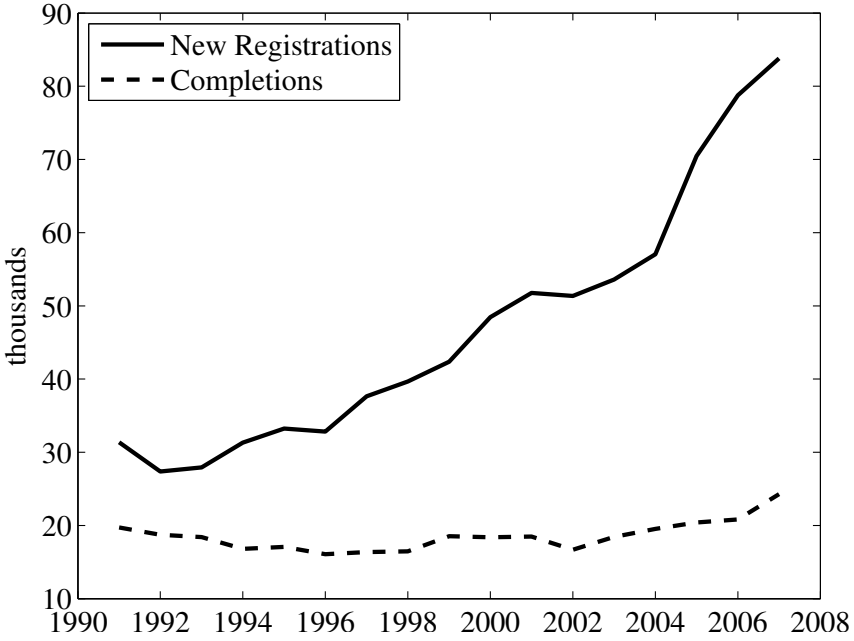
Notes: See notes to table 4. When year dummies are included the missing year is 1992.

Table 6: Completion Rate Regressions: Completion Rate 3

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Mandatory Certification	0.1080 (0.016)	0.1124 (0.016)	0.1098 (0.016)	0.1083 (0.016)	0.0031 (0.023)	0.1144 (0.015)	0.1073 (0.015)	0.1099 (0.015)
Experience Requirement	0.0335 (0.006)	0.0350 (0.007)	0.0346 (0.006)	0.0394 (0.007)	0.0124 (0.009)	0.0463 (0.007)	0.0335 (0.006)	0.0453 (0.007)
Training Requirement	-0.0024 (0.003)	-0.0008 (0.003)	0.0023 (0.003)	0.0007 (0.003)	-0.0115 (0.003)	-0.0041 (0.004)	0.0086 (0.003)	-0.0042 (0.004)
Education Requirement	-0.0220 (0.007)	-0.0209 (0.007)	-0.0137 (0.007)	-0.0097 (0.007)	-0.0415 (0.007)	0.0169 (0.010)	0.0332 (0.008)	0.0384 (0.010)
Proportion Female		0.0335 (0.044)	0.0458 (0.043)	0.0705 (0.049)	0.3365 (0.165)	0.0648 (0.044)	0.1233 (0.042)	0.0738 (0.044)
Age		-0.1864 (0.050)	-0.1566 (0.051)	-0.1229 (0.052)	-0.0909 (0.065)	-0.1432 (0.049)	-0.1433 (0.050)	-0.1089 (0.049)
Age^2		0.0032 (0.001)	0.0027 (0.001)	0.0022 (0.001)	0.0015 (0.001)	0.0026 (0.001)	0.0026 (0.001)	0.0020 (0.001)
NOC Unemployment Rate			-0.0040 (0.002)	-0.0030 (0.002)	0.0060 (0.003)	-0.0066 (0.002)	-0.0041 (0.002)	-0.0072 (0.002)
Aggregate Unemployment Rate			-0.0067 (0.004)	-0.0027 (0.004)	-0.0189 (0.005)	0.0712 (0.009)	-0.0221 (0.005)	0.0167 (0.021)
Block Release Training Dummy				0.0474 (0.037)				
Intercept	0.2831 (0.039)	2.9240 (0.745)	2.5130 (0.769)	1.8726 (0.798)	2.1630 (0.949)	1.5222 (0.744)	2.4046 (0.743)	1.4829 (0.759)
Trade Dummies	No	No	No	No	Yes	No	No	No
Province Dummies	No	No	No	No	No	Y es	No	Yes
Time Dummies	No	No	No	No	No	N o	Yes	Yes
N	960	960	960	889	960	960	960	960
R^2	0.093	0.111	0.132	0.133	0.398	0.247	0.237	0.280

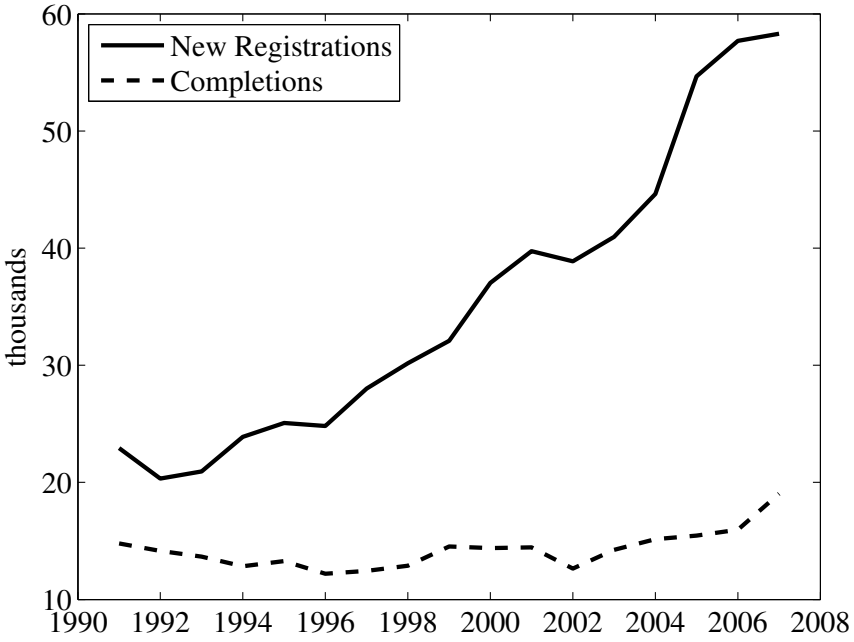
Notes: See notes to table 4. When year dummies are included the missing year is 1993.

Figure 1: New Apprenticeship Registrations and Completions in Canada: All Trades



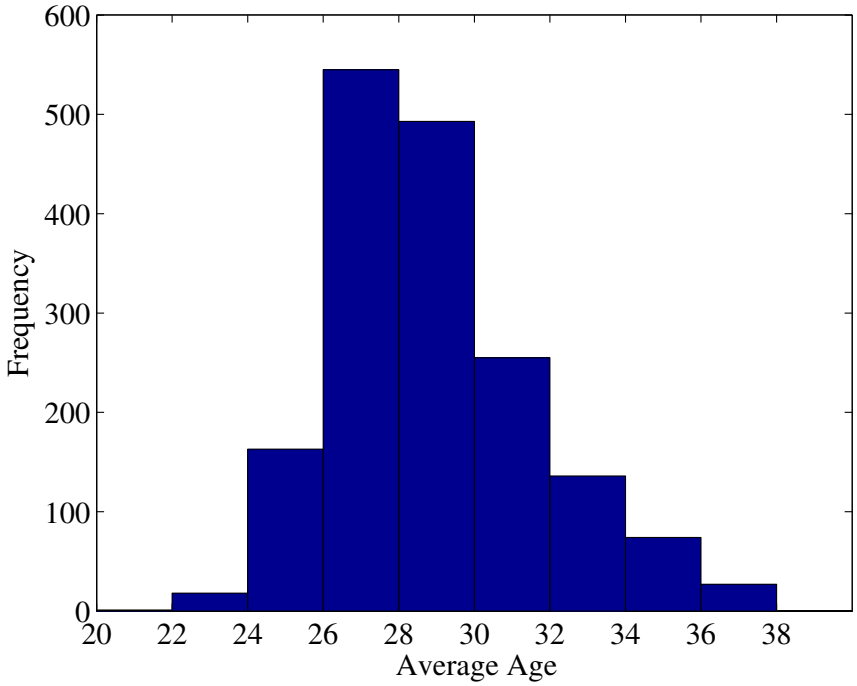
Source: Registered Apprenticeship Information System.

Figure 2: New Apprenticeship Registrations and Completions: Sample Trades and Provinces



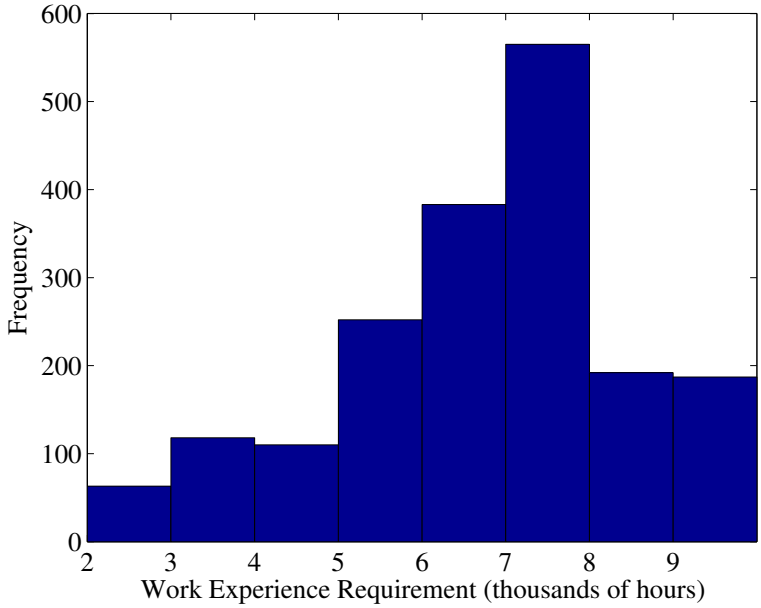
Source: Registered Apprenticeship Information System.

FIGURE 3: AVERAGE APPRENTICESHIP AGE: SAMPLE TRADES AND PROVINCES 1991-2007



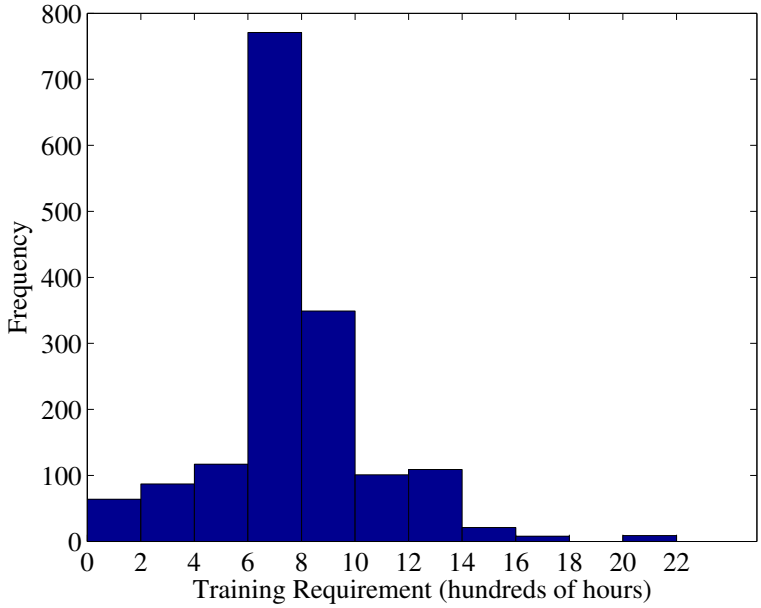
Source: The average age for each trade-province-year is calculated using data from the RAIS as outlined in the data appendix. $N = 1731$.

FIGURE 4: WORK EXPERIENCE: SAMPLE TRADES AND PROVINCES 1991-2007



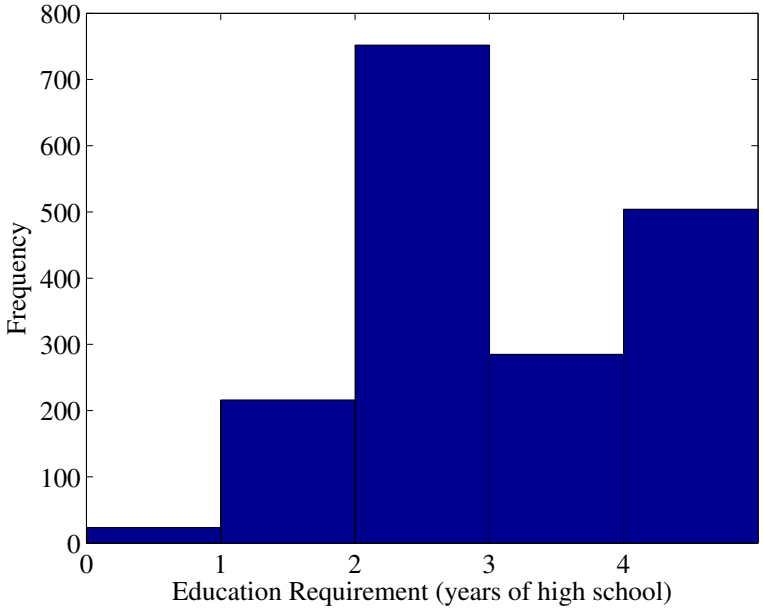
Source: Ellis Charts. $N = 1870$.

FIGURE 5: TRAINING TIME: SAMPLE TRADES AND PROVINCES 1991-2007



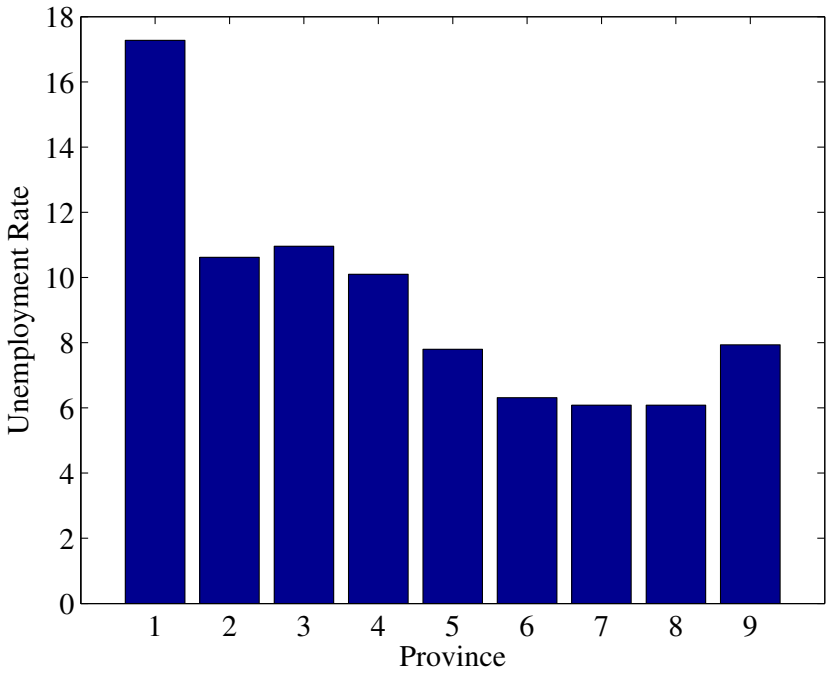
Source: Ellis Charts. $N = 1637$.

FIGURE 6: EDUCATION REQUIREMENT: SAMPLE TRADES AND PROVINCES 1991-2007



Source: Ellis Charts. $N = 1780$.

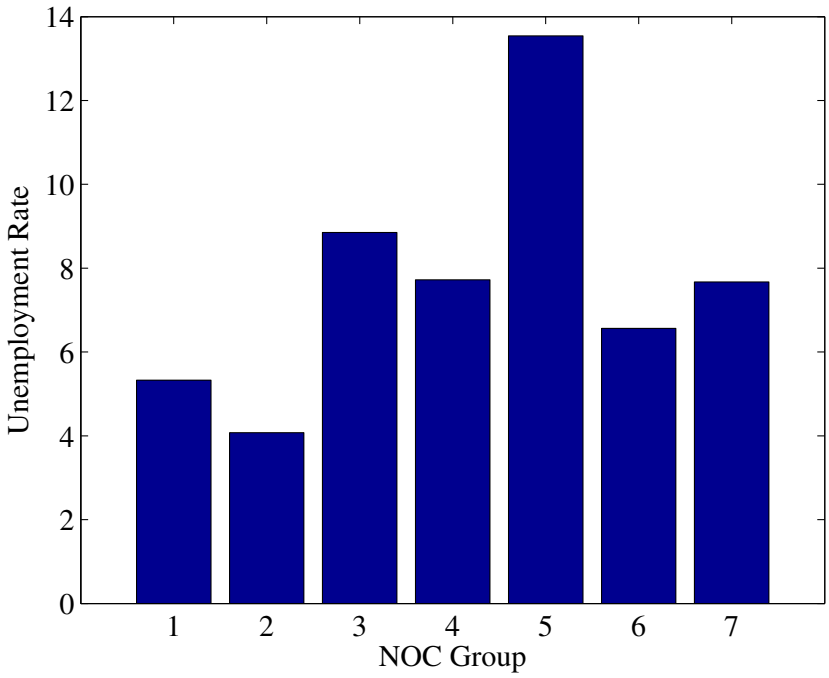
FIGURE 7: AVERAGE UNEMPLOYMENT RATE BY PROVINCE: 1991-2007



Source: CANSIM II. The numbers on the $x-$axis refer to the provinces:

1. Newfoundland and Labrador.
2. Nova Scotia.
3. New Brunswick.
4. Quebec.
5. Ontario.
6. Manitoba.
7. Saskatchewan.
8. Alberta.
9. British Columbia.

FIGURE 8: AVERAGE UNEMPLOYMENT RATE BY NOC: CANADA 1991-2007



Source: CANSIM II. The numbers on the $x-$axis refer to the following NOC groups:

1. Clerical occupations, including supervisors (NOC-S codes B411-B576).
2. Natural and applied sciences and related occupations (C011-C183).
3. Chefs and cooks, and occupations in food and beverage service, including supervisors (G012, G411-G513).
4. Sales and service occupations not elsewhere classified, including occupations in travel and accommodation, attendants in recreation and sport as well as supervisors (G013-G016, G711-G732, G911-G983).
5. Construction trades (H111-H145).
6. Other trades occupations (H211-H535).
7. Transport and equipment operators (H611-H737).

FIGURE 9: CANADIAN AND PROVINCIAL UNEMPLOYMENT RATES 1991-2007

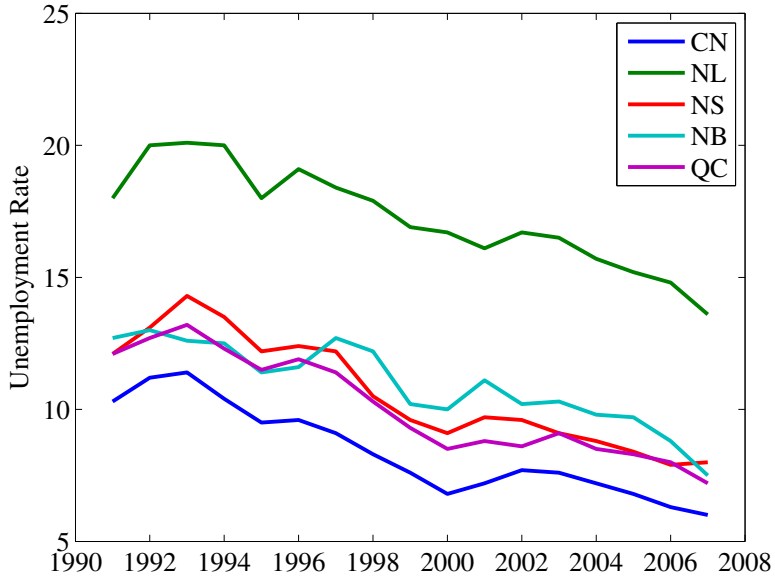
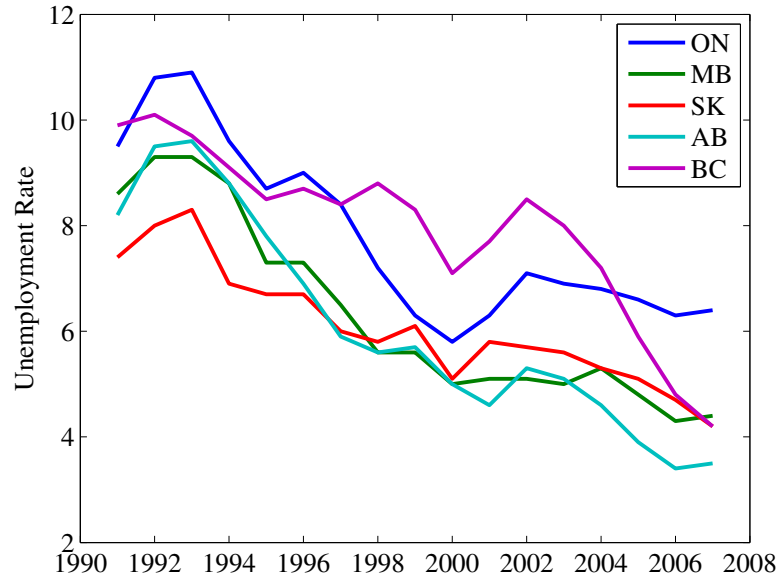


FIGURE 9 (CONTINUED): PROVINCIAL UNEMPLOYMENT RATES 1991-2007



Source: CANSIM II.

Data Appendix

This appendix outlines the sources of the data used in the paper and gives further details on which trade-province combinations are included in the sample. The data are taken from three sources, the Registered Apprenticeship Information System (RAIS), the Ellis Charts and the Labour Force Survey.

A.1 Sample

The Registered Apprenticeship Information System (RAIS) contains a record for every individual registered in the apprenticeship system for each year since 1991. Each apprentice's registration status at the beginning and during the reporting period is classified as being (i) already registered at beginning of period; (ii) newly registered, added during the reporting period or reinstatement, (iii) added during the reporting period. The system covers a total of 329 trades. However, for 76 of those trades there were no new registrations at all in Canada between 1991 and 2007. For many other trades the numbers of new apprentices is very low for every year of the sample and so small changes in the number of completions or new registrations can lead to large changes in completion rates.[34] For this reason trade province combinations with less than a total of 1000 new registrations over the whole of the 1991-2007 sample period are excluded from the sample.[35]

Also, some trades are relatively new and so while they have over 1000 new registrations for the period 1991 to 2007, these are all near the end of the sample. Obviously calculating a time series of completion rates for these trades is not feasible and so they are also excluded from the sample. These trades are Child and Youth Worker, Construction Craft Worker, Educational Assistant, Early Childhood Educator, Glazier, Grip / Motion Picture / Theatre,

[34]This effect is exacerbated by the fact that the RAIS reports the number of new registrations and completions in each trade in each province rounded to the nearest 5.

[35]One exception to this is bricklayers in Quebec. The RAIS reports an extremely high number of reinstatements for this trade in this province. This is high relative both to other trades in Quebec and to bricklayers in other provinces and so most likely reflects mis-reporting in the RAIS. This possibility is reinforced by the fact that calculating the completion rate for bricklayers in Quebec using the number of new registrations reported in the RAIS leads to completion rates in excess of one. Therefore, for bricklayers in Quebec the completion rate is calculated using the number of new registrations plus the number of reinstatements as the denominator. This yields a completion rate that is more in line with those seen for other trades and provinces.

Information Technology - Contact Centre - Customer Care Agent, Information Technology - Contact Centre - Inside Sales Agent, Native Residential Construction Worker, Software - Informations Systems Analyst and Rig Technician - Driller.[36]

There are a total of 50 trades for which there is at least one province with at least 1000 new registrations between 1991 and 2007 and are not excluded on the basis of being "new." Using the Ellis Charts I am able to determine the apprenticeship program requirements for most of these trades. Looking at these charts it is clear that the RAIS reports some trades which are the same under different names. The most obvious in the sample is hairstylist and hairstyling. In addition to this obvious example, the Ellis Charts also reveal that the trades listed as cabinetmaker in Alberta and joiner in BC are the same, and that the trades listed as landscape gardener in Alberta and B.C. and both landscape gardener and horticulture in Ontario are the same. Combining these trades leaves 47 unique trades.

Of these 47, there are seven trades that have at least 1000 new registrations, but are excluded from the sample either because they do not appear in the Ellis Charts or because there is sufficient uncertainty over the trade name in the Ellis Charts. These seven instances are as follows:

1. There is no Ellis Chart for Building Services Technician (only Ontario has 1000+ new registrations).

2. For Crane and Hoist Operators (Quebec and Alberta have 1000+ new registrations) there is no clear match of trade name in the Ellis Charts. While there are a number of possible matches none of these is more obvious than the others and given that these charts all have different requirements, Crane and Hoist Operators are excluded from the sample.

3. While there is an Ellis Chart for Drywall Mechanics it does not list requirements for Ontario which is the only province with 1000+ new registrations.

4. For Hoisting Engineer - Boom Truck only Alberta has 1000+ new registrations. While there are a number of trades listed in the Ellis Charts for which the description begins Hoist Operator, the program for Alberta appears minimal with only 500 hours of work

[36]In the case of Glaziers, only Quebec has over 1000 new registrations over the sample period. However, these are all for the years 1997 - 2007.

experience and 3 weeks of training. Given this, and the fact that in the RAIS the trade is described as "engineer" while in the Ellis Charts it is described as "operator" this trade is excluded from the sample.

5. For Gasfitters the Ellis Charts report (different) requirements for 1st class and 2nd class Gasfitters, while the RAIS does not distinguish. As a result Gasfitters are excluded from the sample.

6. For Quebec the reporting of requirements in the Ellis Charts is less comprehensive than it is for other provinces. For the trade of Cement Finisher, Quebec is the only province with at least 1000 new registrations. Unfortunately for this trade, requirements are not reported in sufficient detail to allow inclusion in the sample.

7. Power Shovel Operators are excluded for exactly the same reason as Cement Finisher.

Overall seven trades are dropped due to insufficient coverage in Ellis Charts, leaving 40 different trades in the sample. In a few instances a province has 1000 or more new registrations in a trade and although there is an Ellis Chart for that trade, the requirements are not reported for that particular province, or are reported in a way that does not allow comparison with other trades/provinces. These cases are Heavy Duty Equipment Operator in Newfoundland and Labrador, Industrial Electrician in Quebec, Insulator - Heat and Frost in Ontario, Lather - Interior Systems Mechanic in Quebec and Welder in Ontario. Therefore, these provinces are dropped from the sample for these trades. Finally, in Alberta from 1996 onwards the RAIS aggregates the counts for plumbers togther with those of gasfitters, meaning that plumbers in Alberta also have to be excluded from the sample.

Table A1 reports the total number of new registrations for each of the 111 trade-province combinations that are included in the sample. A natural question is what proportion of total new apprenticeship registrations do these 111 trade-province combinations represent? Table A2 answers this by reporting the fraction of total new registrations in Canada are in the 111 trade-province combinations that are included in the sample for each year from 1991 to 2006. It shows that the sample covers a large majority of new apprenticeship registrations in Canada with the average between 1991 and 2006 being around 75%. It also shows that this fraction is

fairly stable ranging from a low of 73.1% (1991) to a high of 78.2% (2004).

A.2 Completion Rates

The RAIS classifies each apprentice's status at the end of the reporting period as either (i) continuing, apprentice is still registered; (ii) successfully completed the entire program; (iii) discontinued, not completed, dropped out of the program; (iv) transferred to another trade; (v) suspended or cancelled or (vi) completed a level or class in the program (with a certificate granted). Using the counts of apprentices who have completed the entire program apprenticeship completion rates can be calculated for each of the 111 trade-province combinations discussed above using the three equations given in the paper. When the number of apprenticeship completions is between zero and five the RAIS reports a missing value in order to preserve confidentiality. In these cases the number of completions is set at 2.5.[37]

Another question that speaks to the representativeness of the sample is whether or not the completion rates for the 111 trade-province combinations are similar to those for Canada as a whole. Table A2 provides some evidence on this by reporting average completion rates for the cohorts that were newly registered apprentices in each year from 1991 to 2003, assuming a four year nominal duration.[38] These figures show that for each of these years the completion rate for the sample trade-province combinations is very close to the Canadian aggregate and that the trend in the aggregate completion rate is matched by that in the sample.

A.3 Other RAIS Variables

The RAIS also reports the number of apprentices by sex and age for each trade and province. This data is used to calculate the percentage of apprentices that are female and a measure of the average age of apprentices for each trade-province combination. The percentage female is simply the count of female apprentices divided by the sum of the counts of male and female

[37] In these cases, the true number of completions is either, one, two, three or four and so 2.5 is simply the average of those figures. Of the $111 \times 17 = 1887$ completion counts in the sample this situation only applies in 21 cases.

[38] Very similar results are obtained when assuming a 3 year nominal duration.

apprentices.[39]

The RAIS reports the number of apprentices in each of eight age groups, under 20, 20-24, 25-29, 30-34, 35-39, 40-44, 45-49 and 50 plus. These figures are used to create shares in each age group which are then multiplied by the mid-point of each group in order to create a measure of the average age for each trade-province combination. For the under 20 and over 50 group the midpoints are represented by 18 and 55. For the under 20 group, 18 is used as the midpoint between the minimum school leaving age for most Canadian provinces (17) and the upper end of the range (19). For the over 50 group, 55 is used as it is one-third of the way between 50 and the traditional retirement age of 65. This is chosen on the basis that there is probably less incentive to undertake an apprenticeship as one approaches retirement. In practice only around 2% of registered apprentices are in the 50 plus age group and so a different choice is unlikely to have a significant impact on the imputed average age. Table A3 reports some summary statistics for the shares of apprentices in each age category and the average age calculated using these shares.

The RAIS reports the type of technical training that each apprentice is enrolled in. This can be (i) day release, full-time; (ii) block release, full-time; (iii) modular, full-time; (iv) other, full-time; (v) day release, part-time; (vi) evening, part-time; (vii) modular, part-time; (viii) other part-time or (ix) not reported. For all the trade-province combinations in the sample the training type is either one of the full-time types or it is not reported. In most cases for each year, apprentices are either reported as all being in one type of training or all apprentices training type is classified as "not reported." In a few cases there are some apprentices reported as undertaking training of a different format to the majority, but these are always a small minority. It is also not uncommon that for a particular trade-province combination the RAIS will report that all apprentices are doing their training by (for example) block release for a number of years, and then classify all apprentices as "not reported" for a few years, before then reporting that they are all doing their training by block release again. Given the unreliable nature of the reporting of training type in the RAIS, I use the data that is reported to create

[39]There is also a count of apprentices for whom sex is not reported and this is why the percentage female is not calculated as the number of female apprentices over total apprentices.

a set of dummy variables rather than to create shares of apprentices in each type of training. These dummy variables take on a value of one when the majority of apprentices (usually 100%) for which a training type is reported undertake their training in the relevant form, and zero otherwise. It also takes on a value of one in the cases where training type is not reported for a given year, but in adjacent years all apprentices are in training of the relevant type. In other words I assume that while the reporting of the format of delivery of technical training has temporarily changed, the format itself has not. Finally, there are only three instances of a training type dummy switching for a trade-province combination during the sample. These all took place in New Brunswick and are:

1. For automotive service technicians it was by block release until 1998 and then modular for the remainder of the sample.
2. For carpenters it was modular until 2003 and then by block release.
3. For construction electricians it was modular until 1998 and then by block release.

The RAIS also reports the normal duration each apprentice's program in years. For a given trade-province combination this is the same for almost every apprentice. This variable is not used in the empirical work in the paper, but is used in the next section of the appendix to help date changes in apprenticeship requirements.

A.4 Ellis Charts

The Ellis Charts report the requirements for apprenticeship programs in Canada as well as whether or not certification is mandatory to work in a trade in each province. Unfortunately, these Charts have not been published on an annual basis since 1991. Instead they are published infrequently with the relevant issues for this paper being 1990, 1997, 1999, 2004 and 2007.[40] While in most cases the requirements do not change between editions, changes do exist and so the issue when constructing a time series of apprenticeship requirements is dating these changes. A discussion with the Trades and Apprenticeship department at HRSDC suggests

[40]While the paper reports changes in program requirements between the 2004 and 2007 Ellis Charts, the 2007 requirements are not used in the empirical work as the data from the RAIS ends in 2007. As a result, any apprentices completing during the sample period will have started their programs prior to 2007.

that most changes occur just prior to the publication of a new Ellis Chart.[41] In addition to reporting information on the number of apprentices in various types of training program the RAIS also reports the number of apprentices by program length in years by trade, province and year. Looking at these counts gives some insight into the timing of changes in requirements. There are only three changes in the type of apprenticeship training over the sample period and all of these coincide with the publication of a new Ellis Chart (two are in 1999 and one is in 2004). Looking at the duration of the apprenticeship program in years from the RAIS suggests a total of 18 changes during the sample period.[42] Of these 18, 11 coincide exactly with the publication of a new Ellis Chart, even though a new Chart was only published for four of the years between 1991 and 2007. Given this, and the discussions with HRSDC, I assume that requirements are unchanged until the publication of a new chart. That is I use the 1990 requirements for 1991-1996, the 1997 requirements for 1997 and 1998, the 1999 requirements for 1999-2003 and the 2004 requirements for 2004-2006.

A.5 Unemployment Rates

The unemployment rates used in this paper are taken from the Labour Force Survey (LFS) as reported in the CANSIM II database. These are the aggregate provincial unemployment rates and the provincial unemployment rates by National Occupational Classification (NOC). The LFS reports unemployment rates by NOC at a fairly aggregated level. The 40 trades that are studied in this paper fall into 7 broad classifications:

1. Clerical occupations, including supervisors (NOC-S codes B411-B576).
2. Natural and applied sciences and related occupations (C011-C183).
3. Chefs and cooks, and occupations in food and beverage service, including supervisors (G012, G411-G513).

[41] I am also grateful to Benoit Cadieux and the Trades and Apprenticeship division at HRSDC for access to historical Ellis Charts.

[42] Note this number is much lower than the number of changes in the work experience variable discussed in the paper because the RAIS only reports the duration in years and not the number of hours of work experience. Therefore, the relatively minor changes in the work experience requirement that happen due to changes in the number of hours per year will not be reflected in the RAIS measure.

4. Sales and service occupations not elsewhere classified, including occupations in travel and accommodation, attendants in recreation and sport as well as supervisors (G013-G016, G711-G732, G911-G983).
5. Construction trades (H111-H145).
6. Other trades occupations (H211-H535).
7. Transport and equipment operators (H611-H737).

The Ellis Charts uses the standard NOC, while the CANSIM II database uses the National Occupational Classification - Statistics (NOC-S). These can be matched using the concordances available from Statistics Canada. Both classifications as well as the CANSIM codes of the unemployment rate series used for each trade are reported in table A4. For both series I use the unemployment rates for workers of both sexes aged 15 and over.

Table A1: Total Number of New Registrations 1991 - 2007 by Trade and Province for Those Combinations With at Least 1000 New Registrations

Occupation	NFL	NS	NB	QC	ON	MB	SK	AB	BC
Automotive Service Technician	1365	2190	1680		36215	1865	1905	11500	9195
Baker								1385	
Bricklayer				4295	2515				
Cabinetmaker / Joinery								1930	2090
Carpenter	1720	1630	1695	33005	13295	2370	2925	14200	17395
Construction Electrician	2080	2375	1910	11755	21140	2615	3025	23300	16220
Cook		1325			11995		1010	6255	7460
Electrician (Communications)								1255	
Gasfitter Domestic and Commercial									1190
Hairstylist / Hairstyling	1835				29170	1525	2425	13065	4095
Heavy Duty Equipment Mechanic Technician					3305	1030		13065	3260
Heavy Duty Equipment Operator				4880					
Horticulture / Landscape Gardener					2785			1130	1060
Industrial Electrician					5405				
Industrial Instrument Mechanic								6080	
Industrial Mechanic-Millwright					11985		1140	6190	3315
Insulator Heat and Frost								2135	
Ironworker				1775	2000			2275	
Ironworker (Reinforcing)				1085					
Lather-Interior Systems Mechanic				2990					
Machinist					8860			3720	1705
Mobile Crane Operator					1415			1705	
Motor Vehicle Body Repairer					4400			3915	2330
Motor Vehicle Painter									1920
Moulder and Engraver					3295				
Painters and Decorator				5300	1010				1425
Partsperson (Industrial Engine and Equipment)								3430	
Plasterer				2915					1350
Plumber		1080			9915	1165	1600		8280
Powerline Technician					1755			1250	
Refrigeration and Air Conditioning Mechanic				2570	5210			2065	1695
Roofer				4805					2700
Sheet Metal Worker				3020	5750			3720	1705
Sprinkler System Installer					1150				1335
Steamfitter - Pipefitter				12575	2105			8820	
Steel Fabricator									1930
Tile Setter				2135					
Tool And Die Maker					8035				
Truck And Transport Mechanic					8865				2185
Welder	1815						1940	26675	2105
NT	5	5	3	14	24	6	8	23	23

Source: Registered Apprenticeship Information System.
Note: NP indicates the number of provinces included for each trade and NT indicates the number of trades included for each province.

Table A2: Sample Information

Year	Sample New Registrations as a Fraction of Canada Total	Completion Rate Sample	Completion Rate All Apprenticeships
1991	0.731	0.579	0.544
1992	0.742	0.600	0.587
1993	0.749	0.594	0.586
1994	0.762	0.540	0.526
1995	0.754	0.579	0.558
1996	0.756	0.580	0.561
1997	0.744	0.516	0.491
1998	0.761	0.419	0.421
1999	0.757	0.444	0.435
2000	0.764	0.409	0.403
2001	0.768	0.389	0.394
2002	0.757	0.411	0.405
2003	0.764	0.464	0.453
2004	0.782		
2005	0.776		
2006	0.733		

Source: Registered Apprenticeship Information System.
Notes: (1) The second column is the total number of new apprenticeship registrations in the 111 trade-province combinations included in the sample divided by the total number of new registrations in Canada. (2) The third column is the average completion rate for the 111 trade-province combinations for the cohorts starting apprenticeships in each of the years 1991 to 2003 assuming a four year duration for the program. (3) The final column is the completion rate for all apprentices in Canada for the same years, again assuming a four year program.

Table A3: Summary Statistics for Age Shares and Average Age

	Mean	Min	Max
Share in Age Group			
Under 20	0.0625	0	0.5693
20 - 24	0.2965	0	0.6667
25 - 29	0.2539	0.0702	0.4727
30 - 34	0.1643	0	0.3916
35 - 39	0.1055	0	0.3333
40 - 44	0.0626	0	0.2500
45 - 49	0.0323	0	0.1610
50 plus	0.0223	0	0.2412
Imputed Average Age	29.04	21.68	40.29

Source: RAIS.

Note: The means (or min or max) of the shares in each group are means (etc) over time and trade-province combinations. The average age is calculated as described in the text of this appendix and the mean (etc) of this variable is its mean (etc) over time and trade-province combinations.

Table A4: NOC, NOC-S and CANSIM II Labels for Unemployment Rates by Trade

Occupation	NOC	NOC-S	Last 4 Digits of CANSIM II Labels								
			NFL	NS	NB	QC	ON	MB	SK	AB	BC
All Occupations			9745	0969	1581	2193	2805	3741	4029	4641	5253
Automotive Service Technician	7321	H421	9771	0995	1607		2831	3443	4055	4667	5279
Baker	6252	G942					2827			4663	
Bricklayer	7281	H131				2218	2830				
Cabinetmaker / Joinery	7272	H122								4666	5278
Carpenter	7271	H121	9770	0994	1606	2218	2830	3442	4054	4666	5278
Construction Electrician	7241	H211	9771	0995	1607	2219	2831	3443	4055	4667	5279
Cook	6242	G412		0988			2824		4048	4660	5272
Electrician (Communications)	7245	H215								4667	
Gasfitter Domestic and Commercial	7253	H113									5278
Hairstylist / Hairstyling	6271	G911	9767				2827	3439	4051	4663	5275
Heavy Duty Equipment Mechanic Technician	7312	H412					2831	3443		4667	5279
Heavy Duty Equipment Operator	1628	H611				2220					
Horticulture / Landscape Gardener	2225	C125					2813			4649	
Industrial Electrician	7242	H212					2831				
Industrial Instrument Mechanic	2243	C143								4649	
Industrial Mechanic-Millwright	7311	H411					2831		4055	4667	5279
Insulator Heat and Frost	7293	H143								4666	
Ironworker	7264	H324				2219	2831			4667	
Ironworker (Reinforcing)	7264	H324				2219					
Lather-Interior Systems Mechanic	7284	H134				2218	2830				
Machinist	7231	H311					2831			4667	5279
Mobile Crane Operator	7371	H621				2220	2832			4668	
Motor Vehicle Body Repairer	7322	H422					2831			4667	5279
Motor Vehicle Painter	7322	H422									5279
Moulder and Engraver	7232	H312					2831				
Painter and Decorator	7294	H144				2218	2830				5278
Partsperson (Industrial Engine and Equipment)	1472	B572								4648	
Plasterer	7284	H134				2218					5278
Plumber	7251	H111		0994			2830	3442	4054	4666	5278
Powerline Technician	7244	H214					2831			4667	
Refrigeration and Air Conditioning Mechanic	7313	H413				2219	2831			4667	5279
Roofer	7291	H141				2218					5278
Sheet Metal Worker	7261	H321				2219	2831			4667	5279
Sprinkler System Installer	7252	H112					2830				5278
Steamfitter - Pipefitter	7252	H112				2218	2830			4666	
Steel Fabricator	7263	H323									5278
Tile Setter	7283	H133				2218					
Tool And Die Maker	7232	H312					2831				
Truck And Transport Mechanic	7321	H421					2831				5279
Welder	7265	H326	9771				2831		4055	4667	5279

Source: Statistics Canada

Note: The CANSIM II codes for Newfoundland and Labrador are all of the form V236xxxx where the last 4 digits are given in the table above. For the remaining provinces the codes are all of the form V237xxxx, and again the last 4 digits are given in the table above.