

The Effect of Vocational Training on Labor Market Outcomes: Evidence from an Educational Reform in Romania

Ofer Malamud and Cristian Pop-Eleches*

March 2005

Abstract

Vocational training and general education are the two predominant forms of secondary schooling around the world. Most studies that compare the effect of vocational and general education on labor market outcomes in the cross-section suffer from selection bias since less able students are more likely to enroll in vocational programs. This paper exploits a 1973 educational reform in Romania that shifted a large proportion of students from vocational training to general education in order to avoid the bias caused by non-random selection. Using data from the 1992 Romanian Census, we analyze the effect of this policy in the context of a transition economy that experienced a decline in manufacturing and a reallocation of labor to new jobs. We find that cohorts affected by the policy were significantly less likely to work in manual or craft-related occupations but no less likely to be unemployed or out of the labor force than their counterparts who were not affected by the policy. We therefore conclude that the cross-sectional differences in labor market outcomes between graduates of vocational and general schools are largely a consequence of selection.

*Email: malamud@fas.harvard.edu and cp2124@columbia.edu respectively. We wish to thank Claudia Goldin, Caroline Hoxby, and Larry Katz for extensive comments, as well as seminar participants at Columbia University and the Harris School of Public Policy at the University of Chicago. Ofer Malamud gratefully acknowledges the financial support of the Spencer Foundation. All errors are our own.

1 Introduction

Most educational systems around the world contain both a general and a vocational component of secondary schooling. But there is remarkable diversity in the emphasis on general versus vocational education across different countries and a long-standing debate about the relative benefits of these different types of education.¹ In recent years, the World Bank has adopted a policy that supports general education rather than school-based vocational training (IBRD, 1991, 1995). This policy, which affects funding for vocational programs in many developing nations, is based on a large number of international case studies. However, cross-sectional comparisons across individuals with general and vocational education are plagued by selection bias since admission into different types of educational tracks is usually based on ability. In this paper, we address the problem of selection bias by considering an educational reform in Romania that essentially shifted a large proportion of students from vocational training to general education in 1973. We examine the labor market outcomes of cohorts affected by the policy in the context of a transition economy that experienced major technological and institutional change.

The debate about the relative benefits of general versus vocational education is often framed by the contrast between the American and European systems of education. Whereas the United States emphasizes formal general education in secondary schools, much of Europe relies on vocational training and apprenticeships to prepare its workforce for the labor market. Goldin (2000, p. 277) notes the essential trade-off between these different approaches: “Formal, school based education enabled American youths to change occupations over their lifetimes and to respond rapidly to technological change. Apprenticeships and highly specific training were more cost effective for individuals who expected to spend their lives in the same place and in the same industry and occupation.” Thus, Germany’s impressive growth following World War II may have been due to its highly qualified workforce trained in vocational schools while the superior

¹Appendix Table 1 highlights the wide range of vocational education enrollment across a selection of countries. Zymelman’s (1976) review of the evidence on rates of return to general and specific secondary schooling reveals contradictory findings from different studies. Psacharapoulos (1987) argues in favor of general secondary education but more recent evidence from Neuman and Ziderman (1991, 1999) suggests that vocational education may be beneficial when there is a match between the type of training and the occupation.

performance of the US economy in the 1980s and 1990s during a time of rapid technological change may be testimony to the flexible nature of its general education. Krueger and Kumar (2002, 2003) have recently applied this logic to explain the trends in relative growth between the US and Europe over the previous half-century. The rate of technological change is therefore an essential factor in determining the dominance of one form of education over another.²

A particularly dramatic instance of technological and institutional change occurred in the countries of Central and Eastern Europe after the fall of Communism. These countries, which relied to a large extent on vocational and technical training, suffered significant declines in their industrial sectors and a gradual reorientation of their economic activities towards services. Romania's experience was no different. Industrial employment fell from almost 45 percent of total employment in 1989 to only about 30 percent in 1995. (Earle, 1997) Registered unemployment rose from essentially no unemployment in 1991 to over 10 percent in 1993 and remained at a high level throughout the mid-1990s. (Earle and Pauna, 1996, 1998) Given such a profound economic transformation, we might expect the relative advantages of general education over vocational training to become apparent. Indeed, an OECD (2000) report on Romania argues that some of the blame for its disappointing economic performance during the transition period rests with the inflexibility of vocational training: "Under an emerging democratic and competitive market system, the state enterprises have had to adapt to changing demand and new competition. This adaptation has been hindered by a workforce trained in narrow specializations with little ability to adjust to changing skill demand." (p. 109)

So how have individuals with vocational training fared during transition compared to individuals with general education? The existing empirical evidence, based on cross-sectional comparisons, indicates that individuals with vocational training had worse labor market outcomes than those with general education. In particular, Earle (1997) finds that individuals with a general education were more likely to find jobs in the service sector and less likely to end up in agriculture or out of the labor force than their counterparts with vocational training. Similar findings emerge from other countries during their transition from Communism to a market-based

²Another important factor is the likelihood of making a mistake – relative to an individual's own specific abilities – by selecting students into specific educational tracks at such an early age.

economy. (Nesporova, 2001) However, one of the main problems with the interpretation of these results is that selection into different types of education tracks is not random. Admission into general and vocational schools is usually determined by a competitive examination so that less able students are more likely to enroll in vocational programs.³ Indeed, this problem affects most studies examining the relative benefits of vocational training and, as Bennel notes, “sample selection bias...is a pervasive weakness of almost all the...studies utilized in the 1993 [World Bank] global update.” (1996, p.238).⁴

This paper exploits an unusual educational reform in Romania to avoid the problem of selection bias. The reform, which occurred in 1973, prevented students from entering vocational schools after only 8 years of schooling and, instead, required them to receive an additional two years of general education. As a result of this policy change, secondary school cohorts born after January 1, 1959 were treated with more general education and less vocational training than cohorts born immediately before this date. Assuming that these adjacent cohorts were otherwise similar in unobserved characteristics, we can identify an unbiased estimate for the effect of shifting students from vocational training to general education. We consider the reduced-form effect of the policy, the effect of the policy on the treated population, and derive the specific effect of a year of vocational versus general education while accounting for additional schooling induced by the policy.

Using data from Romanian Census of 1992, we examine labor market outcomes for individuals some 20 years after the 1973 educational reform. The timing of the education reform and observance of labor market outcomes provide an excellent setting for understanding the effect of vocational education at a time of technological change: cohorts born around 1959 were in their mid-thirties during the early part of a transition period which may have begun to make their previously acquired skills obsolete. We find that cohorts born immediately before and

³Certainly, this is the case in Romania and most European countries that have a separate track for vocational education. Even in countries such as England and the United States that do not administer a competitive examination, there is a large degree of self-selection into vocational courses.

⁴Lechner (2000) represents one attempt to address this issue by using propensity score methods to evaluate a public sector vocational training programs in East Germany and finds no evidence of any positive effects on employment probabilities and earnings.

after January 1, 1959 received *very different* types of secondary education and but experienced *quite similar* labor market outcomes in 1992. Among individuals that were employed in 1992, those in cohorts affected by the policy were significantly less likely to be engaged in manual and craft occupations, indicating that the policy did alter the occupational composition of workers. However, the incidence of unemployment and nonemployment was not significantly different between cohorts affected and cohorts unaffected by the educational reform. Differences in imputed wages that reflect “occupational prestige” were also not significant. We interpret these results as evidence that the large cross sectional differences in most labor market outcomes between graduates of vocational and general secondary schools are driven mainly by selection.

The sign of the reduced-form estimates indicates that treating students with more general and less vocational education may actually reduce the likelihood of being gainfully employed, especially when one considers the possibility that the policy may have also increased overall educational attainment. But it is important to note that these estimates are relevant for the marginal student shifted from vocational to general education rather than for the average student.⁵ Our findings suggest that individuals who would have otherwise attended vocational schools may have benefited if they had remained in a more specialized vocational track. Furthermore, it is possible that 1992 was still relatively early in the transition period and the specialized vocational training was still beneficial. Perhaps a re-examination of these outcomes in later years will yield different findings.⁶ Finally, the consequences of such a drastic short-term expansion in general education may have introduced some crowding resource constraints. In switching teachers and resources from vocational training to general education, instruction in general schools may have been of a somewhat lower quality.

The paper is organized as follows. Section 2 provides a background of the Romanian educational system and the 1973 educational reform. Section 3 describes the data and the relevant samples. Section 4 explains the empirical strategy used to identify the effect of the policy and

⁵Since we are estimating a local average treatment effect (LATE) for individuals affected by the policy, these results may not hold for the population at large. See Imbens and Angrist (1994) for a thorough discussion of this issue and some instructive examples.

⁶The Romanian Census of 2002 is of particular interest in this regard. Unfortunately, we have so far been unable to gain access to this data.

derives the specific effect associated with vocational training. Section 5 presents the results, and Section 6 concludes.

2 Background

2.1 The Development of the Romanian Educational System

The educational system in Romania experienced several major reforms following the establishment of the Communist regime in late 1947. The first, undertaken in 1948, aligned Romania's educational system with that of the Soviet Union by nationalizing all educational institutions and adopting Marxist-Leninist principles of education.⁷ The second reform, undertaken in 1956 and 1957, established a unified system of primary and secondary schools and called for the reorganization of higher education.⁸ The unified system of primary and secondary schools became known as schools of general education. Soon after the 1956 reform, the overall period of schooling was raised from 10 to 11 years, and further lengthened to 12 years in 1961 by extending the length of compulsory education from 7 to 8 years.⁹

The third major reform, enacted under Law No. 11 of May 1968, called for the gradual extension of compulsory schooling from 8 to 10 years.¹⁰ However, five years after establishing government commitment for extending compulsory schooling, "the rate of 10-year school generalization was thought to be inadequate." (Dimitriu et. al, 1981, p. 37) As a result, the government introduced an explicit mandate to implement the 10 year system of general education under the provisions of Decree No. 278 and the Resolution of the Communist Party's Central Committee of June 18 and 19, 1973. These educational reforms of 1973 effectively pre-

⁷This reform was undertaken under Decree No. 175 of the Presidium of the Grand National Assembly of August 3, 1948. The reforms also stipulated the eradication of illiteracy.

⁸This reform was initiated by the Second Congress of the Romanian Communist Party in 1955 and undertaken by Decree No. 1380 and Decision No. 1003 of 1956 and 1957 respectively.

⁹Prior to the Communism, the combined primary-secondary school period was 12 years (4 years of primary school and 8 years of secondary schools or lyceum). The school period was reduced to 11 years in 1948 and to 10 years in 1951 (7 years of primary and 3 years of secondary) to coincide with the Soviet model.

¹⁰In addition, this law established new schools for training junior engineers and architectural foremen, and organized post-university education to offer refresher courses for specialists. However, these were largely minor changes to the existing organizational structure of the educational system.

vented students from pursuing vocational training after only 8 years of general education and, instead, required them to complete two additional years of general education. Decision No. 577 of the Council of Ministers in 1975 reaffirmed the earlier resolutions concerning 10 year compulsory general education and the restrictions on entry into vocational schools. Finally, all of these changes were brought together under Law No. 28 of May 1978, which replaced the earlier Law No. 11 of May 1968.

2.2 The Structure of Education in Romania

Apart from the changes induced by the 1973 reform, the structure of education in Romania throughout the 1970s was relatively stable. Students generally began compulsory schooling by entering schools of general education (*scoală de cultură generală*) after the age of 6.¹¹ More specifically, students entered grade 1 in September of the year following the calendar year in which they reached 6 years of age.¹² Since the mid-1950's, these schools offered a continuous sequence of 8 years of general education, nominally composed of primary education from grades 1 to 4 and gymnasium education from grades 5 to 8. Approximately 40 percent of the subjects taught in schools of general education were in the humanities and social sciences, 30 percent were in the sciences, while the remaining courses included industrial and technological subjects, art and physical education. After graduating from schools of general education, students could continue into secondary school lyceums or enter vocational schools and apprenticeship programs. With the extension of compulsory general schooling to 10 years of education, some general schools also began to include grades 9 and 10 (often as branches of the secondary school lyceums).¹³ The educational reform of 1973 prevented students from entering vocational and technical schools directly from schools of general education. Instead these students were required to stay on to grades 9 and 10 of general schools or enter lyceum schools in order to receive a general education.

¹¹Preschool education was offered in kindergartens for children ranging from 3 to 6 years of age.

¹²For example, students born in 1958 would enter grade 1 in 1973-74 while students born in 1959 would enter grade 1 in 1974-75. Furthermore, students born on December 31st would normally enter grade 1 at the age of 6 years and 9 months while students born on January 1st would normally enter grade 1 at the age of 7 years and 9 months.

¹³These additional years were also known as the upper 2-year cycle (*ciclul superior de 2 ani*) of schools of general education.

As mentioned above, students could enter secondary school lyceums after completing 8 years of general education. Secondary schools included academic or humanistic lyceums (*licee umanistice*), science lyceums (*licee reale*), art lyceums (*licee de artă*), industrial lyceums (*licee industriale*), agricultural lyceums (*licee agricole*), economic lyceums (*licee economice*), and health-oriented lyceums (*licee sanitare*). There were also teacher training lyceums (*licee pedagogice*) for teachers of lower elementary grades and kindergarten. Appendix Figure 2 provides some indication of the breakdown across the largest types of lyceums. Lyceums operated at two distinct levels. The first level corresponded to grades 9 and 10 of compulsory general education, while the second level encompassed further general education in grades 11 and 12. Graduates from the first level of lyceum who did not take further courses in the second level received a certificate of graduation from 10-year compulsory education (*certificat de absolvire a învățământului obligatoriu de 10 ani*). Admission to the second level was based on a composite score computed from academic achievement in the lower level and a competitive entrance exam.¹⁴ Graduates from the second level who passed the baccalaureate exam received the baccalaureate diploma (*diploma de bacalaureat*) while those who failed received a certificate of graduation (*certificat de absolvire*). Curriculum in lyceums was relatively homogenous despite differing in emphasis and specialty:

“During the first 2-years of lyceum education, students are offered a basically uniform curriculum both in academic and practical subjects whatever the character or orientation of a lyceum, its stated aims are to offer a well-balanced integrated curriculum composed of a number of subjects in the humanities, social studies, and the sciences, as well as subjects related to practical training in a particular field.” (Braham, 1978, p. 10)

According to one count, about 56 percent of the classes were taken by basic training and general knowledge classes, 14 percent by specialty subjects and 31 percent by productive activities. (Dimitriu et. al, 1981, p. 41)

Vocational schools (*școli profesionale*) provided training in numerous trades ranging from aircraft maintenance to winemaking. Appendix Figure 1 provides some indication of the breakdown across the broad specialties. The length of training varied by trade and depending on

¹⁴Agricultural, industrial and teacher-training lyceums sometimes offered 5 years of schooling.

whether students completed an additional two years of general education: “In 1967-68 vocational schools offered training in 232 trades, 175 of which required 3 years and 57, 2 years. With the decision to extend the compulsory educational system to 10 years the duration of day sessions in vocational schools was reduced in most fields.” (Braham, 1972, p. 73, footnote 10) Indeed, for graduates from the first stage of lyceum schools, training generally lasted from 1 to $1\frac{1}{2}$ years, depending on the trade. (Dimitriu et. al, 1981, p. 41) On-the-job apprenticeships (*ucenicia la locul de muncă*) trained workers in basically the same fields as those offered by vocational schools. The practical training period for apprenticeships was also normally between 2 and 3 years depending on the difficulty or complexity of the particular trade. Thus, though on-the-job apprenticeships were generally provided on-site rather than in vocational schools, they were sufficiently similar to be considered jointly in most government statistics. We shall do the same in our analysis.

Several different institutions provided further education beyond secondary and vocational schools. Technical schools for master craftsmen admitted graduates of vocational schools and lyceums who spent between 3 and 5 years in production. Courses in these schools lasted from 1 to 3 years and were intended to train technicians skilled in the organization and management of the production process. Postsecondary specialization schools admitted graduates of lyceums and trained them in specialized fields ranging from as aircraft construction and radiology.¹⁵ Finally, entrance to higher education in universities, institutes, academies and conservatories were open to graduates of the second level of lyceum schools and required a baccalaureate diploma.

2.3 The Educational Reform of 1973

The educational reforms of 1973, consisting of Decree No. 278 and the Resolution of the Communist Party’s Central Committee of June 18 and 19, 1973, were intended to increase the proportion of students with 10 years of general schooling. However, rather than increasing the educational attainment of students with less than 10 years of schooling, their principal effect was to shift students from vocational training to general education. In particular, Resolution of

¹⁵These schools were discontinued in 1977.

June 1973 stated that “beginning with the school year 1974-75, the entire graduating class of grade 8 will start in grade 9 of lyceums; vocational schools will no longer accept students from this class [grade 8] directly.”¹⁶ Thus, these reforms effectively prevented students from entering vocational schools after 8 years of general education and required them to enter the first level of lyceum schools instead. The structures of the educational system before and after the change in 1973 are depicted in Figure 1. Following the reform, students who would have otherwise received vocational training for two or three years were required to obtain an additional two years of general education.

Depending on their aptitudes, skills, and preferences, graduates of the first level of lyceum schools could (i) seek immediate gainful employment in production, (ii) continue to vocational school for $1-1\frac{1}{2}$ years, or (iii) continue to grades 11 and 12 in the second level of lyceum schools. In each case, students affected by the policy received less vocational training and more general education. Obviously, the effect of the policy on overall educational attainment for this group of students depended on the relative proportion of students in each category after the policy change. The emphasis on additional general education after 1973 caused a marked decrease in the prevalence of vocational training. As one secondary source explains, “the number of apprentices decreased during the 1970’s because of the extension of compulsory education to include 2 years in the lyceum,” and similar drops were observed in the number of students in vocational schools. (Braham, 1978, p. 11) But even students that continued to enter vocational schools after the policy change were treated with more general and less vocational training.

The Resolution of June 1973 provided for the expansion of compulsory schooling by introducing measures to assure that sufficient qualified teachers and school resources (such as science laboratories, classrooms, and dormitories) were allocated to local authorities. In particular, the Resolution stated that:

“[The expansion of compulsory general education to 10 years] will function within existing lyceums and in those that will be created (academic, industrial, agricultural and economic lyceums), as well as their branches located in existing gymnasiums or vocational schools.”

¹⁶These excerpts from the Resolution of the Communist Party’s Central Committee of June 18 and 19, 1973 are translated by the authors from the original Romanian text.

We can document some of these changes using the *Annual Statistics of the Socialist Republic of Romanian*. Figure 2 shows the large decline in the number of students enrolled in vocational schools and on-the-job apprenticeships between the school years 1973-74 and 1975-76. These declines occurred across all specialities in vocational schools as depicted by Appendix Figure 1. During this period, enrollment in lyceums increased sharply, as shown in Figure 3. Appendix Figure 2 indicates that enrollment increased across all types of lyceums with the largest increases occurring in industrial lyceums. As mentioned above, even these industrial lyceums emphasized general education much more than vocational schools. At the same time, the number of teachers in vocational schools fell while the number of teachers in lyceums rose in the initial years following the educational reform. In many cases, these changes did not represent any physical movement of resources; teachers and schools remained the same but their training and the curriculum were changed. As stated in the 1973 Resolution, “in order to provide for an effective educational environment and to use the existing facilities efficiently industrial lyceums will, in general, function within the same premises as vocational schools and under the same leadership.”

Further evidence for these dramatic changes is available from the Romanian Census of 1992. Since students began their compulsory schooling at age 6, they would have completed grade 8 by age 14 and grade 10 by age 16. Consequently, students born in 1958 would have been unaffected by the policy while those students born in 1959 would have been required to continue to grades 9 and 10 of lyceum schools. Figure 4 shows the educational attainment of all individuals from the Romanian Census of 1992 by year of birth. There is a sharp decline in the proportion of individuals with vocational training between cohorts born in 1958 and 1959. At the same time, we observe a sharp increase in the number of individuals that completed the first and second level of lyceum education (grades 9-10 and 9-12 respectively). Thus, the 1973 educational reform altered the proportion of students across vocational and general education as well as the nature of their exposure to vocational training.

3 Data

The main source of data for this research is the 15% sample of the Romanian Census of 1992. The 1992 Census provides information on gender, marital status, and age as well as ethnicity, and region of birth for about 50,000 individuals in each year of birth.¹⁷ There is also detailed information about the day and month of birth that prove especially useful in identifying the discontinuity induced by the policy within a narrow window of time. The 1992 Census distinguishes between various levels of education attainment: completion of primary education, gymnasium education, first stage of lyceum education (grade 9 and 10), second stage of lyceum education (grades 11 and 12), vocational training and apprenticeships, post-secondary technical education, and higher education. However, these categories are mutually exclusive so we cannot determine whether students with vocational training and apprenticeships also completed the first stage of lyceum education (for cohorts unaffected by the educational reform). As explained in the following section, this problem makes it more difficult to estimate the local average treatment effect of vocational training. Nevertheless, we will use aggregate data from the *Annual Statistics of the Socialist Republic of Romanian* on school enrollment for different types of education to move from reduced-form estimates of the effect of the policy to the effect of the policy on the treated population and the local average treatment effect of vocational education.

The Romanian Census contains several outcome variables of interest relating to employment status and occupations in 1992. Unfortunately, there is no direct wage or income data. We consider two different measures of employment status: unemployment and nonemployment. The former is restricted to individuals that are actively seeking work and therefore part of the labor force. The latter consists of all individuals not currently working and includes those out of the labor force. For individuals that are employed, we have detailed information on their current occupation based on 3 digit ISCO 88 codes. We use this information to infer whether individuals are employed in a manual (ISCO codes 5-9) or craft-related occupation (ISCO code 7), as well

¹⁷In addition, there is information on the status of the dwelling and availability of amenities in 1992. However, since these are contemporaneous with other outcomes, they may not be appropriate as proxy controls for income and class.

as particular gender-specific occupations such as metal workers and clerks for men, and textile workers and nurses for women. In addition, we construct a measure of occupational prestige by imputing wages based on the 3 digit occupation codes using an external data source.¹⁸ These “imputed wages” are computed separately for men and women. Finally, we consider an indicator for whether the individual is employed in the private sector.

Throughout the remainder of the paper, we will usually restrict our attention to the sample of students with a secondary school education. As Appendix Figure 3 shows, the policy did not seem to alter the proportion of students between secondary education and the higher or lower levels of education. Students completing their education after primary school or gymnasium were probably living in relatively rural areas that could not extend their network of lyceums in any case while students completing higher education should not have been affected by the policy.¹⁹ Consequently, we only consider students that completed the first stage of lyceum education (grade 9 and 10), second stage of lyceum education (grades 11 and 12), or vocational training and apprenticeships. Moreover, we shall often consider the sample of secondary educated men and women separately. Since boys were more likely to attend vocational schools than girls, the effect of the 1973 educational reform on labor market outcomes may be different across men and women. Furthermore, labor market outcomes such as employment status and occupational class vary widely between men and women so it is instructive to analyze these groups separately. Table 1 presents summary statistics for the full sample of men and women born 2 years before and after the policy change, as well as the restricted sample of secondary educated men and women in these same cohorts.

¹⁸These wage data are derived from an extract of a household survey conducted in 1994.

¹⁹In fact, the government established explicit rules about the provision of schools. If the number of students registered in grade 9 exceeded 25, the community had to operate a 10-year school of general education; if the number of students registered in grade 5 is at least 25, the community had to operate a 8-year school of general education; and if the number of children aged 6-9 was at least 7, the community had to operate a 4-year school.

4 Empirical Strategy

4.1 Basic Framework

This paper examines the effect of vocational training on labor market outcomes. Consequently, we begin by considering the following regression model:

$$outcome_i = \beta' \mathbf{X}_i + \delta VOC_i + \sigma S_i + \varepsilon_i \quad (1)$$

where $outcome_i$ is a labor market outcome such as unemployment, \mathbf{X}_i is a set of observable characteristics, VOC_i is years of vocational training, and S_i is years of schooling for individual i .²⁰ According to this specification, the coefficient on VOC_i represents the difference between the benefits from a year of vocational training and a year of general education in terms of some labor market outcome. A positive δ would indicate that the benefits of vocational training exceed the benefits of general education. Most empirical studies have traditionally adopted a simpler specification where individuals who receive vocational training are distinguished from individuals that receive a general education by a dummy variable so that VOC_i is equal to 1 if individual i received vocational training, and 0 otherwise. Clearly, an accurate cost-benefit analysis would also require consideration of the relative costs to providing vocational and general education. We abstract from this consideration here but evidence from other studies has indicated that providing vocational training is usually more expensive than providing general education (Bennel, 1996).

The principal problem with this specification is that years of vocational training may be correlated with unobserved ability that also affects labor market outcomes. Unobserved ability may be important because individuals with higher ability choose to enter general rather than vocational schools or because selection into different tracks is based on a competitive examina-

²⁰We can also motivate this equation from the standard regression equation for estimating the return to schooling $y_i = \beta' \mathbf{X}_i + \sigma S_i + \varepsilon_i$ where y_i is log wages. (Mincer, 1974). Distinguishing between vocational training and general education, we can write $y_i = \beta' \mathbf{X}_i + \nu VOC_i + \gamma GEN_i + \varepsilon_i$ where VOC_i is years of vocational training and GEN_i is years of general education for individual i . Given that total years of schooling $S_i = VOC_i + GEN_i$, we can rewrite the preceding equation as equation 1 when we allow for other labor market outcomes as dependent variables.

tion. The bias associated with such omitted variables could be avoided with an instrumental variable that was correlated with vocational training but uncorrelated with our labor market outcomes. The 1973 educational reform in Romania is one such instrument. By preventing students from entering vocational school after grade 8, cohorts affected by the educational reform were effectively treated with more general education and less vocational training. These changes became effective during the 1974-75 school year. Since students usually entered grade 1 only after reaching the age of 6, we expect that individuals born before 1959 would have been unaffected by the policy while those born after 1959 would have been required to continue to the first level of general lyceum schools instead of vocational schools.²¹

Estimating equation 1 using the 1973 educational reform as an instrument would be relatively straightforward if we had information on VOC_i and S_i for each individual i and if we could isolate the group of students that were affected by the policy. Unfortunately, not all of this information is available from the 1992 Romanian Census. Hence, we first consider the reduced form effect of the policy and the effect of the policy on the treated population. Only then do we attempt to derive the local average treatment effect of a year of vocational versus general education and account for additional schooling induced by the policy.

4.2 Reduced-form effect of the policy

As mentioned above, we do not have precise information on the number of years of vocational training and the total years of schooling for each individual. Instead, we only have information on whether students completed the first stage of lyceum school, the second stage of lyceum school, or vocational school.²² The first and second stage of lyceum school are associated with 10 and 12 years of general education respectively. Following the 1973 educational reform, all students that completed vocational school also completed the first stage of lyceum school. These students therefore received 10 years of general education and $1-1\frac{1}{2}$ years of vocational training.

²¹Thus, for example, individuals born on Dec 31st, 1958 would have entered grade 1 in 1965-66 and grade 9 in 1973-74. On the other hand, individuals born on Jan 1st, 1959 would have entered grade 1 in 1966-67 and grade 9 in 1974-75.

²²In addition, we know whether they completed gymnasium (8 years of schooling), primary school (4 years of schooling) or some form of postsecondary schooling.

However, prior to the 1974-75 school year, most students who completed vocational school would have received 8 years of general education and 2 to 3 years of vocational training. We cannot distinguish individuals who completed 2 year vocational courses from individuals who completed 3 year vocational courses before the policy change and individuals who completed 1 year vocational courses from individuals who completed $1\frac{1}{2}$ year vocational courses after the policy change. Furthermore, we cannot distinguish individuals who entered vocational school after grade 8 prior to the educational reform from those individuals who entered vocational schools after grade 10 and completed shorter vocational courses. Each of these problems will be addressed in the subsequent sections. The remainder of this section will explore reduced-form estimates for the effect of the policy.

Romania's educational reform of 1973 prevented students from entering vocational school after grade 8 and, instead, required them to receive an additional 2 years of general education in the first stage of lyceum schools. Consequently, students who were entering vocational courses of 2 to 3 years prior to the policy could either (i) enter the workforce, (ii) enter vocational school for shorter courses of $1-1\frac{1}{2}$ years, or (iii) enter the second stage of lyceum schools. In each case, individuals would be treated with less vocational training and more general education than they would have otherwise received in the absence of the policy. We can calculate a reduced-form effect of increasing vocational training by estimating the following regression model:

$$outcome_i = \beta' \mathbf{X}_i + \delta AFTER_i + \varepsilon_i. \quad (2)$$

where $AFTER_i$ is equal to 1 if individual i was born on or after January 1, 1959, and 0 if born on or before December 31, 1958 and all other variables are as defined in equation 1. As before, a positive δ would indicate that the benefits of vocational training exceed the benefits of general education. However, this coefficient represents the reduced-form effect of the policy on labor market outcomes rather than the effect of a year of vocational versus general education. Note that this specification does not control for years of schooling so any increase in educational attainment induced by the policy would also be captured by δ . We shall account for the effect of additional schooling associated with the policy in a later section.

This regression-discontinuity approach essentially compares the labor market outcomes of individuals in cohorts affected by the 1973 educational reform to their counterparts in cohorts born too early to be affected.²³ Restricting attention to a narrow window of cohorts minimizes any confounding effects associated with age or time of entry into the labor force. But an excessively narrow window reduces the sample size and leads to imprecise estimates. We therefore focus on a window that includes cohorts born 2 years on either side of the cutoff. Other windows will be considered for robustness. We can examine the effect of the policy on different populations by restricting attention to certain samples. In particular, we may be interested in the effect of the policy on the treated population. However, as explained in the following section, we cannot identify the treated population so we focus on the reduced-form estimates of the policy for individuals with a secondary education; that is, individuals who have completed the first stage of lyceum school, the second stage of lyceum school, or vocational school. Similarly, we can examine the reduced-form estimates of the policy for the entire population, including individuals who completed primary school, gymnasium, or higher education and were unaffected by the educational reform of 1973.

4.3 Effect of the policy on the treated population

There is no way to identify the group of students who would have entered vocational school after grade 8 had they not been affected by the policy since we only observe their educational outcomes in the presence of the policy. Instead, we examine the broader group of students who received a secondary level education and therefore *may* have been affected by the policy. If, as we contend in Section 3, the policy did not alter the composition of students between secondary schools and primary or further education, we can calculate the reduced-form effect of the policy on *secondary educated students* according to equation 2. Assuming that we could identify the group of students who entered vocational school after grade 8 prior to the educational reform, we would be able to calculate the proportion of students, π , who would have been affected by

²³See Hahn, Todd, and van der Klaauw (2000) for a detailed discussion of the specific assumptions necessary to identify treatment effects.

the policy out of the total population of secondary educated students. Then, scaling up the reduced-form effect, we could determine the effect of the policy on the treated population as δ / π .²⁴ Note that this resembles the standard calculation used in moving from an intention-to-treat (ITT) estimator to a treatment-on-the-treated (TOT) estimator. However, the reason for employing this method here is that we cannot identify the group of students who were affected by the treatment, rather than the conventional worry that individuals may be self-selecting into the treatment. Inflating the reduced-form estimate to yield an effect of the policy on the treated population requires the assumption that only *compliers* who were shifted from vocational to lyceum schools were affected by the policy. In other words, it is important that the educational experience of students who would have attended lyceum schools even in the absence of the policy was not affected due to the shift in students from vocational to lyceum schools.²⁵ However, we have reason to believe that the effect on the quality of education due to crowding or changing peer groups was small. Data indicates that the number of teachers rose in line with enrollment in lyceum schools so that pupil-teacher ratios probably remained roughly constant. Moreover, the nature of the expansion of lyceum schools probably largely retained the peer groups that existed prior to the educational reform.

Unfortunately, the group of students that entered vocational school after grade 8 prior to the policy change is not easily identified. We only have information on the highest level of education attained and some individuals that are listed as having completed vocational school may have already entered after grade 10 and were therefore not affected by the policy change. Lacking this information, we cannot scale up the estimate derived from the entire population of secondary educated student to determine the effect of the policy change on the treated population. There are two possible solutions: First, determine a lower bound for the effect of the policy on the treated population by scaling the reduced-form estimate using the proportion of students that completed vocational training (ignoring whether they were necessarily those students that

²⁴Such scaling of the reduced form estimate by the proportion of individuals that actually received the treatment was introduced by Bloom (1984).

²⁵Note that this type of interaction is usually assumed away in policy evaluations. It corresponds to the Stable Unit Treatment Value Assumption (SUTVA) in the terminology of casual inference (Angrist et. al., 1996).

entered vocational school after grade 8 and hence affected by the policy). In other words, we would knowingly scale up by a smaller number and include some students who were not affected by the policy. Second, we can use enrollment data to try and infer the proportion of students that were entering vocational school after grade 8 out of the total number of students entering vocational school before the policy change.

We estimate the rough proportion of vocational students at each level using enrollment data from the *Annual Statistics of the Socialist Republic of Romania*. Suppose, for convenience, that all courses in vocational school available after grade 8 lasted for exactly three years and that all courses in vocational schools available after grade 10 lasted for exactly one year. Furthermore, assume that there were no dropouts and that the number of students entering vocational school after grade 10 remained constant over time. Then we can estimate that approximately 45 percent of the students with vocational training born in 1958 had entered vocational school after grade 8.²⁶ Furthermore, we can estimate that approximately 40 percent of students that would have entered vocational school after grade 8 but for the policy reform, entered vocational school following grade 10 after completing an additional two years of general education.²⁷ Including students who were in apprenticeship programs (which are counted jointly with vocational students in the 1992 Census), we need to adjust these calculations so that approximately 50 percent of the students with vocational training or apprenticeships in 1958 were affected by the

²⁶Based on the enrollment data, approximately 250,000 students were enrolled in vocational schools in 1973-74 and 190,000 students were enrolled vocational schools in 1974-75. Since enrollment in 1973-74 includes three cohorts of students that entered after grade 8 whereas enrollment in 1974-75 only includes two cohorts of students that entered after grade 8 (in addition to a cohort of students that entered after grade 10 in each case), we can solve for the size of each cohort: 60,000 in the cohort that entered vocational after grade 8 and 70,000 in the cohort that entered vocational school after grade 10. Given these predicted sizes, we would expect the number of students enrolled in the following school year 1975-76 to equal 130,000 (which is not too far from the actual figure of 123,000).

²⁷Enrollment in vocational schools in 1976-77 was approximately 94,000. Although no more cohorts of students who entered vocational school after grade 8 should remain, students who would have wished to enter vocational school after grade 8 in 1974-75 could now enter after having completed grade 10 in general school. Since the numbers of students entering vocational school after grade 10 is assumed to remain constant, we can calculate that approximately 24,000 out of 60,000 students who were denied entrance in vocational school after grade 8 decided to continue on to vocational school after completing their additional two years of general education. Assuming that a similar proportion wished to continue into vocational school from the second and third cohorts after the policy reform, we would expect the number of students enrolled in the years 1977-78 and 1978-79 to be equal to 118,000 and 142,000 respectively (which is not too far from the actual figures of 114,000 and 138,000).

policy and about 45 percent of these students continued onto these programs after completing their additional two years of general education following the reform.²⁸ Given these numbers, we expect that the size of the cohort of students completing vocational training or apprenticeship programs of 1959 was about 75 percent of the size of the cohort of 1958, which is almost exactly what find in the data from the 1992 Census.

If we regard the calculations performed above seriously, then we must conclude that about 50 percent of the students with vocational training before 1959 – or 33 percent of the students with secondary education – were affected by the policy. Consequently, we would need to scale up the reduced-form estimate over all secondary educated individuals by a factor of 3 to derive an estimate of the policy on the treated population. Alternatively, scaling the reduced form estimate using the proportion of *all* students who completed vocational training requires a factor of 1.5. As discussed above, this represents a lower bound on the estimate of the policy on the treated population.

4.4 Effect of vocational training

The calculations of the preceding section imply that the effect of the educational reform on the treated population is approximately 3δ . However, it is difficult to interpret the magnitude of this estimate because the policy did not affect exposure to vocational training in the same way for all individuals. Recall that following the 1973 educational reform, students who would otherwise have entered vocational courses of 2 to 3 years could have either (i) entered the workforce, (ii) entered vocational school for shorter courses of $1-1\frac{1}{2}$ years, or (iii) entered the second stage of lyceum school. Consider the *maximum* possible change in vocational training that would arise if all courses in vocational schools for students entering after grade 8 prior to the policy change lasted 3 years and all courses in vocational schools after the policy change lasted 1 year. Then individuals in groups (i) and (iii) would have experienced three fewer years of vocational training

²⁸We employ a similar method is to derive the number of students in apprenticeship programs: Given enrollments of about 100,000 and 70,000 students in apprenticeships in 1973-74 and 1974-75 respectively, we calculate that approximately 30,000 students entered after grade 8 and 10,000 entered after grade 10. However, we also need to account for the secular decline in apprenticeships over time so that predictions of following years are adjusted accordingly.

while individuals in group (ii) would have experienced two fewer years of vocational training. On the other hand, the *minimum* possible change in educational attainment would arise if all courses in vocational schools for students entering after grade 8 prior to the policy change lasted 2 years and all courses in vocational schools after the policy change lasted $1\frac{1}{2}$ years. Then individuals in groups (i) and (iii) would have experienced two fewer years of vocational training and individuals in group (ii) would have experienced half a year less of vocational training. In order to derive the effect of the policy on vocational training, we need to calculate the relative proportion of students among the three groups.

We can provide some rough calculations on the average difference in vocational training before and after the policy change by comparing cohorts of individuals born in 1958 and 1959 using data from the 1992 Census. Based on this data, the number of students completing the first and second level of lyceum schools increased by about 4 and 11 percentage points respectively while the number of students completing vocational school fell by about 15 percentage points. Moreover, according to the calculations of the previous section, the number of students completing vocational school after having attended the first level of lyceum school increased by about 18 percentage points after the policy.²⁹ These estimates suggest that, among secondary educated individuals, the *maximum* average decrease in vocational training was .8 years and the *minimum* average decrease in vocational training was .4 years.

Now, rather than scaling the reduced-form estimate of the effect of the policy by the proportion of individuals who were affected by the policy, we can scale the reduced-form estimate by the average change in vocational training induced by the policy. In other words, we can calculate the local average treatment effect (LATE) of a year of vocational versus general education. We

²⁹Those calculations suggest that approximately 50 percent of the students with vocational training in 1958 were affected by the policy and about 45 percent of these students entered vocational schools after completing the first stage of lyceum schools. Since about 65 percent of secondary educated students received vocational training in 1958, the number of students completing vocational school after first level of lyceum education decreased by 18 percentage points.

can express an estimate of this effect as follows:³⁰

$$E[outcome_i | V_i] = \frac{E[outcome_i | AFTER_i = 1] - E[outcome_i | AFTER_i = 0]}{E[V_i | AFTER_i = 1] - E[V_i | AFTER_i = 0]} \quad (3)$$

Conditional on observable characteristics, \mathbf{X}_i , the numerator of this expression is simply δ from equation 2. The denominator of the expression is the difference in the average quantity of vocational training between individuals in cohorts that were affected by the educational reform and their counterparts in cohorts that were unaffected. Applying the calculations above, we can conclude that the effect of an additional year of vocational training instead of general education on labor market outcomes is between 1.25δ and 2.5δ . Note that the standard method for estimating this expression is by two-stage least squares (2SLS). However, given the data limitations, we have had to resort to this rather indirect approach.

4.5 Accounting for additional schooling

Since we do not have information on schooling at the individual level, it is important to consider the average effect of the policy on total years of schooling. If, for example, the policy increased overall educational attainment then we might expect that the educational reform would have improved labor outcomes conditional on years of vocational training. A cursory comparison between the difference in years of schooling for individuals in groups (i) to (iii) suggests that the policy may have increased average educational attainment. Consider the *minimum* possible change in educational attainment that would arise if all courses in vocational schools for students entering after grade 8 prior to the policy change lasted 3 years and all courses in vocational schools after the policy change lasted 1 year. Then individuals in group (i) would have experienced one less year of schooling, individuals in group (ii) would have experienced no change in their quantity of schooling, and individuals in group (iii) would have experienced one additional year of schooling. On the other hand, the *maximum* possible change in educational attainment would arise if all courses in vocational schools for students entering after grade 8

³⁰See Imbens and Angrist (1994) for the assumptions that underly estimates of LATE. In particular, we need to assume a version of their monotonicity requirement if we wish to allow for non-constant treatment effects.

prior to the policy change lasted 2 years and all courses in vocational schools after the policy change lasted $1\frac{1}{2}$ years. Then individuals in group (i) would have experienced no change in their quantity of schooling, individuals in group (ii) would have experienced a year and a half of additional schooling, and individuals in group (iii) would have experienced two and a half years of additional schooling.

As with the preceding analysis of vocational training, we can provide some rough calculations on the average difference in educational attainment before and after the policy change by comparing cohorts of individuals born in 1958 and 1959 using data from the 1992 Census. These estimates suggest that, among secondary educated individuals, the *maximum* average increase in educational attainment was .6 years of general schooling and the *minimum* average increase in educational attainment was .1 years of general schooling. Appendix Figure 4 shows the average quantity of schooling by year of birth based on the calculations described above. We should therefore regard unadjusted estimates of the effect of the policy as an upper bound which understates the effect of vocational training on labor market outcomes. Furthermore, these approximate calculations could be used to correct the estimates of the effect of the policy using estimates from the literature or by considering an earlier expansion from 7 to 8 years of compulsory education that occurred in Romania in 1961. Finally, it is possible that the increase in educational attainment was a result of the shift from vocational to general education.³¹ In this case, we might not wish to control for the effect of any additional schooling at all.

5 Results

5.1 Cross-sectional analysis

Before turning to the central findings of the paper associated with the 1973 educational reform, we examine the standard cross-sectional relationship between vocational training and labor market outcomes. As mentioned earlier, studies in Romania and other Eastern European countries

³¹Students that were required to attend general secondary school for an additional two years may have been better prepared and interested in furthering their education (perhaps as a way of increasing their chances of enrolling in university).

during the transition from Communism to a market system have found that rates of unemployment are higher among individuals with vocational training than those with general education.³² We will consider the effect of vocational training on both occupational outcomes and other labor outcomes indicating labor market participation in 1992. Among the occupational outcomes are the probability of being employed in a manual and craft-related occupation, as well as more particular gender specific occupations. Employment status in 1992 is reflected using two different measures: unemployment and nonemployment. The former consists only of individuals actively seeking work whereas the latter includes all individuals out of the labor force as well as those that are unemployed. Other labor market outcomes include the probability of being employed in the private sector and log wages associated with the current occupation, imputed from external sources of data. Tables 2 and 3 illustrate the cross-sectional relationship between vocational training and these various labor market outcomes. Essentially, we run the regression associated with equation 1 described in section 4. The sample includes individuals with a secondary education who were born between 1957 and 1961 to correspond with the samples in the reduced-form regressions to be presented later. Results for men and women are presented separately and all regressions control for a linear month of birth trend, marital status, ethnicity, region of birth, and an indicator for urban region of birth.

The effect of vocational training on occupational outcomes in 1992 is shown for men and women in panels A and B of Table 2. All the coefficients on *VOC* are highly significant. Column (1) indicates that both men and women with vocational training are significantly more likely to be employed in manual occupations than their counterparts with general education who completed the first or second stage of lyceum school. In particular, men are approximately 22 percent and women are approximately 42 percent more likely to be manual workers. Recall from Table 1 that 85 percent of men and 53 percent of women are employed in manual occupations, so vocational training makes a greater difference for women than men.³³ Similarly, column

³²The relevant study for Romania by Earle (1997) uses data from Labor Force surveys in 1993 and 1995.

³³Though not shown, covariates indicate that men who are married and individuals who were born in urban areas are less likely to be employed in manual occupations. Moreover, all individuals with a Hungarian and Gypsy ethnic background are more likely to be employed in manual occupations compared to Romanians.

(2) reveals that both men and women with vocational training are significantly more likely to be employed in craft occupations than those with general education (approximately 13 and 28 percent respectively). In considering more particular occupations, a similar pattern emerges. Column (3) shows that men with vocational training are significantly more likely to be metal workers while women with vocational training are significantly more likely to be textile workers. On the other hand, men with vocational training are significantly less likely to be clerks or technicians while women with vocational training are significantly less likely to be nurses, as evidenced in column (4). This confirms that clerks and nurses correspond to occupations that are not associated with much vocational training.

The effect of vocational training on unemployment in 1992 is shown for men and women in column (1) of Table 3. Men with vocational training are approximately 1.2 percentage points more likely to be unemployed than their counterparts with general education who completed the first or second stage of lyceum school. On a base of 6 percent unemployment, the coefficient on *VOC* represents a large and significant difference. Women with vocational training are approximately .7 percentage points more likely to be unemployed than their counterparts with general education. Although smaller in absolute value, this effect is still highly significant and relatively large on a base of only 5 percent unemployment.³⁴ Column (2) shows the effect of vocational training on nonemployment for men and women. Not surprisingly, since most men are employed in the labor force, the effect on nonemployment for men is similar to the effect on unemployment – approximately 1.3 percentage points. But this effect is much larger for women who are also more likely to be nonemployed than men. Women with vocational training are approximately 3.6 percentage points more likely to be nonemployed than those with general education. Nevertheless, with a base of more than 15 percent nonemployment, the relative effect for women is not substantially different than for men. Column (3) indicates that both men and women with vocational training are significantly more likely to be employed in the

³⁴Though not shown, the effect of the covariates on unemployment generally accord with intuition. The coefficient on the month of birth trend is positive and significant reflecting that younger individuals are more likely to be unemployed. Individuals that are married are significantly less likely to be unemployed and those born in urban regions are significantly more likely to be unemployed. Finally, men with a Hungarian or Gypsy ethnic background are also significantly more likely to be unemployed compared to Romanians.

private sector. Finally, the effect of vocational training on log wages associated with the 1992 occupation is shown in column (4). Since these wages are imputed by occupation, they provide some indication of occupational prestige rather than a measure of individual earnings.³⁵ Men with vocational training are employed in occupations that earn approximately 4.5 percent less than their counterparts with general education. Women with vocational training are employed in occupations that earn almost 7 percent less than those with general education.³⁶

Thus, results from the cross-section confirm the findings from earlier studies that individuals with vocational training are more likely to be unemployed or exit from the labor force than their counterparts with general education. They also indicate that individuals with vocational training are more likely to be employed in manual and craft-related occupations that have lower occupational prestige. These results hold when examined separately in the period before and after January 1, 1959 (not shown). Furthermore, the effect of vocational training on all these labor market outcomes is almost identical when we include fixed effects for month of birth in order to focus on the relationship within each cohort (not shown).

5.2 Effect of the 1973 educational reform

Preceding sections have already provided some evidence for the change in the nature of secondary school education resulting from the 1973 educational reform. Recall that the policy prevented students from entering vocational school after only 8 years of schooling, and instead, required them to receive an additional 2 years of general education. Even if all students affected by the policy continued on to a shortened vocational course after completing the additional years of general education, they would have been treated with less vocational training and more general

³⁵It is also possible to construct measures of skill ranging from 1 to 4 using the International Labor Organization (ILO) classification. This measure defines occupational skill level as 1 for manual laborers and elementary occupations, 2 for craftsmen and clerks, 3 for skilled technicians, and 4 for professionals, managers, and administrators. Simple linear regressions suggest that vocational training is associated with lower occupational skill levels (not shown).

³⁶Again, the effect of the covariates on this measure of wages is generally significant and consistent with previous findings. Individuals who were born later are employed in occupations that earn significantly less. Married men are employed in occupations that earn more while married women are employed in occupations that earn slightly less. Individuals born in urban areas are employed in occupations that earn significantly more and those with non-Romanian ethnicity are employed in occupations that earn significantly less than Romanians.

education. However, as Figure 4 indicated, there was also a sharp drop in the proportion of students who received vocational training for cohorts born between 1958 and 1959. Many students who would have otherwise attended vocational school prior to the educational reform ended up completing their education in general lyceum schools instead. The 1973 educational reform thus altered the proportion of students across different types of educational categories as well as the nature of their exposure to vocational training.

The effect of the 1973 educational reform on the proportion of students with vocational training is even more striking when we define cohorts narrowly. Figure 5 plots the proportion of secondary educated men and women with vocational training by month and week of birth (panels A-D). Each panel indicates an extremely sharp discontinuity in the first month – month 0 – following January 1, 1959. Linear regression analysis of the break in trend around this cutoff indicates that the probability of completing vocational school drops by about .13 for secondary-level educated men and .14 for secondary educated women (not shown).³⁷ In other words, the probability of completing vocational school fell by more than 20 percent for cohorts of men and by almost 34 percent for cohorts of women that were affected by the policy. Individuals born merely two weeks apart were exposed to extremely different types of education. In this section, we examine the reduced-form results for labor market outcomes based on equation 2 from section 4. We include individuals with a secondary education who were born between 1957 and 1961 and therefore within 2 years of the January 1, 1959 cutoff.³⁸ Robustness checks for alternative ranges of cohorts and samples are discussed in the subsequent section.

Table 4 shows the the reduced-form effect of the 1973 educational reform on occupation outcomes in 1992. Almost all of the coefficients on *AFTER* in the table are significant, suggesting that the educational reform did alter the occupational structure of individuals that were affected by the policy. Columns (1) and (2) indicate that the probability of being employed in a

³⁷These results represent the coefficient on *AFTER* derived from equation 2 with vocational training as the dependent variable: i.e. $VOC_i = \beta' \mathbf{X}_i + \delta AFTER_i + \varepsilon_i$.

³⁸Most regressions include controls for a month of birth trend, marital status, ethnicity, region of birth (not shown in the tables), and an indicator for urban region of birth. Some specifications also include the dummy variables for the calendar month in order to avoid any confounding effect resulting from a particular month of birth).

manual occupation were significantly lower for both men and women in cohorts affected by the policy than their counterparts who were not affected by the policy.³⁹ For men, the reduced-form effect of approximately 1.7 percentage points represents an effect of about 5 percentage points for the treated population. Based on the calculations of section 4, these estimates indicate that a year of vocational training instead of general education probably increased the probability of being employed in a manual occupation by 3 to 4 percentage points.⁴⁰ For women, the effect of the policy on the probability of being employed in a manual occupation is approximately 3.5 percentage points, implying an effect of over 10 percentage points for the treated population. Columns (3) and (4) show that the probability of being employed as a craft worker was also significantly lower for people in cohorts affected by the policy. The magnitudes of these coefficients are even larger: 2.5-3 percentage points for men and about 4.5 percentage points for women. The corresponding effect on the treated population is 9 percentage points for men and 15 percentage points for women. Thus, an additional year of vocational training instead of general education probably increased the probability of being employed in a craft-related occupation by 4 to 8 percentage points for men and by 5 and 12 percentage points for women.

Looking at particular occupations in columns (5)-(8) confirms that the policy had an effect on occupational structure. For men, the policy had a significantly positive effect on the probability of being employed as a metal worker and a significantly negative effect on the probability of being a clerk or technician. This is not surprising given that metal workers were more likely to have received vocational training and clerks were more likely to have received general education since the policy reduced the probability of receiving vocational training. While the coefficients are smaller in magnitude, the effects are relatively large considering the small numbers of men in these occupations. For women, a similar pattern emerges: The policy had a significantly positive

³⁹The effect of the policy is not quite significant for men when we include demographic controls and dummies for calendar month of birth. It is, however, significant at the 10% level and just barely insignificant at the 5% level.

⁴⁰This effect are slightly smaller than expected based on the cross-sectional relationships between vocational training and manual occupations. However, these results need to be interpreted in the context of Romania's unique Communist "labor market". Even individuals with more general education may have been required to enter manual occupations when joining the labor force. Thus, the effect on their occupation in 1992 may have been muted due to their standard labor market experience.

effect on the probability of being employed as a textile worker and a significantly negative effect on the probability of being a nurse. Figure 6 plots the proportion of secondary educated men employed as manual workers, craft workers, metal workers, and clerks/technicians by month of birth around the policy change. There is a clear break in the trend around the policy change for each occupation. Figure 7 plots the analogous proportions for women by month of birth around the policy change (substituting textile workers and nurses for metal workers and clerks). Again, the break in trends are clearly visible. Together with the regression results, these findings confirm that the educational reform of 1973 altered the occupational structure for individual in cohorts that were affected by the policy in a substantial fashion.

Table 5 shows the reduced-form effect of the 1973 educational reform on labor market participation and other outcomes in 1992. Columns (1) and (2) shows that the effect of the policy on the probability of being unemployed is insignificant for both men and women. Similarly, columns (3) and (4) show that the effect of the policy on nonemployment is insignificant for both men and women. The effect of the policy on the probability of being employed in the private sector is also insignificant for both men and women, as shown in columns (5) and (6). Columns (7) and (8) shows the reduced-form effect of the 1973 educational reform on log wages associated with 1992 occupations. The effect of the policy on this measure of occupational prestige is insignificant in all of the specifications and samples. Given that these wages are imputed by occupation, only a variation in occupational structure between cohorts affected and unaffected by the policy could yield any significant results. Though the previous section revealed that the policy did affect occupational structure, there do not appear to be any strong findings related to this occupation-based outcome.⁴¹ Figures 8 and 9 confirm these findings. None of the panels reveal any obvious effect of the policy on the proportion of secondary educated men or women that are unemployed, nonemployed, working in the private sector, or on their occupational prestige. These findings contrast sharply with those from the cross-sectional analysis which indicated

⁴¹Results using the ILO classification of occupational skill suggest that individuals in cohorts affected by the policy had a greater average skill level compared to their counterparts in cohorts that were unaffected by the policy (not shown). However, these simple linear regressions are somewhat problematic given the nature of this measure.

that vocational training increased the likelihood of unemployment and nonemployment, and was associated with lower imputed wages.

5.3 Robustness checks

The results of the previous section were based on a sample of individuals with a secondary education who were born between 1957 and 1960 and therefore within 2 years of the January 1, 1959 cutoff (4 year window). We consider two alternative samples that extend or restrict the window around the cutoff: individuals with a secondary education that were born between 1958 and 1959 (2 year window) and individuals that were born between 1955 and 1962 (8 years window). We expect the effect of the policy to be larger in the narrow windows but the precision of the estimates to be higher in the broad windows. Panels A and B of Appendix Table 2 presents results for men and women with a secondary education for the main outcomes of interest under these alternative window specifications.⁴² The effect of the educational reform on the probability of being employed as a manual worker and the probability of being employed as a craft worker remain as before. As expected, the magnitudes of the effect of the policy are larger in the narrow windows and the standard errors smaller in the broad windows. Moreover, the effect of the policy on unemployment and log wages is not significant in any of the specifications. Panels C and D presents results with the same alternative windows for *all* individuals, including those with primary, gymnasium and higher education. Since the policy should not have affected these other individuals, we expect the results to be smaller in magnitude but largely unchanged. Indeed, the coefficients on *AFTER* that are significant do appear to be smaller in magnitude. But scaled up appropriately, these reduced-form estimates yield similar effects of the policy on the treated population.

Appendix Table 3 presents additional robustness checks for each labor market outcome. Focusing on the standard window of 4 years and including a full set of controls, we examine reduced-form estimates around alternative year cutoffs. In essence, we consider “placebo” exper-

⁴²These regressions include a full set of controls except dummy variables for the calendar year of birth. Since they are colinear, these dummy variables cannot be included together with a month time trend for the 1-year specification. They are excluded from all specifications for the purposes of comparability.

iments around January 1 of the three preceding and three following years. Columns (1) shows that there is no significant difference in the likelihood of being unemployed or nonemployed for cohorts born before or after January 1 in most other years while column (3) confirms the exceptional effect of the policy in significantly reducing the likelihood of being employed in a manual or craft-related occupation.⁴³ Columns (2) and (4) indicate that there is no significant effect of alternative cutoffs on nonemployment or log wages imputed by occupation in 1992.

In addition to these robustness checks, we also considered adding higher-order polynomial trends based on month of birth, week of birth, and day of birth. We also attempted to cluster by month of birth and year of birth to account for any correlation in the errors among individuals born in similar time periods. None of these variations altered our results in any way.

6 Conclusion

The relative benefits of vocational and general education have long been a subject of debate among scholars and policy makers in the fields of economics and education. This paper exploits an educational reform that occurred in Romania in 1973 in order to avoid the selection bias that arises because less able students are more likely to enroll in vocational programs. By requiring students born after January 1, 1959 to complete an additional two years of general education instead of entering vocational schools, the policy shifted about 15% of the students in secondary school from vocational to general lyceum schools within a single year. The policy also shortened the length of vocational courses so even students affected by the policy who continued to vocational school after completing an additional two years of general education received at least a year less of vocational training. The 1973 educational reform thus caused secondary students to unambiguously receive more general education and less vocational training. Using the Romanian Census of 1992, we find evidence that individuals who were affected by the policy were more likely to work in manual and craft occupations than their counterparts who were

⁴³There appears to be some effect associated with the January 1, 1957 cutoff. Both unemployment and the probability of being employed in a manual occupation are significantly higher for individuals that were born after this date. However, examining figures 7 and 9 does not reveal any obvious break in the trend.

born too early to be affected by the policy. However, we find no significant difference in the probability of being unemployed or out of the labor force between individuals who were affected by the policy and those who were unaffected by the policy.

The findings associated with the 1973 educational reform are in sharp contrast to the cross-sectional evidence that individuals with vocational training are significantly more likely to be unemployed or out of the labor force. They suggest that the positive relationship between vocational training and unemployment highlighted by previous studies may largely be a consequence of selection. One reason that we do not observe the positive benefits of a general education may be associated with the nature of the policy itself. The sudden change in the educational character of secondary schooling in Romania that is essential to credibly identifying the effect of vocational training may not have been ideal for the actual students. Such a drastic expansion in general education may have caused a reduction in the quality of general education. While we argue that crowding in general lyceum schools was not an issue because of the influx of teachers, these teachers may have been relatively inexperienced. As a result, the average level of instruction in general schools may have declined in the initial years following the 1973 educational reform. Another explanation for the findings may rest with the specific time-period being examined. The transition to a market economy was still in its initial stages during 1992. The readjustment of labor across different sectors persisted throughout the 1990s as employment in industry declined and gradually shifted to agriculture and services. Unemployment continued to rise after 1992 and only reached a peak in 1999.⁴⁴ Although substantial technological and institutional change had already occurred by 1992, vocational training may have remained relatively beneficial in the early part of the transition period. Examining labor market outcomes in later years may help shed further light on the effects of general and vocational training.

The sign on the reduced-form estimates indicate that vocational training may actually reduce the likelihood of unemployment, especially when considering the possibility that the policy increased overall educational attainment. Is it possible that, contrary to conventional wisdom,

⁴⁴Statistics from the Romanian Statistical Yearbook of 2002 indicate that employment in industry continued to decrease from 29.2 percent in 1996 to 23.5 percent in 2001. Unemployment in the overall population rose from about 7 percent in 1996 to almost 12 percent in 1999 and then fell back to 9 percent in 2001.

vocational education is more effective than general education? It is important to remember that these estimates are relevant for the marginal student shifted from vocational to general education and not necessarily for the average student. The population of students affected by the educational reform may, in fact, have benefited more if they had remained in vocational schools that taught specific skills. More able students who were already attending general lyceum high schools would not necessarily gain from such specialized vocational training.⁴⁵ In other words, it is crucial to consider the effect of vocational training on different segments of the population and across different parts of the ability distribution. The sweeping emphasis on general education adopted by the World Bank may not be appropriate for all individuals.

⁴⁵Bowlby and Schriver (1973) consider the possibility that rates of return to vocational training might differ by ability.

References

- ANGRIST, J., IMBENS, G.W., and D.B. RUBIN (1996) "Identification of Causal Effects Using Instrumental Variables" *Journal of the American Statistical Association* 91(434): 444-455
- BENNEL, P. (1996) "General versus Vocational Secondary Education in Developing Countries: A Review of the Rates of Return Evidence" *Journal of Development Studies* 33(2): 230-47
- BLOOM, H. (1984) "Accounting for No-shows in Experimental Evaluation Designs" *Evaluation Review* 8: 225-46
- BOWLBY, R.L. and W.R. SCHRIVER (1973) "Academic Ability and Rates of Return to Vocational Training" *Industrial and Labor Relations Review* 26(3): 980-90
- BRAHAM, R.L. (1972) *Education in Romania: A Decade of Change*, US Government Printing Press
- BRAHAM, R.L. (1978) *The Educational System of Romania*, US Government Printing Press
- DIMITRIU, E., IONESCU, O. NICA, I. and I. ORGHIDAN (1981) *A Concise History of Education in Romania*, Editura Stiintifica si Enciclopedica
- EARLE J.S. (1997) "Industrial Decline and Labor Reallocation in Romania" Working Paper 118 of the William Davidson Institute
- EARLE J.S. and C. PAUNA (1996) "Incidence and duration of unemployment in Romania" *European Economic Review* 40: 829-837
- EARLE J.S. and C. PAUNA (1998) "Long-term unemployment, social assistance and labor market policies in Romania" *Empirical Economics* 23: 203-235
- GOLDIN, C. (2001): "The Human-Capital Century and American Leadership: Virtues of the Past" *Journal of Economic History* 61(2): 263-292
- HAHN, J., TODD, P., and W. VAN DER KLAAUW (2001) "Identification and Estimation of Treatment Effects with a Regression Discontinuity Design" *Econometrica* 69(1): 201-209
- IBRD (1991) *World Bank Policy Paper: Vocational and Technical Education and Training*. Washington, DC: World Bank
- IBRD (1995) *Priorities and Strategies for Education: A World Bank Sector Review*. World Bank Education and Social Policy Department, Washington , DC

- IMBENS, G.W. and J.D. ANGRIST (1994) "Identification and Estimation of Local Average Treatment Effects" *Econometrica* 62(2): 467-475
- KRUEGER, D. and K. KUMAR (2003a) "Skill-specific rather than General Education: A Reason for US-Europe Growth Differences?" NBER Working Paper 9408
- KRUEGER, D. and K. KUMAR (2003b) "US-Europe Differences in Technology-Driven Growth: Quantifying the Role of Education" NBER Working Paper 10001
- LECHNER, M. (2000) "An Evaluation of Public Sector Sponsored Continuous Vocational Training Programs in East Germany" *Journal of Human Resources* 35(2): 347-375
- MIDDLETON, J., ZIDERMAN, A. and A. VAN ADAMS (1993) *Skills for Productivity: Vocational Education and Training in Developing Countries*. Oxford University Press
- MINCER, J. (1974) *Schooling, Experience, and Earnings*. New York: Columbia University Press
- NESPOROVA, A. (2002) "Unemployment in Transition Economies" Economic Analysis Division Seminar Paper, United Nations Economic Commission for Europe
- NEUMAN, S. and A. ZIDERMAN (1991) "Vocational Schooling, Occupational Matching, and Labor Market Earnings in Israel" *Journal of Human Resources* 26(2): 256-281
- NEUMAN, S. and A. ZIDERMAN (1999) "Vocational Education in Israel: Wage Effects for the VocEd- Occupation Match" *Journal of Human Resources* 34(2): 407-420
- PSACHAROPOULOS, G. (1987) "To Vocationalize or Not to Vocationalize?: That is the Curriculum Question" *International Review of Education* 33(2): 187-211
- OECD (2000) *Reviews of National Policies for Education: Romania*
- ROMANIA GOVERNMENT, *Annual Statistics of the Socialist Republic of Romanian 1960-1980*
- ROMANIA GOVERNMENT, *Statistics Yearbook 2004*, http://www.insse.ro/download/anuar_2002/aseng2002.
- ROMANIA GOVERNMENT (1973) *Resolution of the Communist Party's Central Committee of June 18 and 19, 1973*, Editura Politica, Bucharest
- ROMANIA GOVERNMENT (1968) *The Education Law of the Socialist Republic of Romania*, Didactical and Pedagogical Publishing House, Bucharest
- ZYMELMAN, M. (1976) *The Economic Evaluation of Vocational Training Programs*. Baltimore, MD: Johns Hopkins University Press

Table 1: Descriptive Statistics

	Entire sample			Secondary-educated sample		
	Mean	SD	N	Mean	SD	N
Panel A: Men						
<i>Demographic controls</i>						
Married	0.80	0.40	90,072	0.82	0.38	56,085
Urban	0.27	0.44	90,120	0.26	0.44	56,114
Romanian	0.89	0.31	90,172	0.91	0.29	56,128
Hungarian	0.07	0.25	90,172	0.07	0.25	56,128
Gypsy	0.02	0.15	90,172	0.01	0.08	56,128
<i>Education variables</i>						
Vocational	0.36	0.48	89,909	0.58	0.49	55,865
Lyceum 9-10	0.03	0.16	89,909	0.04	0.21	55,865
Lyceum 11-12	0.24	0.42	89,909	0.38	0.49	55,865
<i>Labor market outcomes</i>						
Manual worker	0.80	0.40	85,076	0.85	0.36	54,044
Craft worker	0.44	0.50	85,076	0.52	0.50	54,044
Metal worker	0.03	0.17	85,431	0.03	0.18	54,262
Clerk	0.09	0.28	85,431	0.10	0.30	54,262
Unemployed	0.07	0.26	86,841	0.06	0.24	54,829
Nonemployed	0.10	0.30	90,004	0.08	0.27	56,010
Private sector	0.08	0.28	90,174	0.05	0.22	56,130
Imputed log wages	6.74	0.24	85,417	6.74	0.19	54,248
Panel B: Women						
<i>Demographic controls</i>						
Married	0.88	0.32	86,760	0.89	0.32	44,454
Urban	0.27	0.44	86,772	0.29	0.45	44,453
Romanian	0.90	0.30	86,812	0.92	0.27	44,474
Hungarian	0.06	0.24	86,812	0.06	0.25	44,474
Gypsy	0.02	0.14	86,812	0.00	0.05	44,474
<i>Education variables</i>						
Vocational	0.18	0.38	86,475	0.34	0.47	44,135
Lyceum 9-10	0.04	0.21	86,475	0.09	0.28	44,135
Lyceum 11-12	0.29	0.45	86,475	0.57	0.50	44,135
<i>Labor market outcomes</i>						
Manual worker	0.60	0.49	68,156	0.53	0.50	38,661
Craft worker	0.25	0.43	68,156	0.29	0.45	38,661
Metal worker	0.01	0.09	68,170	0.01	0.10	38,673
Clerk	0.21	0.41	68,170	0.33	0.47	38,673
Unemployed	0.05	0.21	68,813	0.05	0.21	38,970
Nonemployed	0.24	0.43	86,636	0.16	0.37	44,375
Private sector	0.11	0.31	86,814	0.05	0.22	44,474
Imputed log wages	6.57	0.23	68,045	6.57	0.19	38,601

Notes: SD is the standard deviation and N is the sample size. All summary statistics based on cohorts born between 1957 and 1961 (within 2 years of January 1, 1959). The sample of secondary-educated men includes men with vocational and general secondary education only. The sample of secondary-educated women includes women with vocational and general secondary education only. All labor market outcomes are from 1992. Imputed wages are imputed hourly log wages associated with 3 digit occupational codes and computed separately for men and women.

Table 2: Effect of vocational training on occupational outcomes in 1992: cross-section (OLS) results

	Broad occupation		Gender specific occupation	
	Manual worker	Craft worker	Men: Metal worker Women: Textile w.	Men: Clerk Women: Nurse
	(1)	(2)	(3)	(4)
Panel A: Men				
VOC	0.223** [0.003]	0.127** [0.004]	0.025** [0.001]	-0.175** [0.003]
Constant	0.776** [0.010]	0.486** [0.015]	-0.002 [0.004]	0.170** [0.008]
Month of birth trend	Y	Y	Y	Y
Dem. Controls	Y	Y	Y	Y
R ²	0.11	0.02	0.01	0.09
Sample Size	53,712	53,712	53,930	53,930
Panel B: Women				
VOC	0.420** [0.005]	0.284** [0.005]	0.156** [0.004]	-0.011** [0.001]
Constant	0.394** [0.016]	0.179** [0.015]	0.056** [0.011]	0.009** [0.003]
Month of birth trend	Y	Y	Y	Y
Dem. Controls	Y	Y	Y	Y
R ²	0.19	0.1	0.07	0.01
Sample Size	38,408	38,408	38,420	38,420

Notes: Robust standard errors in brackets. ** and * indicate statistical significance at the 1 and 5 percent level, respectively. Samples include cohorts with a secondary-level education born between January 1, 1957 and December 30, 1960. Demographic controls include marital status, ethnicity, region of birth, and an indicator for urban or rural area of birth. VOC is defined as 1 if an individual completed a course in vocational training, and 0 otherwise. Manual worker is defined as 1 if an individual is employed in an occupation with ISCO category 5-9, and 0 if otherwise employed. Craft worker is defined as 1 if an individual is employed in an occupation with ISCO category 7, and 0 if otherwise employed. Metal/Textile corresponds to metal workers and textile workers for men and women respectively. Clerk/Nurse corresponds to clerks/technicians for men and nurses for women.

Table 3: Effect of vocational training on labor market participation and other outcomes: cross-sectional (OLS) results

	Labor market participation		Other outcomes	
	Unemployed (1)	Nonemployed (2)	Private sector (3)	Imputed wage (4)
Panel A: Men				
VOC	0.012** [0.002]	0.013** [0.002]	0.008** [0.002]	-0.045** [0.002]
Constant	0.105** [0.007]	0.138** [0.008]	0.068** [0.006]	6.747** [0.006]
Month of birth trend	Y	Y	Y	Y
Dem. Controls	Y	Y	Y	Y
R ²	0.03	0.04	0.01	0.03
Sample Size	54,481	55,571	55,689	53,930
Panel B: Women				
VOC	0.007** [0.002]	0.036** [0.004]	0.006** [0.002]	-0.069** [0.002]
Constant	[0.011] 0.058**	[0.026] 0.108**	[0.014] 0.052**	[0.014] 6.579**
Month of birth trend	Y	Y	Y	Y
Dem. Controls	Y	Y	Y	Y
R ²	0.01	0.02	0.02	0.05
Sample Size	38,709	43,935	44,033	38,355

Notes: Notes: Robust standard errors in brackets. ** and * indicate statistical significance at the 1 and 5 percent level, respectively. Samples include cohorts with a secondary-level education born between January 1, 1957 and December 30, 1960. Demographic controls include marital status, ethnicity, region of birth, and an indicator for urban or rural area of birth. VOC is defined as 1 if an individual completed a course in vocational training, and 0 otherwise. Unemployed is defined as 1 if an individual is actively seeking work, and 0 if employed. Nonemployment is defined as 1 if an individual is not employed (unemployed or out of the labor force) and 0 otherwise. Private sector is defined as 1 if an individual is working in the private sector, and 0 otherwise. Imputed wages are imputed hourly log wages associated with 3 digit occupational codes and computed separately for men and women.

Table 4: Effect of the 1973 educational reform on occupational outcomes: Reduced-form estimates

	Manual worker		Craft worker		Men: Metal worker Women: Textile worker		Men: Clerk Women: Nurse	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Men								
AFTER	-0.017** [0.006]	-0.013 [0.007]	-0.030** [0.009]	-0.024* [0.010]	-0.012** [0.003]	-0.010** [0.003]	0.015** [0.005]	0.013* [0.006]
Constant	0.858** [0.004]	0.921** [0.012]	0.535** [0.005]	0.578** [0.017]	0.039** [0.002]	0.018** [0.005]	0.096** [0.003]	0.054** [0.010]
Month of birth trend	Y	Y	Y	Y	Y	Y	Y	Y
Demographic Controls	N	Y	N	Y	N	Y	N	Y
Calendar month dummies	N	Y	N	Y	N	Y	N	Y
R ²	0	0.02	0	0.01	0	0.01	0	0.01
Sample Size	53,712	53,712	53,712	53,712	53,930	53,930	53,930	53,930
Panel B: Women								
AFTER	-0.036** [0.010]	-0.033** [0.011]	-0.047** [0.009]	-0.044** [0.010]	-0.024** [0.007]	-0.023** [0.007]	0.007** [0.002]	0.006** [0.002]
Constant	0.552** [0.006]	0.492** [0.021]	0.317** [0.005]	0.255** [0.019]	0.136** [0.004]	0.101** [0.013]	0.005** [0.001]	0.006 [0.004]
Month of birth trend	Y	Y	Y	Y	Y	Y	Y	Y
Demographic Controls	N	Y	N	Y	N	Y	N	Y
Calendar month dummies	N	Y	N	Y	N	Y	N	Y
R ²	0	0.04	0	0.02	0	0.02	0	0
Sample Size	38,408	38,408	38,408	38,408	38,420	38,420	38,420	38,420

Notes: Robust standard errors in brackets. ** and * indicate statistical significance at the 1 and 5 percent level, respectively. Estimates are based on a linear probability model. Samples include cohorts with a secondary-level education born between January 1, 1957 and December 30, 1960 (4 years window around January 1, 1959). Demographic controls include marital status, ethnicity, region of birth, and an indicator for urban or rural area of birth. AFTER is defined as 1 for individuals born on or after January 1, 1959 and 0 for individuals born on or before December 31, 1958.

Table 5: Effect of the 1973 educational reform on labor market participation and other outcomes: Reduced-form estimates

	Unemployed		Nonemployed		Private Sector		Imputed wages	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Men								
AFTER	0.005 [0.004]	0.006 [0.004]	0.006 [0.005]	0.007 [0.005]	-0.001 [0.004]	-0.005 [0.004]	0.002 [0.003]	0.004 [0.004]
Constant	0.057** [0.002]	0.111** [0.008]	0.075** [0.003]	0.143** [0.009]	0.051** [0.002]	0.080** [0.007]	6.735** [0.002]	6.715** [0.007]
Month of birth trend	Y	Y	Y	Y	Y	Y	Y	Y
Demographic Controls	N	Y	N	Y	N	Y	N	Y
Calendar month dummies	N	Y	N	Y	N	Y	N	Y
R ²	0	0.03	0	0.03	0	0.01	0	0.02
Sample Size	54,481	54,481	55,571	55,571	55,689	55,689	53,930	53,930
Panel B: Women								
AFTER	0.005 [0.004]	0.001 [0.005]	0.005 [0.007]	0 [0.008]	0.001 [0.004]	0.003 [0.004]	-0.003 [0.004]	-0.003 [0.004]
Constant	0.046** [0.002]	0.057** [0.009]	0.159** [0.004]	0.113** [0.014]	0.049** [0.002]	0.052** [0.008]	6.577** [0.002]	6.566** [0.008]
Month of birth trend	Y	Y	Y	Y	Y	Y	Y	Y
Demographic Controls	N	Y	N	Y	N	Y	N	Y
Calendar month dummies	N	Y	N	Y	N	Y	N	Y
R ²	0	0.01	0	0.01	0	0.02	0	0.02
Sample Size	38,709	38,709	43,935	43,935	44,033	44,033	38,355	38,355

Notes: Robust standard errors in brackets. ** and * indicate statistical significance at the 1 and 5 percent level, respectively. Estimates are based on a linear probability model or OLS (in the case of imputed wages). Samples include cohorts with a secondary-level education born between January 1, 1957 and December 30, 1960 (4 years window around January 1, 1959). Demographic controls include marital status, ethnicity, region of birth, and an indicator for urban or rural area of birth. AFTER is defined as 1 for individuals born on or after January 1, 1959 and 0 for individuals born on or before December 31, 1958.

Appendix Table 1: Vocational educational enrollment in selected countries in 1985

Country	Gross-secondary enrollment as a percentage of secondary school age children	Vocational enrollment as a percentage of secondary enrollment
Africa		
Kenya	20.0	1.7
Senegal	13.0	6.7
Somalia	17.0	13.0
Gabon	25.0	19.6
Cameroon	23.0	24.2
Asia		
Pakistan	17.0	1.9
China	39.0	6.5
Indonesia	39.0	9.2
Thailand	30.0	17.3
Korea	94.0	17.3
Middle East		
Yemen	10.0	1.5
Jordan	79.0	9.2
Tunisia	39.0	18.9
Turkey	42.0	21.1
Egypt	62.0	22.9
		21.1
Europe		
Portugal	47.0	1.3
Greece	86.0	13.4
Yugoslavia	82.0	25.0
Hungary	72.0	73.7
Poland	78.0	77.0
Latin America		
Mexico	55.0	11.7
Chile	69.0	19.3
Panama	59.0	26.6
Brazil	35.0	49.1
Argentina	70.0	60.2

Notes: Source: Middleton, Ziderman, and Adams (1993, Table A-1, p.307-309). Gross secondary enrollment as a percentage of the population of secondary school age children is taken from Table 30 of the World Development Report 1988. Vocational education as a percentage of secondary enrollment was calculated from Table 3.7 of the Statistical Yearbook 1987 and Unesco statistics.

Appendix Table 2: Robustness checks for the effect of the 1973 educational reform on main outcomes of interest

Window around 1/1/59	Manual worker		Crafts worker		Unemployed		Imputed wages	
	2 year (1)	8 year (2)	2 year (3)	8 year (4)	2 year (5)	8 year (6)	2 year (7)	8 year (8)
Panel A: Secondary educated men								
Coefficient on AFTER	-0.018* [0.009]	-0.020** [0.004]	-0.032** [0.012]	-0.034** [0.006]	0.009 [0.006]	0.002 [0.003]	0.004 [0.005]	0.001 [0.002]
Panel B: Secondary educated women								
Coefficient on AFTER	-0.039** [0.014]	-0.038** [0.007]	-0.042** [0.013]	-0.038** [0.006]	0.009 [0.006]	-0.003 [0.003]	-0.004 [0.006]	0 [0.003]
Panel C: All men								
Coefficient on AFTER	-0.012 [0.008]	-0.012** [0.004]	-0.038** [0.010]	-0.029** [0.005]	0.007 [0.005]	0 [0.002]	-0.003 [0.005]	-0.002 [0.002]
Panel D: All women								
Coefficient on AFTER	-0.033** [0.010]	-0.020** [0.005]	-0.023* [0.009]	-0.019** [0.005]	0.007 [0.005]	0 [0.002]	0.005 [0.005]	-0.002 [0.002]

Notes: Robust standard errors in brackets. ** and * indicate statistical significance at the 1 and 5 percent level, respectively. Estimates are based on a linear probability model or OLS (in the case of imputed wages). All regressions include a month of birth trend and demographic controls (marital status, ethnicity, region of birth, an indicator for urban or rural area of birth). AFTER is defined as 1 for individuals born on or after January 1, 1959 and 0 for individuals born on or before December 31, 1958.

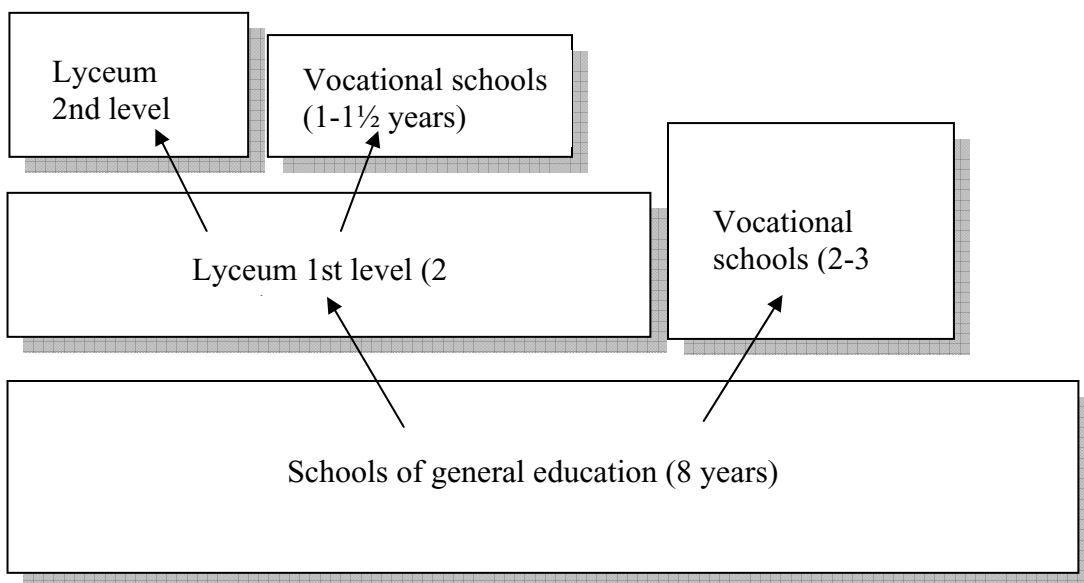
Appendix Table 3: Reduced form estimates on the main outcomes of interest based on alternative cutoffs (Placebo tests)

	Manual worker	Craft worker	Unemployed	Imputed wages
Panel A: Men				
1956	0.001 [0.006]	-0.023** [0.008]	0.002 [0.004]	0.001 [0.003]
1957	0.005 [0.006]	0.012 [0.008]	0.005 [0.004]	-0.001 [0.003]
1958	-0.002 [0.006]	-0.002 [0.008]	-0.002 [0.004]	0 [0.003]
1959	-0.016** [0.006]	-0.029** [0.009]	0.007 [0.004]	0.001 [0.003]
1960	0.002 [0.006]	-0.002 [0.009]	0.001 [0.004]	-0.003 [0.003]
1961	0.001 [0.006]	-0.003 [0.009]	0 [0.004]	-0.004 [0.004]
1962	-0.004 [0.007]	-0.009 [0.009]	0.004 [0.005]	0.004 [0.004]
Panel B: Women				
1956	0.003 [0.010]	-0.006 [0.009]	0.002 [0.004]	0.005 [0.004]
1957	0.036** [0.010]	0.016 [0.009]	0.008 [0.004]	0.002 [0.004]
1958	-0.004 [0.010]	-0.001 [0.009]	0.002 [0.004]	0.007 [0.004]
1959	-0.036** [0.010]	-0.048** [0.009]	0.005 [0.004]	-0.004 [0.004]
1960	0.011 [0.010]	0.021* [0.009]	0 [0.005]	-0.002 [0.004]
1961	-0.013 [0.010]	-0.011 [0.009]	-0.004 [0.005]	-0.003 [0.004]
1962	0.013 [0.010]	-0.001 [0.010]	0.002 [0.005]	-0.002 [0.004]

Notes: Robust standard errors in brackets. ** and * indicate statistical significance at the 1 and 5 percent level, respectively. Estimates are based on a linear probability model or OLS (in the case of imputed wages). All regressions include a month of birth trend and demographic controls (marital status, ethnicity, region of birth, an indicator for urban or rural area of birth). AFTER is defined as 1 for individuals born on or after January 1 of the respective year and 0 for individuals born on or before December 31 of the previous respective year.

Figure 1: Structure of Education in Romania

Panel A: Before 1973 (Individuals born before January 1, 1959)



Panel B: After 1973 (Individuals born after January 1, 1959)

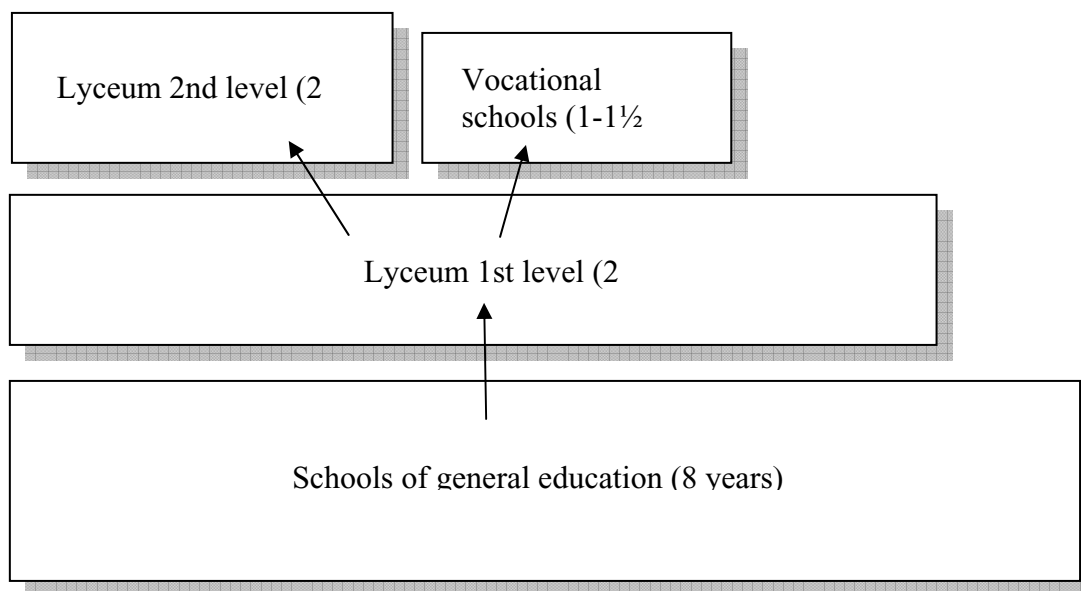


Figure 2: Enrollment in vocational schools and apprenticeships by school-year

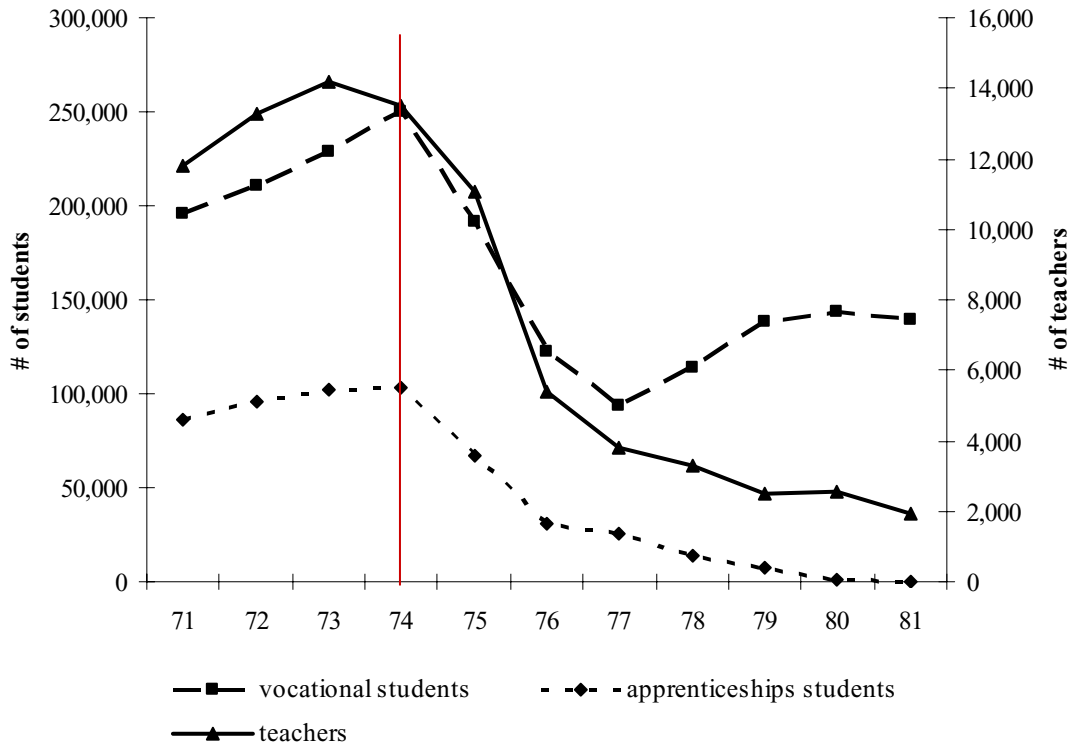


Figure 3: Enrollment in lyceums by school-year

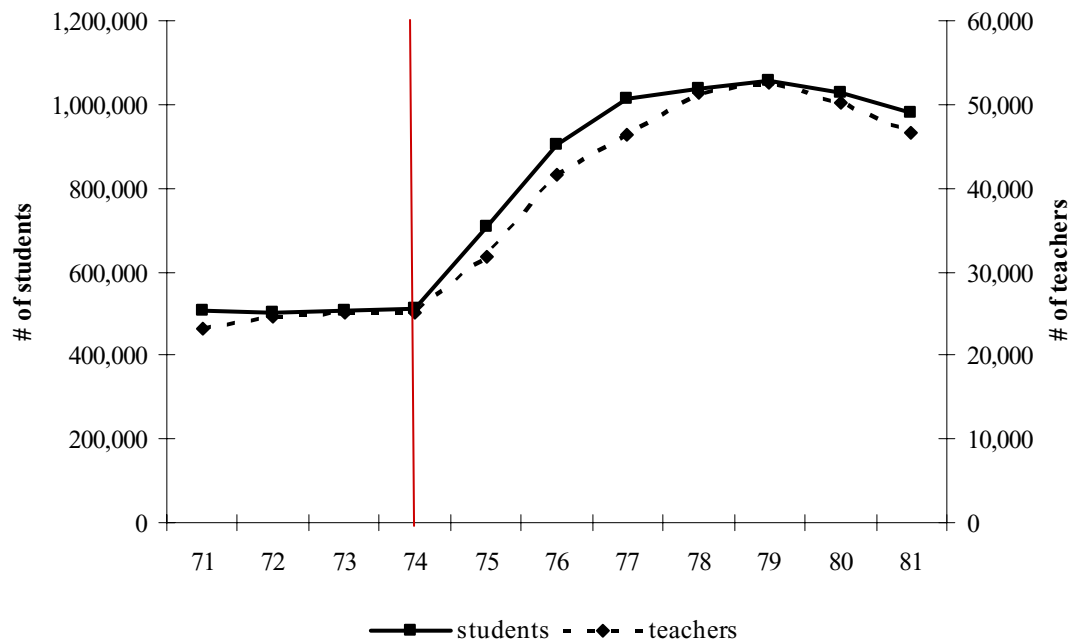


Figure 4: Educational attainment for all individuals (by year of birth)

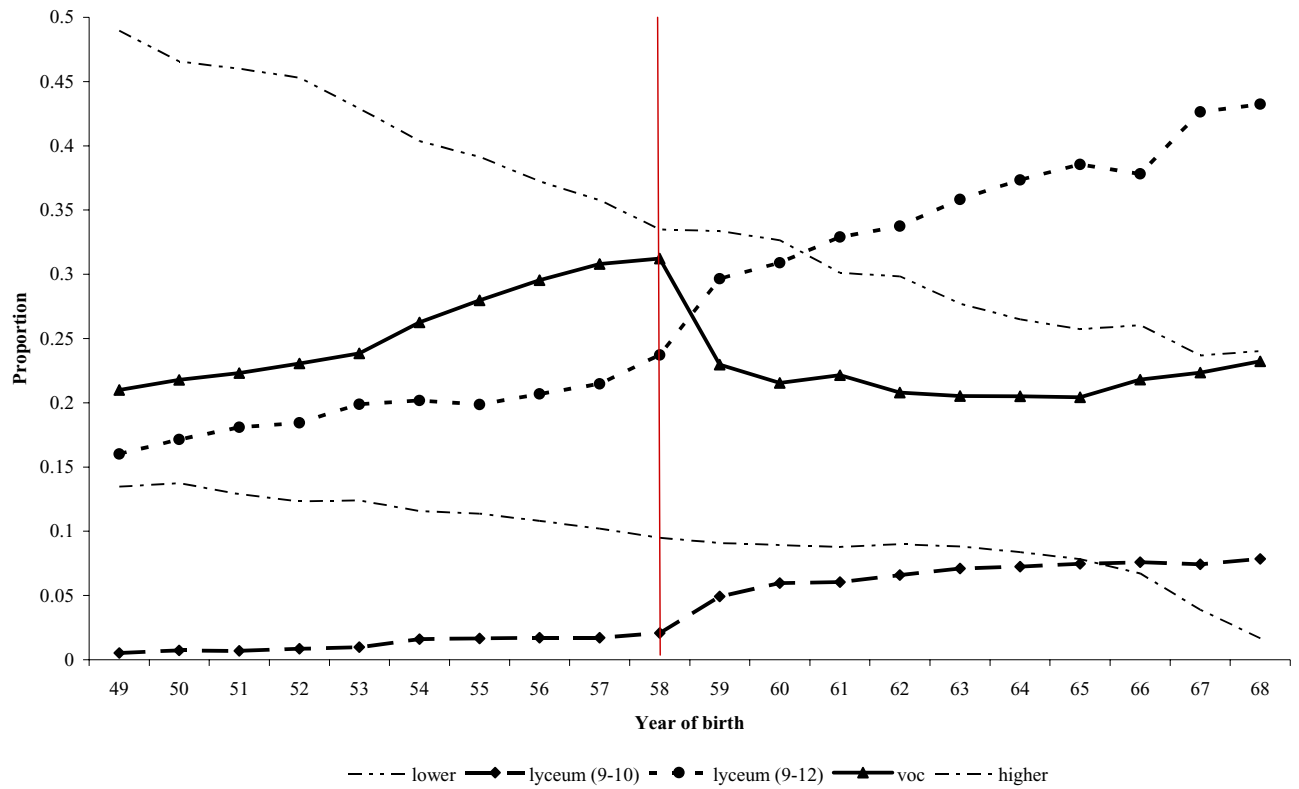
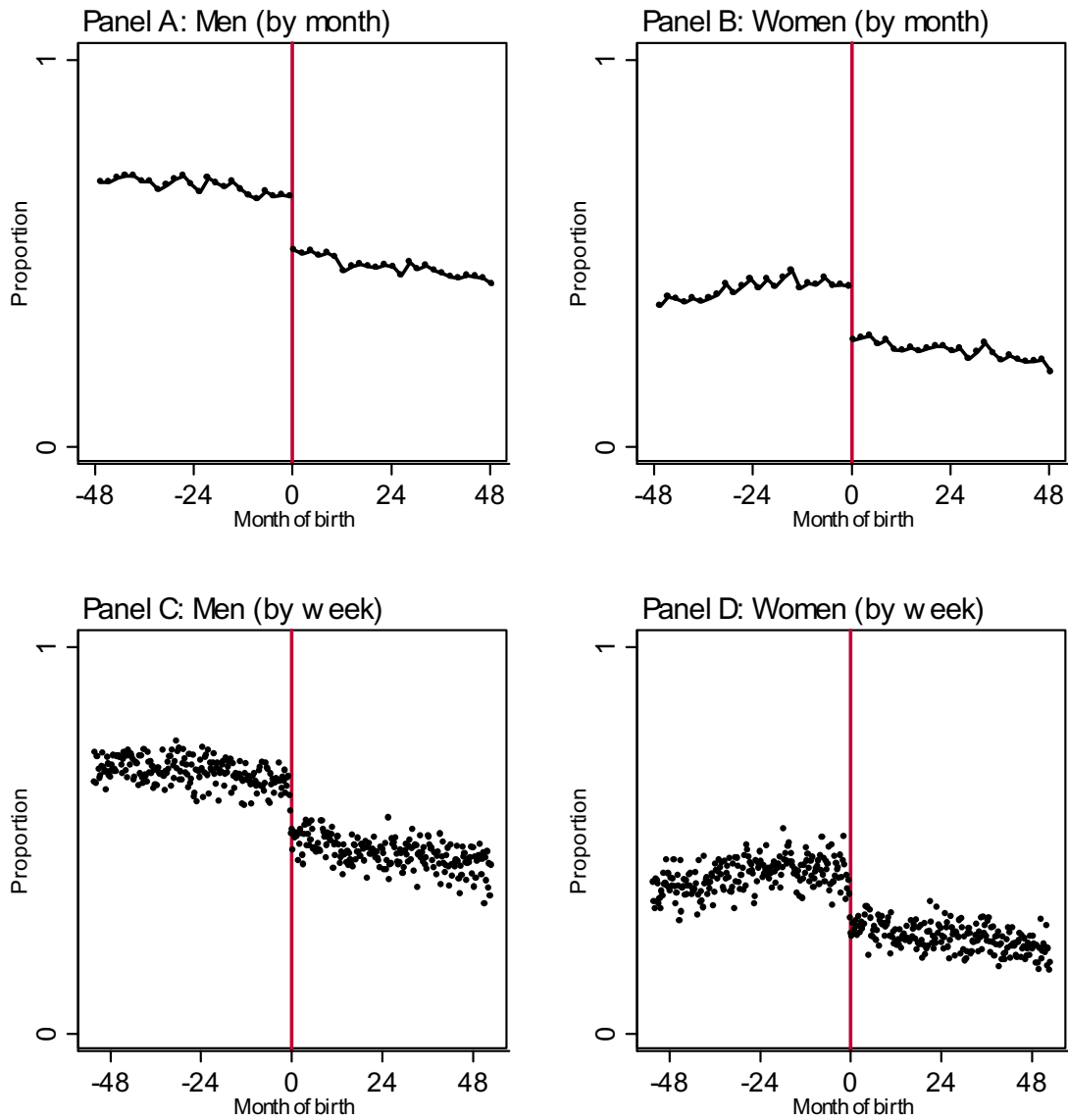
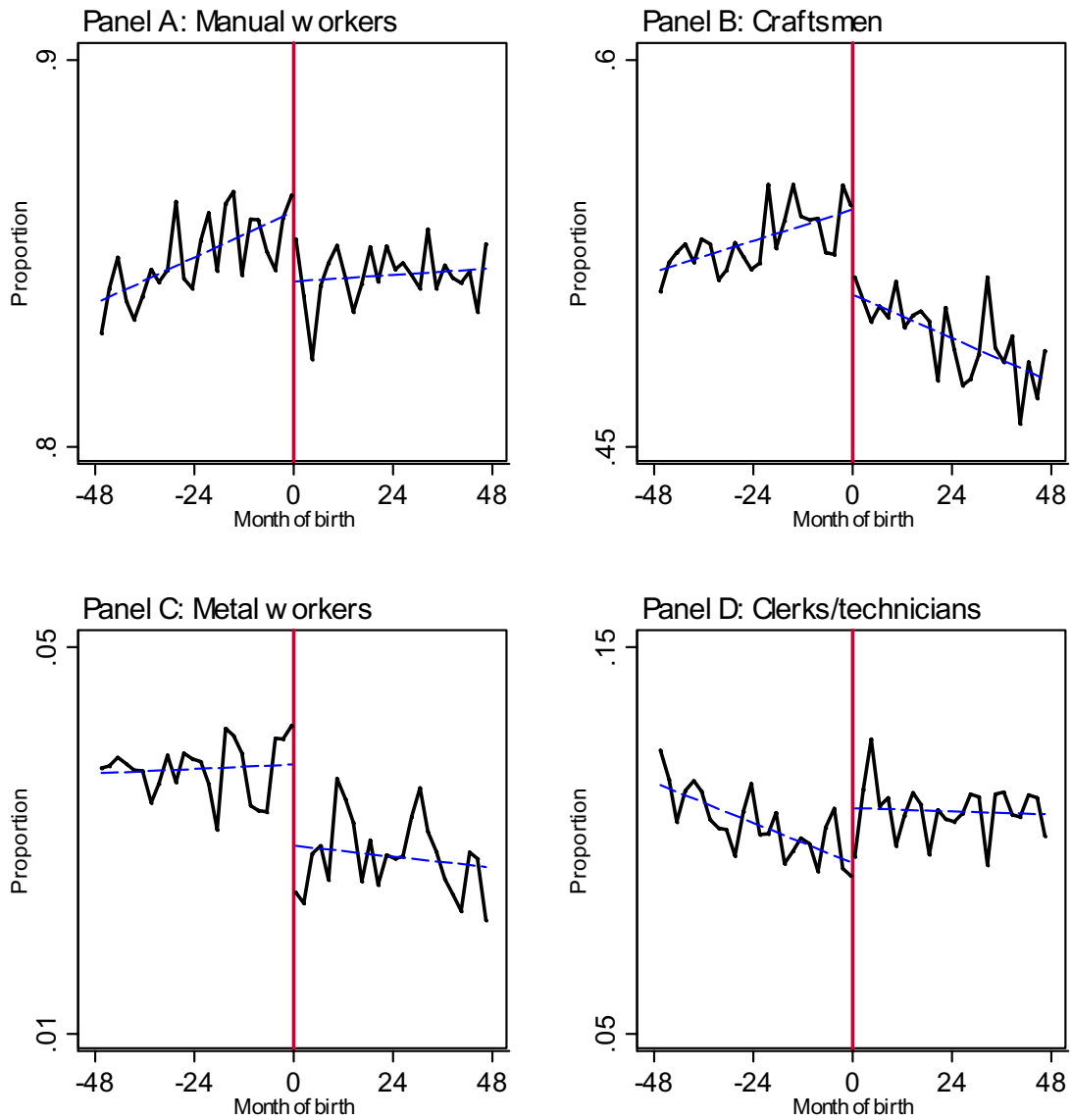


Figure 5: Proportion in Vocational School (by month and week of birth)



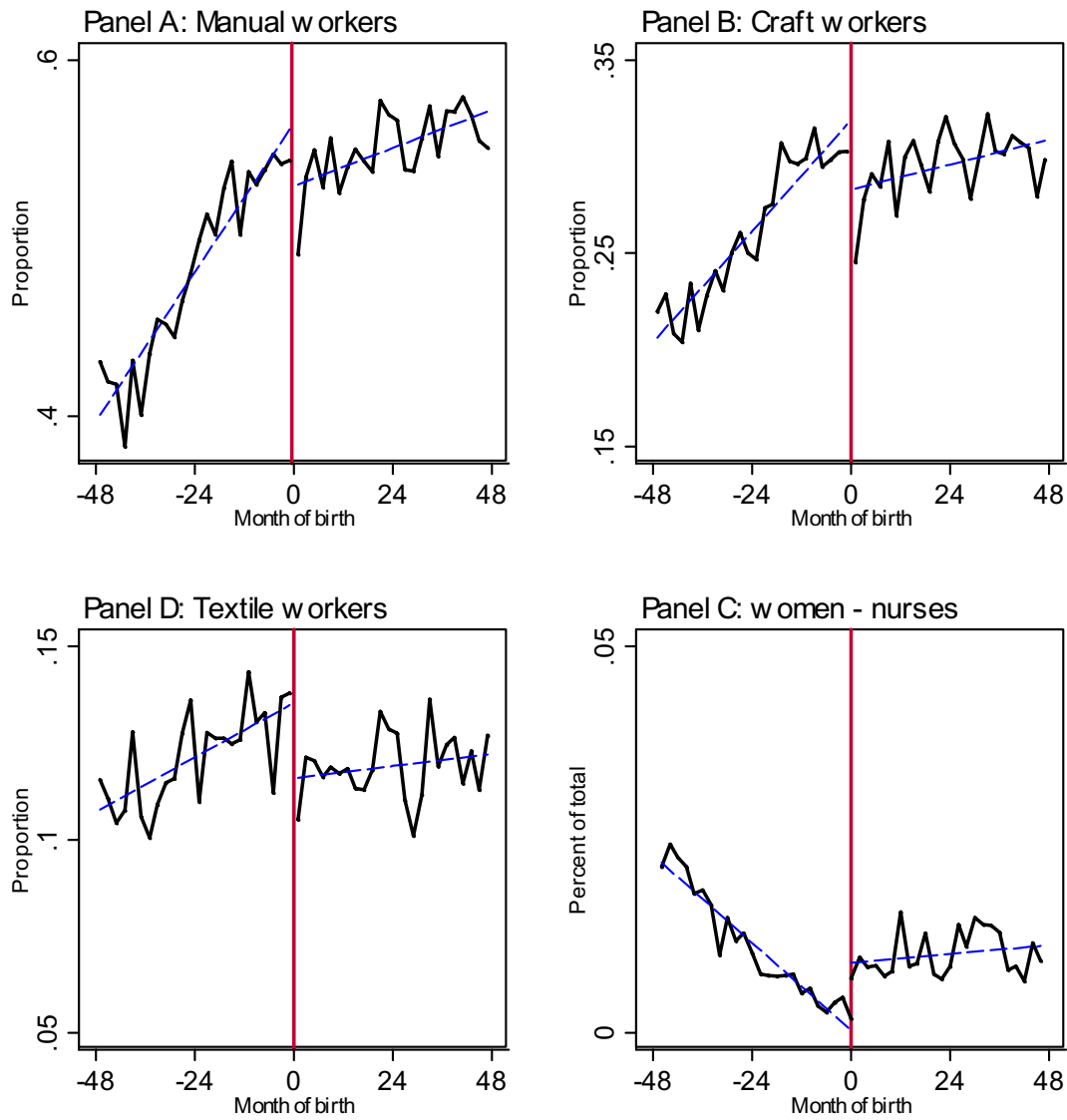
Notes: All panels are restricted to individuals with secondary education (vocational or lyceum) between January 1, 1955 and December 31, 1962.

Figure 6: Men's Occupational Outcomes (by month of birth)



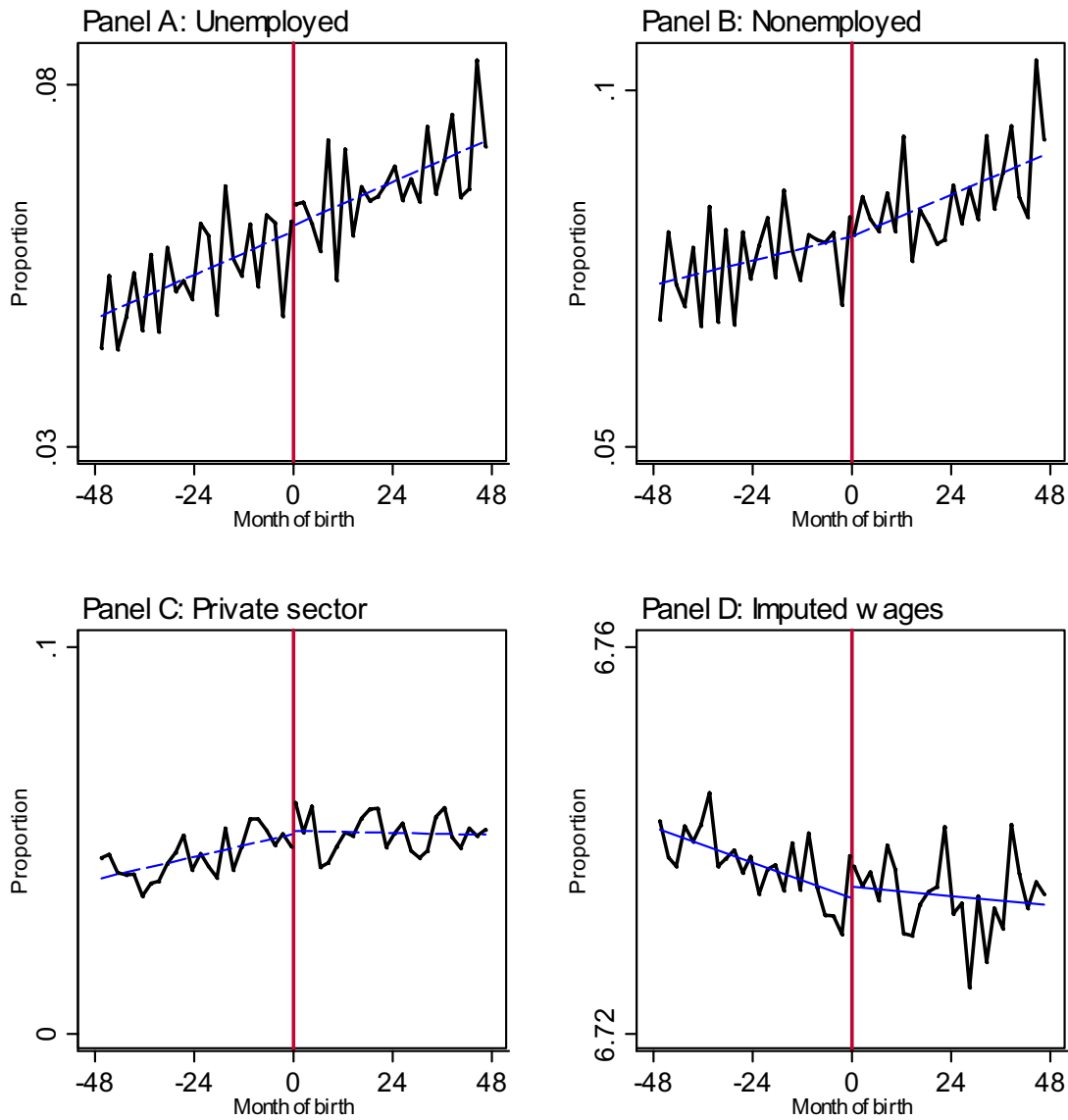
Notes: All panels are restricted to individuals with secondary education (vocational or lyceum) between January 1, 1955 and December 31, 1962. Dotted lines are OLS predictions based on a linear probability model the occupational outcome on the month of birth.

Figure 7: Women's Occupational Outcomes (by month of birth)



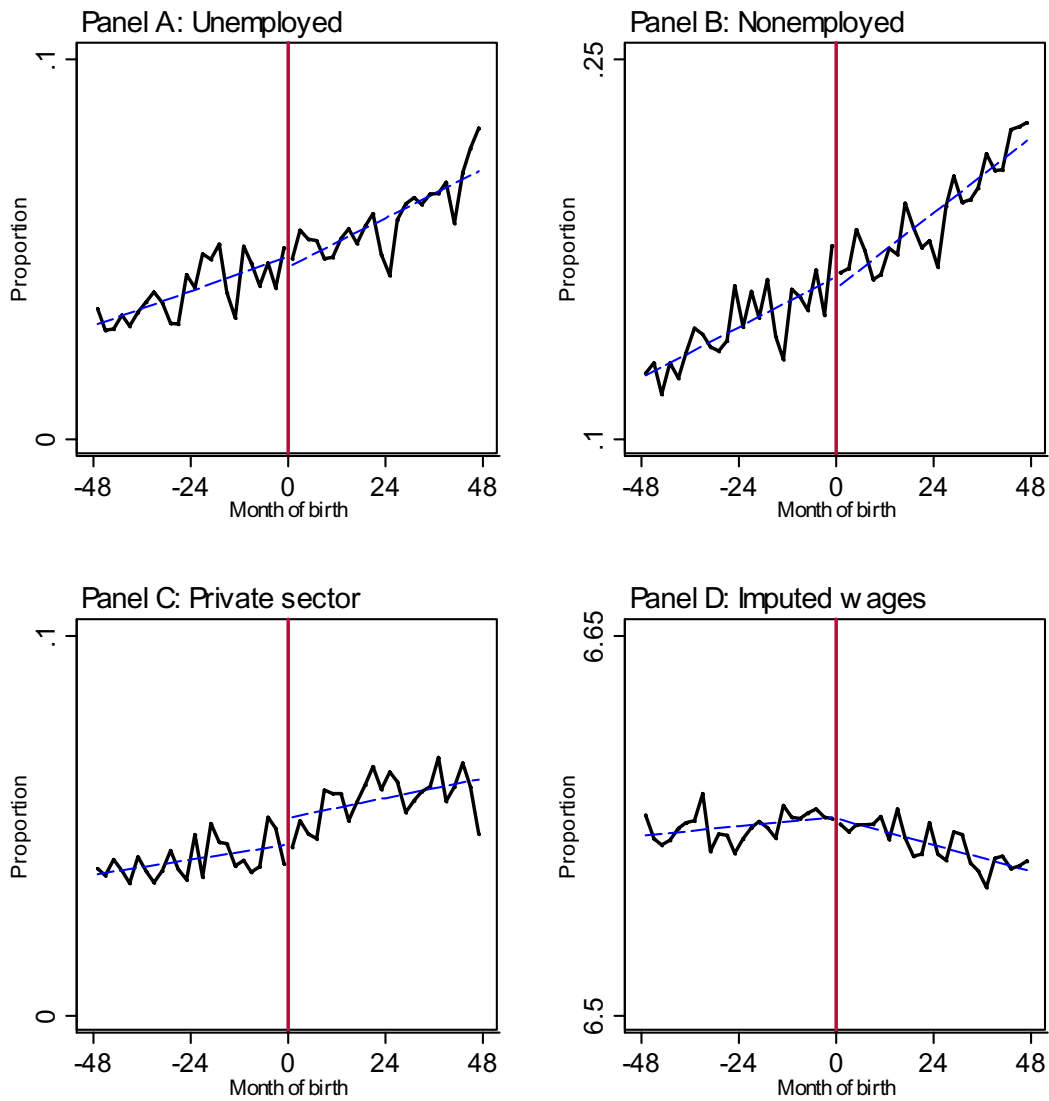
Notes: All panels are restricted to individuals with secondary education (vocational or lyceum) between January 1, 1955 and December 31, 1962. Dotted lines are OLS predictions based on a linear probability model the occupational outcome on the month of birth.

Figure 8: Men's Labor Market Outcomes (by month of birth)



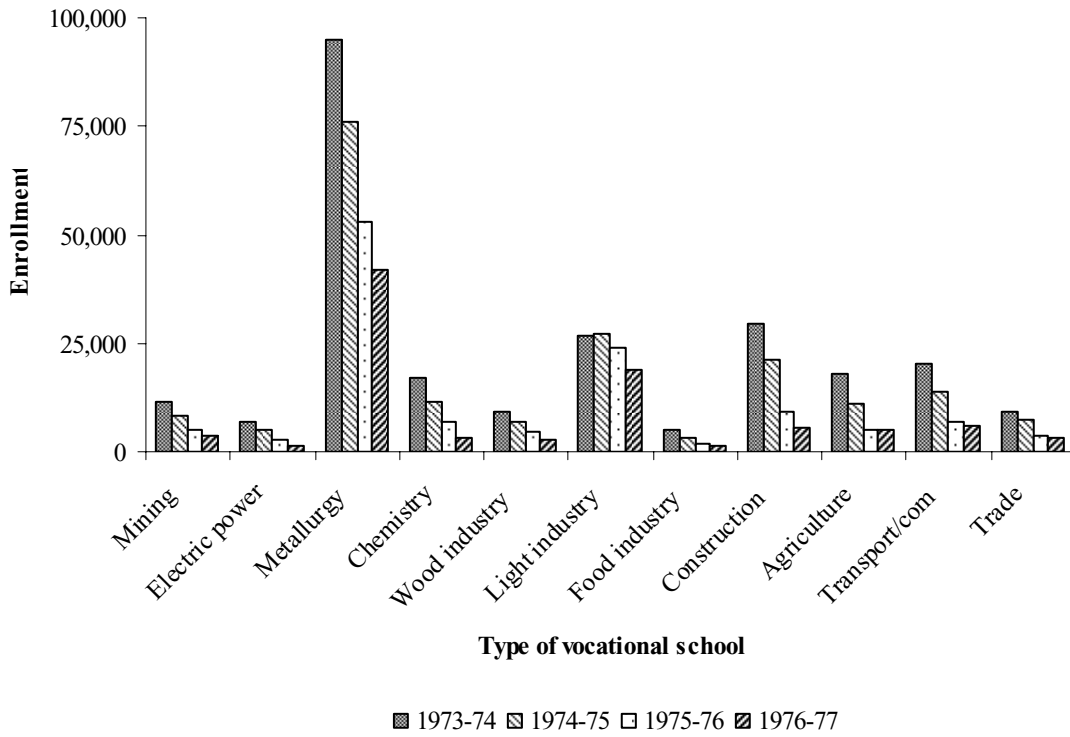
Notes: All panels are restricted to individuals with secondary education (vocational or lyceum) between January 1, 1955 and December 31, 1962. Dotted lines are OLS predictions based on a linear probability model the occupational outcome on the month of birth.

Figure 9: Women's Labor Market Outcomes (by month of birth)

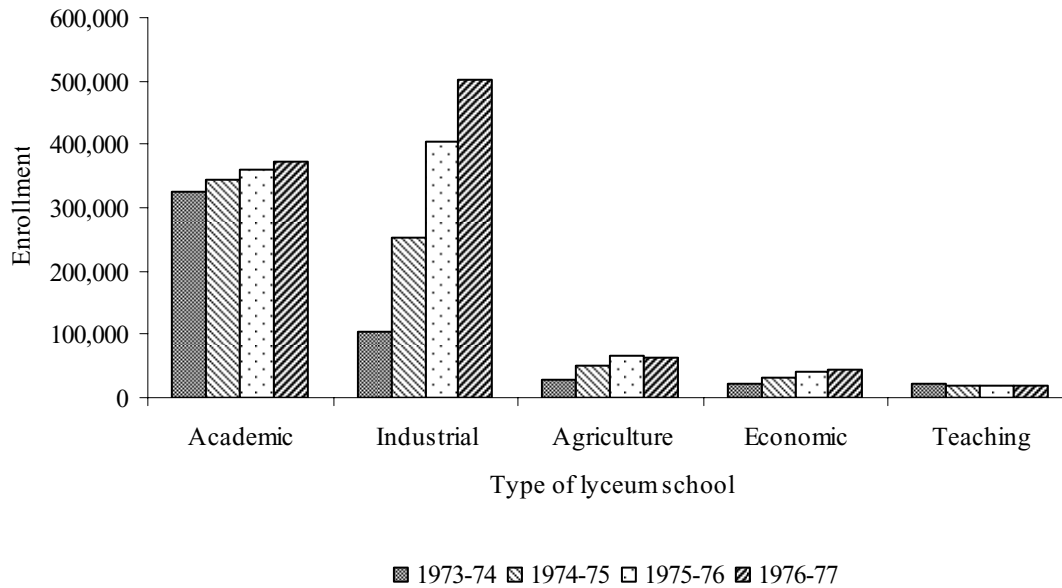


Notes: All panels are restricted to individuals with secondary education (vocational or lyceum) between January 1, 1955 and December 31, 1962. Dotted lines are OLS predictions based on a linear probability model the occupational outcome on the month of birth.

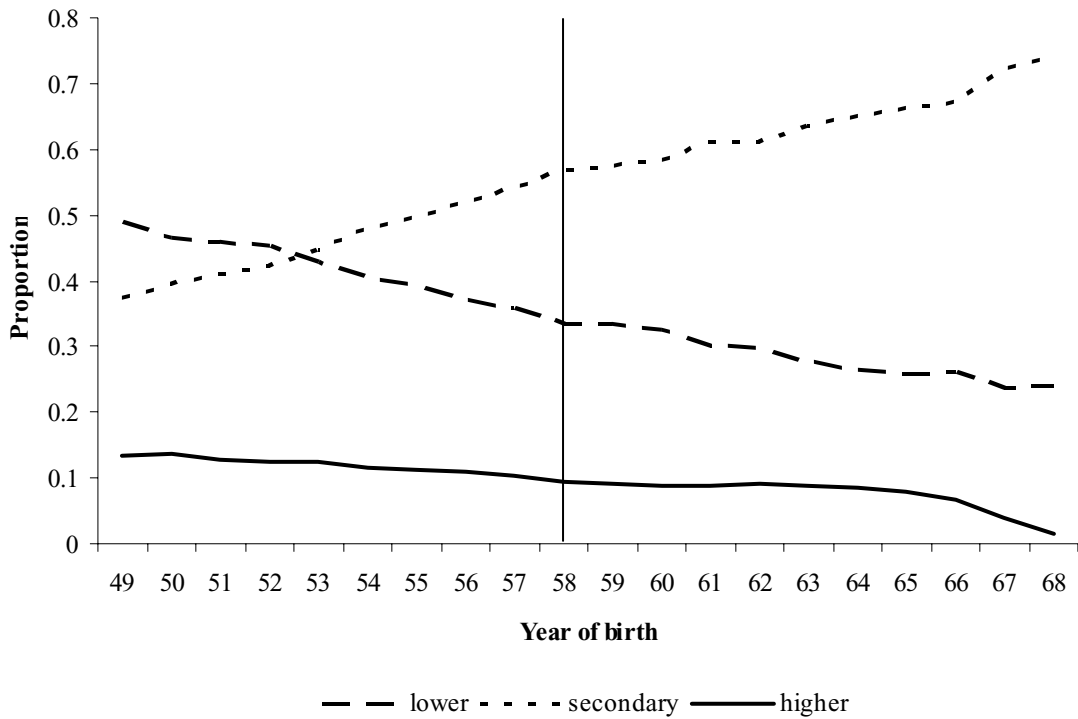
Appendix Figure 1: Change in vocational school enrollment by specialty from 1973-74 to 1976-77



Appendix Figure 2: Change in lyceum enrollment by main specialty from 1973-74 to 1976-77



Appendix Figure 3: Broad educational attainment for all individuals (by year of birth)



Appendix Figure 4: Average schooling for secondary educated individuals (by year of birth)

