GENERAL EDUCATION VERSUS VOCATIONAL TRAINING: EVIDENCE FROM AN ECONOMY IN TRANSITION

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Abstract—This paper examines the relative benefits of general education and vocational training during Romania's transition to a market economy. We examine a 1973 educational reform that shifted a large proportion of students from vocational training to general education. Using census and household survey data, we analyze the effect of this policy with a regression discontinuity design. We find that men affected by the policy are significantly less likely to work in manual or craft-related occupations but have similar levels of labor market participation and earnings compared to their counterparts unaffected by the policy. We conclude that differences in labor market returns between graduates of vocational and general schools are largely driven by selection.

I. Introduction

VOCATIONAL training was an integral part of the educational system in the planned economies of Central and Eastern Europe.[1] However, with the fall of communism and subsequent transition to market economies, many of the centralized sectors that relied heavily on vocational and technical training suffered a major decline. Like other countries undergoing this transition, Romania experienced substantial technological and institutional change as economic activities gradually reoriented toward new sectors. The success of such a profound economic transformation depended on having people adjust to new circumstances.[2] Were individuals with vocational training less able to adapt to these changes? An OECD (2000a) report argues that some of the blame for Romania's 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). Using a regression discontinuity design, this paper examines whether individuals with general education had more success in

Romania's transitory labor market than their counterparts who received vocational training.

Most of the empirical evidence on the benefits of vocational and general education during transition is based on cross-sectional studies. In Romania, 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 those with vocational training. Similar findings emerge from other countries during their transition from communism to a market-based economy (Nesporova, 2002).[3] However, interpreting these results is difficult because selection into different types of educational tracks is not random. Admission into general and vocational schools is usually determined by a competitive examination, so less able students are more likely to enroll in vocational programs. This is certainly the case for Romania. Even in countries such as England and the United States, which do not administer competitive examinations, there is a large degree of self-selection out of vocational courses. Reviewing the literature on general education and vocational training, Bennel (1996, p. 238) finds selection bias to be "a pervasive weakness of almost all the . . . studies."[4] We address the problem of selection bias by analyzing a unique educational reform in Romania that shifted a large proportion of students from vocational training to general education.

We also contributed to a broader debate on the trade-offs between general and vocational education, often framed by contrast between the American and European systems of education.[5] 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 (2001, 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

[1] UNESCO statistical yearbooks (1969, 1975, 1981) indicate that a majority of full-time students in Eastern Europe were enrolled in vocational and technical programs under communism from 1950 to 1980. This represented a substantially higher fraction of vocational training than in any other region of the world.

[2] Barberis et al. (1996) provide evidence on the important role of new human capital for restructuring during the transition, and Brainerd (1998) shows that young educated men were able to take advantage of the new profit-making opportunities in Russia's early transition.

[3] A notable exception is Munich, Svejnar, and Terrell (2005), who do not find significantly different returns to vocational and general secondary education using rich data from the Czech Republic. Indeed, they find that privatized and de novo private firms pay a significant premium for vocational secondary education.

[4] Lechner (2000) attempts to address this issue using propensity score methods and finds no evidence of any positive effects on employment probabilities and earnings from public sector vocational training programs in East Germany.

[5] The difference between (firm) specific and general skills also plays an important role in the standard theory of human capital. Becker (1964) shows that in a competitive labor market, employers pay for training that is firm specific, while workers pay for investments in general skills. However, Acemoglu and Pischke (1998) demonstrate that in models with noncompetitive labor markets, firms will invest even in the general skills of their workers.

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."[6] Krueger and Kumar (2004a, 2004b) have recently applied this logic to explain the trends in relative growth between the United States and Europe over the previous half-century. Nevertheless, as Acemoglu and Pischke (1999) explain, more empirical research is needed to understand the optimal mix between general schooling and vocational training. We explore these issues in the context of a transition economy, where workers who were provided with vocational training under central planning may have found it more difficult to adapt to the flexible environment generated by rapid technological change.

In this paper, we examine a 1973 educational reform on Romania that prevented students from entering vocational schools after only eight 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. We take advantage of detailed information on date of birth to estimate a reduced-form effect of the policy using a regression discontinuity design. Empirical evidence indicates that average years of schooling across these cohorts did not change as a result of the educational reform.[7] Hence, we can identify an unbiased estimate for the effect of the policy on labor market outcomes and, with some additional assumptions, derive the effect of a year of vocational versus general education.

Data from the Romanian censuses of 1992 and 2002 and household surveys from 1995 to 2000 enable us to examine labor market returns throughout the transition period. Although most of our results also hold for women, we focus our analysis on men since they were more affected by the policy change than women. We find that men in cohorts born immediately before and after January 1, 1959, received very different types of secondary education and consequently experienced quite different occupational outcomes, but they had very similar levels of labor market participation and earnings between 1992 and 2002. Among men employed in 1992, those in cohorts affected by the policy were significantly less likely to be employed as manual workers and craftsmen, confirming that the policy did not simply relabel schools but actually led to changes in occupational composition. However, the incidence of unemployment and nonemployment is not significantly different be-

tween cohorts affected and unaffected by the educational reform, even in the later stages of the transition period, when general education may have been more valuable. Differences in family income and wages from 1995 to 2000 are also insignificant between these cohorts. These findings are in sharp contrast to cross-sectional results where general education is associated with significantly better labor market outcomes than vocational training. While the drastic short-term expansion in general education may have introduced some crowding resource constraints, we show that this factor is unlikely to explain why men who received more general education due to the 1973 educational reforms do not perform better. Hence, we interpret these results as evidence that the large cross-sectional differences in labor market outcomes between graduates of vocational and general secondary schools are driven mainly by selection.

The paper is organized as follows. Section II provides background on the Romanian educational system and the 1973 educational reform, as well as the Romanian labor market during the transition period. Section III describes the data and the relevant samples. Section IV explains the empirical strategy used to identify the reduced-form effect of the policy and derive the effect associated with a year of general education versus vocational training. Section V presents the results, and section VI concludes.

II.   Background

A.   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 after the age of six. More specifically, students entered grade 1 in September of the year following the calendar year in which they reached six years of age. From the mid-1950s, these schools offered a continuous sequence of eight years of general education, nominally composed of primary education from grades 1 to 4 and gymnasium education from grades 5 to 8. After graduating from schools of general education, students could continue into secondary school lyceums or enter vocational schools and apprenticeship programs.

Lyceums operated at two distinct levels. The first level corresponded to grades 9 and 10 of compulsory general education, and the second level encompassed general education in grades 11 and 12.[8] Admission to the first and second levels was determined by a competitive entrance exam. Graduates from the first level of lyceum who did not take further courses in the second level received a certificate of graduation from ten-year compulsory education. They could also apply to enter an upper-level track in vocational

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[6] That technological change may affect the return to general education is closely related to early work by Nelson and Phelps (1966), who argue for higher returns to education in the presence of more rapid technological change.

[7] This contrasts with other educational reforms in Europe, which served to increase average years of schooling. For example, Meghir and Palme (2005) show that a Swedish reform that abolished selection into academic and nonacademic streams also led to large increases in years of schooling.

[8] At the second level, there was some specialization across lyceums. Among the different types of lyceums were industrial, math and science, economic, and agricultural lyceums.

schools. Graduates from the second level received a certificate of graduation or a baccalaureate diploma. Curriculum in lyceums was relatively homogeneous despite some differences 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 a curriculum handbook from the early 1970s, "technical practical" training accounted for 20.2% of the total hours of the curriculum in general secondary lyceums (Blideanu, 1972). In other words, approximately 80% of the curriculum in lyceums was devoted to general education.[9]

Vocational schools provided training in numerous trades ranging from aircraft maintenance to winemaking. They also operated at two levels: a lower vocational track for students who had completed eight years of general education and an upper vocational track for students who had received an additional two years of general education in the first level of lyceum. Official guidelines regarding the organization and functioning of vocational education stated that "the proportion of practical training will be 70–80% of the total number of hours" in vocational schools (Romania Government, 1977). The length of training varied by trade and depended on 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). Indeed, for graduates from the first stage of lyceum schools, training usually lasted only one year (Dimitriu et al., 1981). On-the-job apprenticeships trained workers in largely the same fields as those offered by vocational schools. The practical training period for apprenticeships was also normally three years. Thus, although 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 do the same in this analysis.

Several institutions provided education beyond vocational and general schools. Technical schools for master craftsmen admitted graduates of vocational schools and lyceums who had spent between three and five years in production. Postsecondary specialization schools admitted graduates of lyceums and trained them in specialized fields ranging from aircraft construction to radiology. Finally, entrance to higher education in universities was open only

to graduates of the second level of lyceum schools and required a baccalaureate diploma.

B. The Educational Reform of 1973

The educational reform of 1973 prevented students from pursuing vocational training after only eight years of general education and instead required them to complete two additional years of general education. The educational reforms of 1973 were actually preceded by Law No. 11 of May 1968, which called for the extension of compulsory general schooling from eight to ten years. However, five years after establishing government commitment for extending compulsory general 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 ten-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 (Romania Government, 1973). In fact, this policy did not alter the total years of schooling but substituted more general education in lieu of vocational training. The Resolution of 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."[10] We also provide evidence to show that the average years of schooling remained essentially unchanged after these educational reforms. 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 about three years of vocational training were required to obtain an additional two years of general education.[11]

Depending on their aptitudes, skills, and preferences, graduates of the first level of lyceum schools could (a) enter the workforce, (b) continue to vocational school for one year, or (c) continue to grades 11 and 12 in the second level of lyceum schools. Although the policy affected students in different ways, there was no change in overall educational attainment. However, 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 1970s 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 who continued to vocational schools after completing the first stage of lyceum
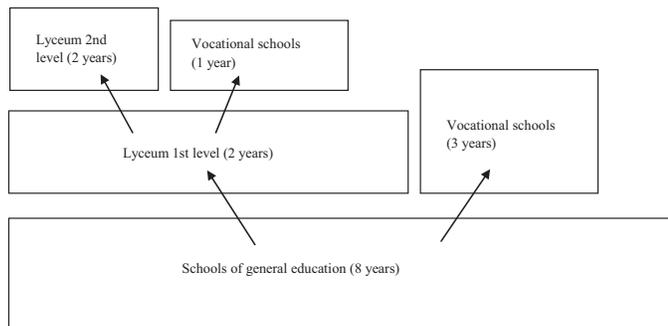
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[9] These approximate proportions have been confirmed in numerous conversations with school administrators in Romania who had firsthand experience of the 1973 educational reform.

[10] These 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.

[11] Decision No. 577 of the Council of Ministers in 1975 reaffirmed the earlier resolutions concerning ten-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 Law No. 11 of May 1968.
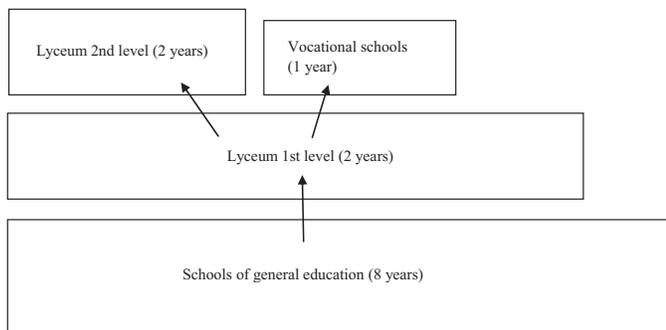
FIGURE 1.—STRUCTURE OF EDUCATION IN ROMANIA

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

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

Source: Braham (1978).

were treated with more general and less vocational training following the policy change.

The Resolution of June 1973 also introduced measures to ensure that sufficient qualified teachers and school resources (such as science laboratories, classrooms, and dormitories) were allocated to local authorities. In most cases, these measures did not require 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, . . . lyceums will, in general, function within the same premises as vocational schools and under the same leadership."

We can document some of these changes using the Romania Government's *Annual Statistics of the Socialist Republic of Romanian.* Figure A1 shows the large decline in the number of students enrolled in vocational schools and on-the-job apprenticeships between school years 1973–1974 and 1975–1976. These declines occurred across all specialities in vocational schools. During this period, enrollment in lyceums increased sharply, as shown in Figure A2. Moreover, the number of teachers in vocational schools fell, while the number of teachers in lyceums rose in the initial years following the educational reform.

Further evidence for these dramatic changes is available from the Romanian census. Since students began compulsory schooling at age six, they would have completed grade 8 by age fourteen and grade 10 by age sixteen. Consequently, students born in 1958 would have been unaffected by the policy, while students born in 1959 would have been required to continue to grades 9 and 10 of lyceum schools. Figure 2 shows the highest educational attainment for all men by year of birth. There is a sharp decline in the proportion of men with vocational training between cohorts born in 1958 and 1959. At the same time, we observe a sharp increase in the proportion of men who completed a general lyceum education. No such discontinuity is observed for the proportion completing only lower or primary education or higher education. 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.

C. The Labor Market in Transition

Compared to other countries in central Europe, such as Poland, Hungary, and the Czech Republic, Romania's transition to a market economy has been relatively more difficult. This has been attributed to the unfavorable initial conditions resulting from Ceausescu's economic, social, and political policies and the overly cautious approach toward market-oriented reforms by Romania's political leadership (OECD, 2000b). Romania's macroeconomic performance in the early 1990s began with a large decline in GDP and increasing inflation. Although it experienced some positive economic growth in the mid-1990s, it suffered another macroeconomic crisis in late 1996 due to the slow pace of restructuring within state-owned enterprises. As a result, a newly elected center-right coalition embarked on an IMF-supported macroeconomic stabilization and structural reform program in 1997. These reforms eliminated all remaining price controls, tightened fiscal policies, and accelerated the rate of privatization. This led to mass layoffs in state firms as well as decreases in real wages and a contraction in real GDP. Nevertheless, from 2000 onward, Romania has experienced a sustained recovery.

The gradual development of a new private sector and the privatization and restructuring of state-owned enterprise had a major impact on the labor market. Registered unemployment rose from essentially no unemployment in 1990 to over 10% in 1993 (Earle & Pauna, 1996, 1998). Industrial employment fell from almost 45% of total employment in 1989 to about 30% in 1995. Figure A3 plots the unemployment rate during the transition period and also shows the sharp increase in unemployment after the onset of the structural reforms in early 1997. The large decrease in industrial employment was partly offset by a large increase in agricultural employment during this period. Following land reforms in 1991, many workers who lost their jobs in the cities migrated back to the countryside

FIGURE 2.—EDUCATIONAL ATTAINMENT BY BIRTH COHORT

Source: 1992 Census.

and started to be active in low-productivity subsistence farming. Empirical evidence indicates that very young and old workers were more likely to lose their jobs and less likely to find new employment opportunities (Voicu, 2005). Moreover, individuals with vocational training had worse labor market outcomes than those with general education. As mentioned earlier, 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.

Romania also made a number of legislative changes with respect to the functioning of the labor market. Unemployment benefits were introduced in 1991 and covered about 50% of previous wages in the first nine months, followed by a reduced allowance for another eighteen months. As part of its reform efforts in 1997, the government also introduced a system of severance benefits to eligible workers who chose to leave specific state enterprises (OECD, 2000b). Thus, by the end of the transition period, their basis legislation governing employment conditions and termination of job contracts was considered relatively liberal by international standards (OECD, 2000b).

III. Data

We use three data sources for our research. The first is a sample from the 1992 Romanian Census, which provides information on occupational structure and labor market

outcomes relatively early in the transition process.[12] The second is a sample from the 2002 Romanian census, which provides a snapshot of these same outcomes toward the end of the transition period. These two census data sets also provide sufficient power to employ a regression discontinuity design and estimate fairly precise labor market outcomes. Finally, we pool six annual LSMS-type household surveys from 1995 to 2000 that are based on yearly cross-sectional representative samples.[13] While the LSMS household data are based on smaller samples, they have the advantage of providing additional information on wages and income. Moreover, the timing of these survey rounds allows us to take a closer look at labor market dynamics before and after the structural reforms of 1997.

All three data sources provide information on the month and year of birth, which proves essential in identifying the discontinuity induced by the policy within a narrow window of time. They also distinguish between various levels of education attainment: completion of primary education,

gymnasium education, first stage of lyceum education (grades 9 and 10), second stage of lyceum education (grades 11 and 12), vocational training and apprenticeships, postsecondary 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). Since this makes it more difficult to estimate the local average treatment effect of vocational training, we use aggregate data on school enrollment from the *Annual Statistics of the Socialist Republic of Romania* to calculate the effect of the policy on the treated population and the local average treatment effect of vocational training. In addition, these three data sources include background variables such as ethnicity and region of birth, as well as indicators for urban or rural place of birth in the census data.[14]

The census data contain several outcome variables of interest pertaining to labor market participation and earnings. We focus on two measures of labor market participation: unemployment and nonemployment. The former is restricted to individuals who 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.[15] We have detailed information on current and previous occupations based on three-digit International Standard Classification of Occupation (ISCO) 88 codes. We use this information to infer whether individuals are employed in a manual (ISCO codes 5–9) or craft-related (ISCO code 7) occupation. The 1995 to 2000 household surveys contain similar questions related to unemployment and nonemployment but somewhat less detailed information on occupations. However, they contain information on individual wages and family income, which are not available in the census data.

Table 1 presents summary statistics for all the data sets described. These are shown for the full sample of men born three years before and after the policy change, as well as a restricted sample of men who completed vocational or general schools in these same cohorts. For the most part, we restrict our attention to this latter sample of men whose highest level of educational attainment is secondary schooling. Figure 2 shows that the policy did not 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 mostly living in relatively rural areas that could not extend their network of lyceums, while students completing higher ed-

ucation should not have been affected by the policy.[16] The next section confirms this in a regression discontinuity setting. Consequently, we focus on men who received a secondary-level education and estimate the effect of the policy for the sample of the entire population only as a robustness check.

IV. Empirical Strategy

A. A Regression Discontinuity Design

Most empirical studies examining the effect of vocational training adopt a simple specification in which individuals who receive vocational training are distinguished from those who receive a general education:[17]

$$outcome_i = \beta' \mathbf{X}_i + \upsilon VOC_i + \varepsilon_i, \qquad (1)$$

where $outcome_i$ is a labor market outcome such as unemployment or wages, VOC_i is equal to 1 if individual i received vocational training and 0 otherwise, and $\mathbf{X}_i$ is a set of observable characteristics for individual i. According to this specification, the coefficient on VOC_i represents the difference between the benefit from vocational training and general education (in terms of some labor market outcome).[18] However, vocational training is usually correlated with unobserved ability because selection into different tracks is based on a competitive examination or because individuals with higher ability choose to enter general rather than vocational schools.

We address the possibility of omitted variable bias using the 1973 educational reform, which prevented students from entering vocational schools with only eight years of schooling and instead required them to receive an additional two years of general education. Since this reform took effect during the 1974–1975 school year and students entered grade 1 in September after the calendar year in which they reached six years of age, those born before January 1, 1959, were unaffected by the policy, while those born after this date were treated with more general education and less vocational training. With detailed information on date of birth, we can estimate a reduced-form effect of the policy using a regression discontinuity design:

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[14] Other socioeconomic indicators, such as information on the status of the dwelling and availability of amenities, are available. However, since these are contemporaneous with other outcomes, they are probably not valid proxy controls for income and class.

[15] Note that the reference period for the question on employment status changed from the "moment of the census" in the 1992 census to "the previous week" in the 2002 census and the 1995–2000 LSMS.

[16] In 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 ten-year school of general education; if the number of students registered in grade 5 is at least 25, the community had to operate an eight-year school of general education; and if the number of children aged six to nine was at least seven, the community had to operate a four-year school.

[17] For example, see the early work on vocational training by Grasso and Shea (1979) and Meyer (1982). Neuman and Ziderman (1991, 1999) introduce some extensions to this simple model.

[18] Clearly, an accurate cost-benefit analysis would require consideration of the relative costs in providing vocational and general education. We abstract from this here, but evidence from other studies suggests that vocational training is often more expensive than general education (Bennel, 1996).

TABLE 1.—DESCRIPTIVE STATISTICS

	Entire Sample			Secondary-Educated Sample		
	Mean	s.d.	N	Mean	s.d.	N
A: 1992 Census						
Urban region of birth	0.283	0.451	227,446	0.268	0.443	143,417
Romanian	0.896	0.305	227,446	0.911	0.285	143,417
Hungarian	0.066	0.248	227,446	0.068	0.252	143,417
Gypsy	0.020	0.139	227,446	0.005	0.071	143,417
Education level						
Lower (primary/gymnasium)	0.255	0.436	227,446	—	—	—
Vocational	0.359	0.480	227,446	0.570	0.495	143,417
Lyceum 9–12	0.271	0.445	227,446	0.430	0.495	143,417
Higher (postsecondary/university)	0.114	0.318	227,446	—	—	—
Labor market outcomes						
Manual worker	0.780	0.414	216,342	0.839	0.367	138,924
Craft worker	0.432	0.495	216,342	0.518	0.500	138,924
Unemployed	0.066	0.249	219,652	0.057	0.232	140,305
Nonemployed	0.098	0.298	227,446	0.077	0.267	143,417
B: 2002 Census						
Urban region of birth	0.314	0.464	87,249	0.298	0.458	53,602
Romanian	0.900	0.300	87,249	0.912	0.283	53,602
Hungarian	0.063	0.243	87,249	0.069	0.253	53,602
Gypsy	0.019	0.137	87,249	0.005	0.069	53,602
Education level						
Lower (primary/gymnasium)	0.234	0.423	87,249	—	—	—
Vocational	0.359	0.480	87,249	0.584	0.493	53,602
Lyceum 9–12	0.255	0.436	87,249	0.416	0.493	53,602
Higher (postsecondary/university)	0.152	0.359	87,249	—	—	—
Labor market outcomes						
Manual worker	0.719	0.449	74,758	0.799	0.401	46,699
Craft worker	0.357	0.479	74,758	0.456	0.498	46,699
Unemployed	0.116	0.320	75,850	0.121	0.326	47,261
Nonemployed	0.231	0.422	87,249	0.225	0.417	53,602
C: LSMS, 1995–2000						
Education level						
Lower (primary/gymnasium)	0.172	0.377	28,395	—	—	—
Vocational	0.385	0.487	28,395	0.567	0.495	19,286
Lyceum 9–12	0.294	0.456	28,395	0.433	0.495	19,286
Higher (postsecondary/university)	0.149	0.356	28,395	—	—	—
Labor market outcomes						
Log family income	15.519	0.816	28,291	15.527	0.736	19,227
Log wages	15.336	0.552	18,523	15.263	0.503	13,133
Unemployed	0.115	0.319	26,973	0.123	0.328	18,459
Nonemployed	0.159	0.365	28,389	0.160	0.367	19,282

Note: All summary statistics based on cohorts born between 1956 and 1961 (within three years of January 1, 1959). The sample of secondary-educated men includes individuals with vocational and general secondary education only. Manual worker is defined as 1 for men employed in an occupation with ISCO category 5–9, and 0 if otherwise employed. Craft worker is defined as 1 for men employed in an occupation with ISCO category 7, and 0 if otherwise employed. Unemployed is defined as 1 for men actively seeking work, and 0 if employed. Nonemployment is defined as 1 for men not employed (unemployed or out of the labor force) and 0 otherwise. Log wages and log family income are based on annual wages and family income.

$$outcome_i = \beta' \mathbf{X}_i + \delta AFTER_i + f(c_i) + \varepsilon_i, \qquad (2)$$

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 $f(c_i)$ is a function of the date of birth, which is the forcing variable in this context. The coefficient on $AFTER$ represents the reduced-form effect of the 1973 educational reform. As in many other recent studies employing this technique, we specify a flexible parametric model by including higher-order polynomials of date of birth, which are allowed to vary on either side of the discontinuity.[19] Our primary specification uses a cubic trend in month of birth fully interacted with $AFTER$ (i.e., a cubic

spline), but we also estimate regressions with alternative polynomial functions for robustness. Binary outcome variables are estimated with a linear probability model. Estimating this equation using nonparametric methods, along the lines of Hahn, Todd, and van der Klaauw (2001) and Porter (2003), leads to similar results.

The main set of observable characteristics, $\mathbf{X}_i$, includes ethnicity, region of birth, and an indicator for urban or rural place of birth.[20] In practice, these control variables have very little effect on our estimates of the discontinuity and serve mainly to increase precision. However, we also include dummy variables for calendar month of birth to control for any seasonal differences among individuals born

[19] See Dinardo and Lee (2004) for use of parametric functions in regression discontinuity design. Lee and McCrary (2005) and Card, Dobkin, and Maestas (2008) specifically use parametric functions of date of birth.

[20] As mentioned previously, indicators for urban or rural place of birth are available only in the census data. Furthermore, all regressions using the pooled LSMS household data include fixed effects for survey year.

TABLE 2.—EFFECT OF THE 1973 EDUCATIONAL REFORM ON EDUCATIONAL OUTCOMES, URBAN STATUS, AND YEARS OF SCHOOLING

A: Highest Educational Level Achieved (out of the Entire Sample)

Dependent Variable	Vocational (1)	General (2)	Secondary (3)
AFTER	−0.080**	0.070**	−0.009
	[0.007]	[0.006]	[0.006]
R^2	0.04	0.04	0.03
Sample size	314,695	314,695	314,695
Mean of dependent variable	0.36	0.26	0.62

B: Born in an Urban Area (Dependent Variable)

	Secondary School Level			
Sample Restricted to:	Vocational (1)	General (2)	All (3)	Entire Sample (4)
AFTER	−0.016	−0.061**	−0.017	−0.012
	[0.010]	[0.017]	[0.011]	[0.009]
R^2	0.08	0.15	0.12	0.13
Sample size	112,988	84,031	197,091	314,695
Mean of dependent variable	0.20	0.34	0.26	0.27

C: Years of Schooling (Dependent Variable)

	Secondary School Level			
Sample Restricted to	Vocational (1)	General (2)	All (3)	Entire Sample (4)
AFTER	−0.198	−0.076	0.018	−0.159
	[0.130]	[0.143]	[0.118]	[0.176]
R^2	0.02	0.04	0.01	0.07
Sample size	1,617	1,313	2,930	4,532
Mean of dependent variable	11.10	11.95	11.48	11.47

Note: Robust standard errors clustered by month of birth in brackets. ** and * indicate statistical significance at the 1% and 5% level, respectively. Samples include all cohorts born between January 1, 1956, and December 31, 1961. 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. Columns in panel A refer to different dependent variables (secondary education, general education, or vocational education). Columns in panels B and C refer to sample restrictions (all men with secondary schooling, men with vocational education, men with general education, and the entire sample). All regressions include a cubic polynomial in month of birth fully interacted with AFTER and fixed effects for calendar of month. Binary outcome variables are estimated using a linear probability model. Data for panels A and B use combined data from 1992 and 2002 census. Data for panel C use data from the 1995 and 1996 LSMS. Demographic controls for the 1992 and 2002 census regressions include ethnicity, region of birth, and an indicator for urban or rural place of birth. Controls for the LSMS regressions include ethnicity, region of birth, and dummies for year of survey.

in different months.[21] 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 three years on either side of the cutoff so that month of birth ranges from −36 to 35, with 0 representing the first cohort affected by the policy. However, we also show results using several alternative windows for robustness. All regressions cluster on month of birth in order to avoid the problems associated with specification error in the case of discrete covariates (Lee & Card, 2007).

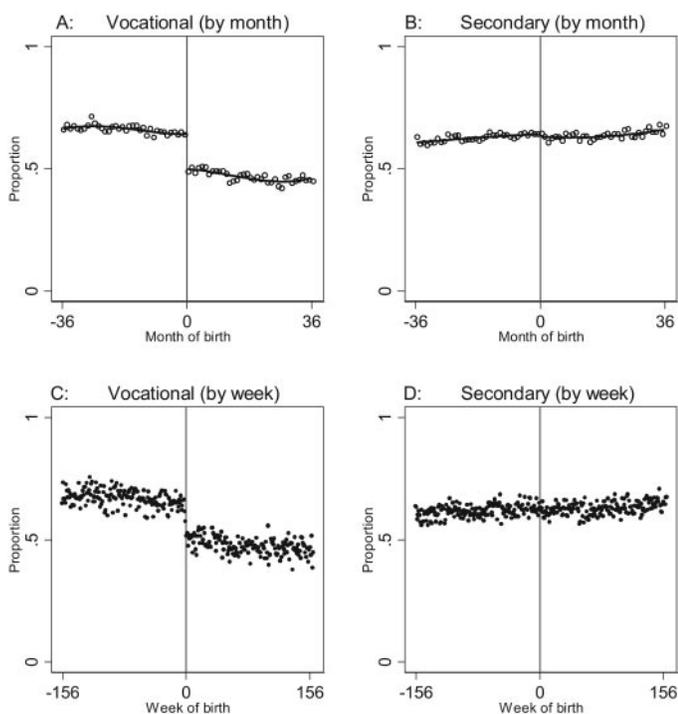### B. Effect of the Reform on Educational Outcomes

Estimating equation 2 with educational outcomes, panel A of table 2 demonstrates the dramatic change in the probability of completing vocational school for cohorts affected by the policy. Column 1 indicates that the probability of completing vocational school declined by .08

among the entire male population. In other words, the probability of completing vocational school fell by about .13, or more than 20%, among men with secondary education. Column 2 shows a corresponding increase in the probability of completing general lyceum school, and column 3 confirms that the proportion of men who completed any type of secondary school did not change with the introduction of the policy. The effect of the 1973 educational reform is even more striking in graphical forms. Panels A and C of figure 3 plot the proportion of secondary-educated men with vocational training by month and week of birth. Each panel indicates an extremely sharp discontinuity after January 1959, normalized as month or week 0. Men born merely two weeks apart were exposed to extremely different types of education. In contrast, panels B and D of figure 3 reveal no change in the proportion of secondary-educated men out of the entire population before and after the policy change.

The evidence described indicates the change in the proportion of students who completed any type of vocational school as a result of the 1973 educational reform. Since we observe only the highest level of education attained, we cannot discern the effect on students who were affected by the policy and continued onto the upper vocational track after receiving an additional two years of general education.

[21] Note that compulsory schooling in Romania is based on years attended rather than age, so there is no concern about differences in years of schooling between those born on either side of the school entry cutoff. But any such differences would be eliminated by the calendar of month dummies, in any case.

FIGURE 3.—PROPORTION IN VOCATIONAL TRAINING AND SECONDARY LEVEL

Note: All panels are restricted to men born between January 1, 1956, and December 31, 1961. Panels A and C are further restricted to men whose highest educational attainment is at the secondary level (vocational or lyceum). The solid lines in panels A and B are fitted values from regressions of the dependent variable on a cubic spline in month of birth. The open circles indicate the fraction of men employed in these occupations by month of birth (panels A and B) or week of birth (panels C and D).
Source: 1992 Romanian Census (PAU sample).

But these students would also have been treated with less vocational training and more general education. Consequently, in order to properly interpret the effect of the policy, we need to account for the effect on the entire treated population. The next section describes how we translate the reduced-form effect of the policy into the effect of the policy on the treated population and the local average treatment effect of a year of vocational training.

C. Interpreting Estimates

If we could identify the group of students who entered vocational school directly after grade 8 prior to the educational reform, we could estimate the effect of the policy on the treated population directly using two-stage least squares (2SLS). Unfortunately, we have information only on the highest level of education attained, so we cannot distinguish vocational students in the lower track who were affected by the policy from vocational students in the upper track who were not affected by the policy. Instead, we use supplementary enrollment data from the *Annual Statistics of the Socialist Republic of Romania* to calculate the proportion of students who entered vocational school after grade 8 prior to the educational reform and scale up the reduced-form effect of the policy to calculate the effect on the treated popula-

tion.[22] As explained in appendix A, we determine that approximately 50% of students with vocational training were in the lower vocational track. Hence, we conclude that about 33% of students with secondary education were affected by the policy. This implies that we need to scale up the reduced-form estimate by a factor of 3 to derive an estimate for the effect of the policy on the treated population.

The effect of the policy on the treated population is still somewhat difficult to interpret because the policy did not affect exposure to vocational training in the same way for all individuals. Appendix A uses both census and aggregate enrollment data to provide a rough calculation of the average difference in vocational training before and after the policy change. These estimates suggest that among individuals whose highest educational attainment was secondary schooling, the average decrease in vocational training was 0.8 years. 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 years of vocational training induced by the policy. In other words, we calculate the local average treatment effect (LATE) of a year of vocational versus general education.[23] Undertaking this calculation, we conclude that the effect of an additional year of vocational training instead of general education on labor market outcomes is approximately 1.25δ.

D. Testing for Selection

Since higher-ability students tended to be selected into general secondary schools by competitive examination, students affected by the policy were probably lower on the ability distribution than those who attended general lyceums before the educational reform. Hence, we expect the average ability of students receiving general education to decline after the policy change. But we do not have good measures of ability in our data. Instead, we examine whether students were born in an urban or rural area, which serves as a proxy for socioeconomic background and is correlated with higher educational attainment. Panel B of table 2 shows the likelihood of being born in an urban area for samples of men with different levels of educational attainment. Specifically, column 2 reveals that men who received general education after the policy change were 6 percentage points less likely to have been born in an urban area than general-educated

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[22] 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 affected by the treatment rather than the conventional worry that individuals may be self-selecting into the treatment.

[23] Since 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.

TABLE 3.—EFFECT OF VOCATIONAL TRAINING ON LABOR MARKET OUTCOMES: CROSS-SECTIONAL RESULTS

A: 1992 Census

	Manual Worker (1)	Craft Worker (2)	Unemployed (3)	Nonemployed (4)
VOC	0.235**	0.135**	0.015**	0.013**
	[0.005]	[0.006]	[0.001]	[0.001]
R^2	0.11	0.02	0.01	0.01
Sample size	138,924	138,924	140,305	143,417
Mean of dependent variable	0.84	0.52	0.06	0.08

B: 2002 Census

	Manual Worker (1)	Craft Worker (2)	Unemployed (3)	Nonemployed (4)
VOC	0.260**	0.109**	0.047**	0.050**
	[0.005]	[0.006]	[0.003]	[0.004]
R^2	0.12	0.02	0.02	0.01
Sample size	46,699	46,699	47,261	53,602
Mean of dependent variable	0.80	0.46	0.12	0.22

C: LSMS, 1995–2000

	Log Family Income (1)	Log Wages (2)	Unemployed (3)	Nonemployed (4)
VOC	−0.146**	−0.073**	0.028**	0.031**
	[0.016]	[0.012]	[0.006]	[0.007]
R^2	0.06	0.1	0.02	0.02
Sample size	14,519	10,102	14,046	14,555
Mean of dependent variable	15.53	15.26	0.12	0.16

Note: Robust standard errors clustered by month of birth in brackets. ** and * indicate statistical significance at the 1% and 5% level, respectively. Samples include cohorts with a secondary-level education born between January 1, 1956, and December 31, 1961. VOC is defined as 1 if an individual completed a course in vocational training and 0 otherwise. All regressions include a cubic polynomial in month of birth and fixed effects for calendar of month. Panel A uses data from the 1992 census, panel B uses data from the 2002 census, and panel C uses data from the 1995–2000 Romanian LSMS. Binary outcome variables are estimated using a linear probability model. Demographic controls for the 1992 and 2002 census regressions include ethnicity, region of birth, and an indicator for urban or rural place of birth. Controls for the LSMS regressions include ethnicity, region of birth, and dummies for year of survey.

men who were unaffected by the policy.[24] This result supports our contention that more able or more advantaged students were selected into general secondary schools. Column 3 in panel B of table 2 also shows that the proportion of men with secondary education who were born in urban regions did not change after the educational reform. We have also confirmed that indicators for ethnicity and region of birth did not exhibit any discontinuous change around the discontinuity. This is reassuring evidence that the composition of men who completed secondary-level education did not change after the policy reform and serves as a check for the validity of the regression discontinuity design.

E. Quantity of Schooling

We have information on years of schooling for a subsample of individuals in the LSMS household surveys of 1995 and 1996. Using this subsample, panel C of table 2 shows the effect of the educational reform on the quantity of schooling for samples of men with different types of educational attainment. Column 3 confirms that

the policy did not lead to additional schooling among cohorts of secondary school students. The point estimate is essentially 0 and quite precisely estimated with a standard error of only 0.12 years of schooling. The remaining columns of panel C indicate no significant difference in years of schooling for other levels and types of educational attainment (similar results are found with higher and primary education). These findings are consistent with the changes induced by the policy. According to the calculations discussed, most students affected by the policy continued to higher-level vocational programs that lasted one year after completing ten years of general education. Since these students would have completed eight years of general education and three years of vocational training prior to the reform, they would not have experienced any change in quantity of schooling. These findings confirm that the policy altered the amount of vocational and general education while keeping the overall quantity of education approximately unchanged.

V. Results

A. Cross-Sectional Analysis

Before turning to the findings associated with the 1973 educational reform, we examine the standard cross-sectional relationship between vocational training and labor market outcomes. Table 3 presents these results,

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[24] That the proportion of men born in urban regions among those with vocational training did not change after the policy reform is also consistent with selection. While the most able among those who received vocational education prior to the policy change probably ended up completing the second level of lyceum, the least able may not have succeeded in progressing to vocational training, which was only available at the higher track after the policy change.

based on equation (1), using both census and household data. The sample is restricted to secondary-educated men born between 1956 and 1961 to correspond with the samples presented later. All regressions control for a cubic spline in month of birth, ethnicity, region of birth, urban or rural place of birth, and calendar month fixed effects, while robust standard errors are clustered by month of birth.

The effect of vocational training on occupational outcomes is shown in columns 1 and 2 of panels A and B. These coefficients indicate that men with vocational training were significantly more likely to be employed as manual workers and craftsmen than their counterparts with general education. In particular, men with vocational training were approximately 23 percentage points more likely to be manual workers and 13 percentage points more likely to be craftsmen in 1992. Similar magnitudes are visible in the 2002 data, during the later stages of the transition period.[25] Columns 3 and 4 of table 3 show the effect of vocational training on labor market participation. Men with vocational training were 1.5 percentage points more likely to be unemployed in 1992 than were men with general education. On a base of 6% unemployment, this represents a large and significant difference.[26] Not surprisingly, since most men were employed in the labor force, the effect on nonemployment for men was similar to the effect on unemployment over this time period. The effect of vocational training on unemployment becomes even larger over time. By 2002, men with vocational training were 4.7 percentage points more likely to be unemployed. Finally, we examine the effect of vocational training on wages and income using the pooled LSMS data from 1995 to 2000. Column 1 of panel C indicates that men with vocational training lived in households with lower family income, while column 2 reveals that men with vocational training earned approximately 7% less than men with general education.[27]

Consistent with other studies from Romania, we find that individuals with vocational training are more likely to be unemployed, exit from the labor force, and earn lower wages than their counterparts with general education.[28] We also confirm that individuals with vocational training are

more likely to be employed in manual and craft-related occupations. Moreover, the adverse labor market outcomes become even more pronounced during the later stages of the transition. These results hold when examined separately in the period before and after January 1, 1959, or when we include cohort fixed effects to focus on the relationship within each cohort (not shown).

B. Effect of the Reform on Labor Market Outcomes

We examine the effect of the 1973 educational reform on labor market outcomes by estimating equation 2. Columns 1 and 2 in panel A of table 4 show the reduced-form effect of the 1973 educational reform on occupational outcomes in 1992. The coefficients on *AFTER* are highly significant, implying that the reform altered the occupational structure. Specifically, men in cohorts affected by the policy were 2.3 percentage points less likely to be employed in a manual occupation than their counterparts who were unaffected by the policy. Based on the calculations in section IV, the corresponding effect on the treated population is approximately 7 percentage points.[29] Moreover, these estimates imply that an additional year of vocational training instead of general education increased the probability of being employed in a manual occupation by about 3 percentage points. The effect of the policy on the probability of becoming a craftsmen is even larger: about 3.4 percentage points, which translates into a 10 percentage point effect on the treated population. In other words, the additional year of vocational training instead of general education increased the probability of working as a craftsman by over 4 percentage points. We also confirm that these findings hold for disaggregated occupations such as metal workers and clerks.[30]

Panels A and B of figure 4 provide a graphical representation of the 1992 results. The raw fractions of secondary-educated men employed as manual and craft workers in each month of birth are indicated with open circles, while solid lines plot cubic functions of these outcomes on either side of the discontinuity. There is a clear break in the trend around the policy change for both occupational outcomes. Together with the regression results, these findings support our contention that the policy did not simply relabel schools from vocational to general lyceum schools. Panels A and B of figure 5 also reveal a discontinuity in occupational outcomes using the 2002 census. However, compared to

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[25] The results for manual and craft occupations in the LSMS data are similar to those from the census data.

[26] Though not shown, the effect of the covariates on unemployment generally accords with intuition. The coefficient on the month of birth trend is positive and significant, reflecting that younger individuals are more likely to be unemployed. Men 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.

[27] Again, the effect of the covariates on this measure of wages is generally significant and consistent with previous findings. Men who were born later are employed in jobs that earn significantly less. Men born in urban areas are earning significantly more, and those with non-Romanian ethnicity earn significantly less than Romanians.

[28] In light of the findings by Munich et al. (2005), we examined whether the cross-sectional findings differed by type of firm ownership. We found

no significant differences in the effect of vocational training on labor market outcomes for private and state-owned firms.

[29] This effect is somewhat 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 previous labor market experience.
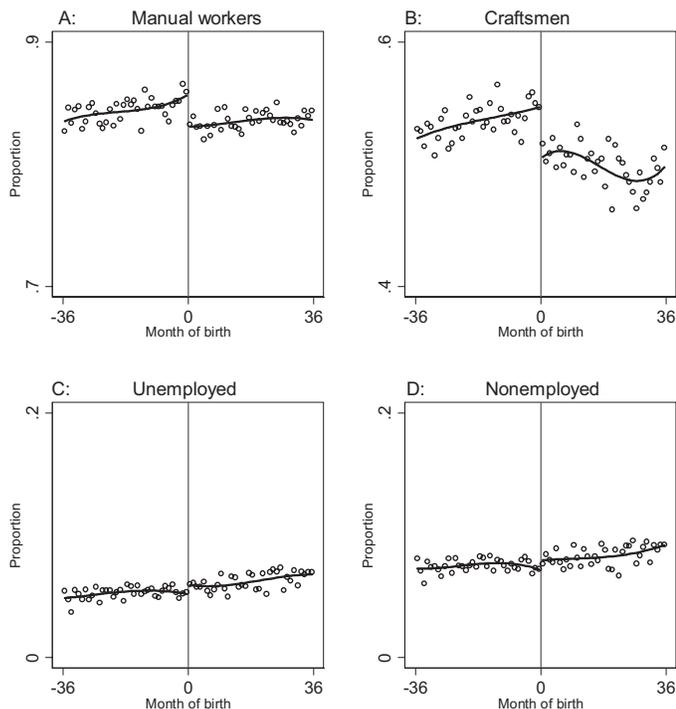
[30] In the case of clerks, we find that men affected by the policy are more likely to be employed as clerks, consistent with the evidence that vocational training is associated with a lower probability of working as a clerk.

TABLE 4.—EFFECT OF THE 1973 EDUCATIONAL REFORM ON LABOR MARKET OUTCOMES: REDUCED-FORM RESULTS

A: 1992 Census

	Manual Worker (1)	Craft Worker (2)	Unemployed (3)	Nonemployed (4)
AFTER	−0.023**	−0.034**	0.005	0.007
	[0.007]	[0.010]	[0.004]	[0.005]
R^2	0.02	0.01	0.01	0.01
Sample size	138,924	138,924	140,305	143,417
Mean of dependent variable	0.84	0.52	0.06	0.08

B: 2002 Census

	Manual Worker (1)	Craft Worker (2)	Unemployed (3)	Nonemployed (4)
AFTER	−0.014	−0.001	−0.001	0.004
	[0.021]	[0.022]	[0.009]	[0.011]
R^2	0.02	0.01	0.01	0.01
Sample size	46,699	46,699	47,261	53,602
Mean of dependent variable	0.80	0.46	0.12	0.22

C: LSMS 1995–2000

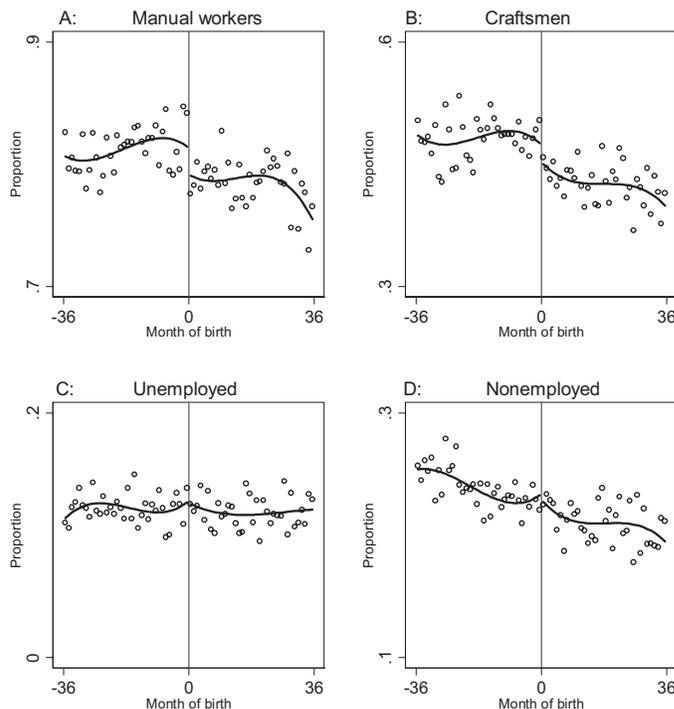|	Log Family Income (1)	Log Wages (2)	Unemployed (3)	Nonemployed (4)
AFTER	0.041	−0.01	0.029	0.016
	[0.078]	[0.045]	[0.021]	[0.025]
R^2	0.05	0.09	0.02	0.02
Sample size	14,519	10,102	14,046	14,555
Mean of dependent variable	15.53	15.26	0.12	0.16

Note: Robust standard errors clustered by month of birth in brackets. ** and * indicate statistical significance at the 1% and 5% level, respectively. Samples include cohorts with a secondary-level education born between January 1, 1956, and December 31, 1961. 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. All regressions include a cubic polynomial in month of birth fully interacted with AFTER and fixed effects for calendar of month. Panel A uses data from the 1992 census, panel B uses data from the 2002 census, and panel C uses data from the 1995–2000 Romanian LSMS. Binary outcome variables are estimated using a linear probability model. Demographic controls for the 1992 and 2002 census regressions include ethnicity, region of birth, and an indicator for urban or rural place of birth. Controls for the LSMS regressions include ethnicity, region of birth, and dummies for year of survey.

FIGURE 4.—LABOR MARKET OUTCOMES IN 1992 (BY MONTH OF BIRTH)

Note: All panels are restricted to men with secondary education (vocational or lyceum) between January 1, 1956, and December 31, 1961. The solid lines are fitted values from regressions of the dependent variable on a cubic spline in month of birth. The open circles indicate the fraction of men employed in these occupations by month of birth.
Source: 1992 Romanian Census.

FIGURE 5.—LABOR MARKET OUTCOMES IN 2002 (BY MONTH OF BIRTH)

Note: All panels are restricted to men with secondary education (vocational or lyceum) between January 1, 1956, and December 31, 1961. The solid lines are fitted values from regressions of the dependent variable on a cubic spline in month of birth. The open circles indicate the fraction of men employed in these occupations by month of birth.
Source: 2002 Romanian census.

estimates from 1992, the corresponding coefficients in panel B of table 4 are smaller and insignificant.[31] This change probably reflects the continuing reallocation of labor to new occupations during the transition period.

The reduced-form effect of the 1973 educational reform on labor market participation is shown in columns 3 and 4 of table 4. The effect of the policy on the probability of being unemployed or nonemployed is small and insignificant in 1992, at the beginning of the transition period (panel A). Moreover, the effect of the policy is still insignificant in 2002, during the later stages of the transition period when general education may have become more valuable (panel B). The bottom panels of figures 4, 5, and 6 confirm these findings in a graphical context. None of the panels reveals any discontinuity in labor market participation. Columns 1 and 2 of panel C show the effect of the policy on family income and log wages using household LSMS data from 1995 to 2000. These estimates are somewhat imprecise, but the effect of the policy on earnings is insignificant. Panels A and B of figure 6 also show the absence of any clear discontinuity. Taken together, these findings contrast sharply with those from the cross-sectional analysis.[32] Based on results from the 1973 educational reform, the reduction in vocational training did not cause an increase in labor market participation or earnings.

C. The Structural Reforms of 1997

The six yearly LSMS surveys from 1995 to 2000 allow us to focus on labor market outcomes immediately before and after the comprehensive macroeconomic stabilization and structural reform program of 1997. Table 5 presents the impact of these economic reforms on labor market outcomes by including an indicator for post-1997 surveys. The cross-sectional effects of vocational training on unemployment, nonemployment, family income, and log wage are shown in panel A.[33] The coefficient on $POST1997$ indicates that the 1997 economic reforms worsened labor market outcomes for all men. Moreover, the coefficient on the interaction of vocational training and $POST1997$ is large and significant for three of the four outcomes, suggesting that the reforms hit vocationally trained individuals particularly hard. Panel B shows the effect of the educational reform of 1973 before and after the 1997 economic re-

forms.[34] While the negative effect of the 1997 reforms is also visible in this specification, the coefficient on the interaction of $AFTER$ and $POST1997$ is very small and statistically indistinguishable from 0. Thus, in contrast to cross-sectional regressions where the benefits of general education show an increase during the period of structural reforms, we do not find a corresponding effect in regressions that exploit the 1973 educational reform. We interpret these results as further evidence that the cross-sectional relationship between vocational training and labor market success is driven by selection.

D. The Quality of General Education

The drastic expansion of general education in Romania so essential to credibly identifying the effect of vocational training may have caused a reduction in the quality of general education. Moreover, with an educational reform that affected such a large fraction of the school-age population, the question of how resources were allocated to implement the reform becomes extremely important. Figures A1 and A2 show the influx of teachers from vocational to general high school and indicate that the average student-to-faculty ratios across the two types of schools were largely maintained. Although we have some anecdotal evidence that retraining occurred, these teachers may nevertheless have been relatively inexperienced at teaching the new curriculum.

We perform two additional tests to examine possible changes in the quality of general education.[35] First, we consider labor market outcomes restricted to individuals who completed general education (as opposed to any secondary education). If the quality of general education declined due to the policy, we expect that labor market outcomes would have been worse for cohorts affected by the policy. However, we find that labor market outcomes for individuals who completed general education are not significantly different before and after the introduction of the policy. Second, we examine whether labor market outcomes differ by region of birth. Since some regions experienced larger expansions in general education, students from these regions should also have been affected more by changes in the quality of education. However, we find no significant differences in labor market outcomes by region of birth for individuals who completed general school before and after the policy change. We conclude that a change in the quality of general education is unlikely to explain why cohorts that have received more general education after the 1973 educational reform do not have better labor market outcomes.

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[31] The effects on occupational outcomes using the 1995–2000 household data (not shown) are similar in magnitude but somewhat less precise.
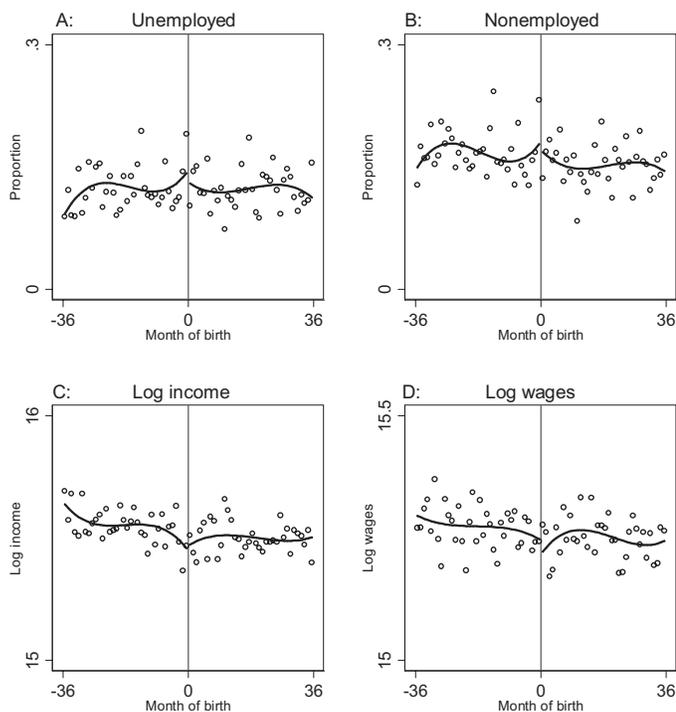
[32] Although manual and craft occupations are associated with higher unemployment and slightly higher wages, the shifts in occupational structure would not be sufficient to result in any substantial differences in labor market outcomes. Moreover, as we discuss in the section on robustness, much of the difference in the outcomes between vocational and general education occurs within occupations as well.

[33] Specifically, we estimate: $outcome_i = \beta' \mathbf{X}_i + \upsilon VOC_i + \gamma POST1997_i + \pi VOC_i \times POST1997_i + f(c_i) + \varepsilon_i$, where $post1997_i$ is defined as 1 for 1998, 1999, and 2000 surveys and 0 otherwise, with other variables as defined previously.

[34] In this instance, we estimate: $outcome_i = \beta' \mathbf{X}_i + \upsilon AFTER_i + \gamma POST1997_i + \pi AFTER_i \times POST1997_i + f(c_i) + \varepsilon_i$.

[35] These robustness checks for changes in the quality of education are presented in more detail in an earlier version of this paper (Malamud & Pop-Eleches, 2005).

FIGURE 6.—LABOR MARKET OUTCOMES IN 1995–2000
(BY MONTH OF BIRTH)

Note: All panels are restricted to men with secondary education (vocational or lyceum) between January 1, 1956, and December 31, 1961. The solid lines are fitted values from regressions of the dependent variable on a cubic spline in month of birth. The open circles indicate the fraction of men who are unemployed and nonemployed, or the average log income and wages by month of birth.
Source: LSMS 1995–2000.

E. Robustness Checks

Our main results were based on a sample of individuals with a secondary education who were born between 1956 and 1961 and therefore within a three-year window of the January 1, 1959, cutoff. Panel A of table A1 confirms these results with all men, by including those with primary, gymnasium, and higher education. In panel B, we consider three alternative samples that extend or restrict the window around the cutoff, ranging from a one-year window to a four-year window. The effect of the reform on the probability of being employed as a manual or craft worker in 1992 remains unchanged. As expected, the standard errors are generally smaller in broader windows. Moreover, the effect of the policy on labor market participation and log wages later in the transition is not significant in any of the specifications. Panel C presents estimates using alternative polynomial functions of the forcing variable. Whether we use linear, quadratic, or quartic splines, the coefficients on *AFTER* are large and significant for occupational outcomes and small and insignificant for the labor market outcomes. Using simple linear, quadratic, cubic, and quartic trends in month of birth does not affect our results in any substantial way (not shown here). Finally, panel D shows reduced-form estimates around alternative-year cutoffs. In essence, we consider "placebo experiments" around January 1 of the two preceding and two following years. We find no significant difference in the likelihood of being employed in a manual

TABLE 5.—EFFECT OF THE 1997 STRUCTURAL REFORM PROGRAM ON LABOR MARKET OUTCOMES (LSMS SAMPLES)

A: OLS	Unemployed (1)	Nonemployed (2)	Log Family Income (3)	Log Wages (4)
VOC	0.013	0.016	−0.104**	−0.043**
	[0.007]	[0.008]	[0.021]	[0.013]
POST1997	0.043**	0.059**	−0.287**	−0.204**
	[0.012]	[0.014]	[0.029]	[0.018]
VOC × POST1997	0.028*	0.028	−0.082*	−0.062**
	[0.013]	[0.015]	[0.029]	[0.020]
R^2	0.02	0.02	0.06	0.1
Sample size	14,046	14,555	14,519	10,102
Mean of dependent variable	0.12	0.16	15.53	15.26
B: Reduced Form	Unemployed (1)	Nonemployed (2)	Log Family Income (3)	Log Wages (4)
AFTER	0.024	0.02	0.046	−0.011
	[0.020]	[0.024]	[0.080]	[0.047]
POST1997	0.054**	0.078**	−0.331**	−0.240**
	[0.013]	[0.015]	[0.024]	[0.019]
AFTER × POST1997	0.009	−0.007	−0.008	0.001
	[0.013]	[0.014]	[0.026]	[0.020]
R^2	0.02	0.02	0.05	0.09
Sample size	14,046	14,555	14,519	10,102
Mean of dependent variable	0.12	0.16	15.53	15.26

Note: Robust standard errors clustered by month of birth in brackets. ** and * indicate statistical significance at the 1% and 5% level, respectively. Samples include cohorts with a secondary-level education born between January 1, 1956, and December 31, 1961. 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. VOC is defined as 1 if an individual completed a course in vocational training and 0 otherwise. POST1997 is defined as 1 if the observation is from LSMS surveys after 1997, the starting year of a macroeconomic stabilization and structural reform program. All regressions include a cubic polynomial in month of birth fully interacted with AFTER and fixed effects for calendar of month. Binary outcome variables are estimated using a linear probability model. Demographic controls include ethnicity and region of birth.

or craft-related occupation or in unemployment and wages using these alternative year cutoffs.[36]

In addition to these robustness checks, we also examined whether the differences in labor market outcomes between vocational and general secondary-educated men could be driven by occupation-specific shocks.[37] Since the old centralized sectors that employed most of the vocationally trained workers were hit hardest during the transition period, it is possible that occupation- and industry-specific shocks might be driving our results. We consider this alternative explanation with regressions that include controls for detailed indicators of previous occupation. While the size of the effect is slightly reduced in the cross-section, the effect of vocational training remains large and significant, implying that differences in labor market performance continue to hold within occupations. The reduced-form results for the effect of the 1973 educational reform remain essentially unchanged. Hence, changes in labor demand for occupations associated with vocational training do not appear to explain our findings.

VI. Conclusion

This paper examines the relative benefits of general education and vocational training in the context of a transition economy that experienced major technological and institutional change. We exploit an educational reform that occurred in Romania in 1973 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 on to vocational school after completing an additional two years of general education received less vocational training. Nevertheless, this policy change did not significantly alter average years of schooling across cohorts of secondary students. Using the Romanian censuses of 1992 and 2002 as well as LSMS household surveys from 1995 to 2000, we find evidence that men who were affected by the policy were less likely to work as manual workers and craftsmen than their counterparts who were born too early to be affected by the policy. However, we find no significant difference in labor market participation or earnings between cohorts that were affected and unaffected by the policy, even during the later stages of the transition period.

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, to be out of the labor force, and to have lower wages. We have argued that possible changes in the quality of general secondary education as a result of the policy are unlikely to explain why we do not observe the positive benefits of a general education. Hence, our findings suggest that the relationship between vocational training and labor market returns highlighted by previous studies may largely be a consequence of selection. 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. But this group of marginal students is probably the most likely to be affected by any policy that encourages general education over vocational training.

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[36] Although not shown here, estimating the binary outcome variables using logit or probit functions does not alter any of our results. Moreover, we find similar results using nonparametric methods such as local linear regression.

[37] These additional checks are presented in an earlier version of this paper (Malamud & Pop-Eleches, 2005).

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APPENDIX

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 have information only on whether students completed the first stage of lyceum school, the second stage of lyceum school, or vocational school.[38] The first and second stages of lyceum school are associated with ten and twelve years of general education, respectively. Following the 1973 educational reform, all students who completed vocational school also completed the first stage of lyceum school. These students therefore received ten years of general education and one year of vocational training. However, prior to the 1974–1975 school year, most students who completed vocational school would have received eight years of general education and three years of vocational training. We cannot distinguish individuals who entered vocational school after grade 8 prior to the educational reform from those who entered vocational schools after grade 10 and completed shorter vocational courses.

A. Effect of the Policy on the Treated Population

We estimate the rough proportion of vocational students at each level using enrollment data from the *Annual Statistics of the Socialist Republic of Romania.* Assuming that there were no dropouts and that the number of students entering vocational school after grade 10 remained constant over time, we estimate that approximately 45% of the students with vocational training born in 1958 had entered vocational school after grade 8.[39] Furthermore, we can estimate that approximately 40% of students who 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.[40] Including students who were in apprenticeship programs (which are counted jointly with vocational students in the 1992 census) requires adjusting these calculations so that approximately 50% of the students with vocational training or apprenticeships in 1958 were affected by the policy and about 45% of these students continued on to these programs after completing their additional two years of general education following the reform.[41] Given these numbers, we expect that the size of the cohort of students completing vocational training or apprenticeship programs of 1959 was about 75% of the size of the cohort of 1958, which is almost exactly what find in the data from the 1992 census. Hence, we conclude that about 50% of the students with vocational training before 1959—or 33% of the students with secondary education—were affected by the policy. Consequently, we

[38] In addition, we know whether they completed gymnasium (eight years of schooling), primary school (four years of schooling), or some form of postsecondary schooling.

[39] Based on the enrollment data, approximately 250,000 students were enrolled in vocational schools in 1973–1974, and 190,000 students were enrolled vocational schools in 1974–1975. Since enrollment in 1973–1974 includes three cohorts of students that entered after grade 8, whereas enrollment in 1974–1975 includes only 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, 1975–1976, to equal 130,000 (which is not too far from the actual figure of 123,000).

[40] Enrollment in vocational schools in 1976–1977 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 1974–1975 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 to 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 to vocational school from the second and third cohorts after the policy reform, we would expect the number of students enrolled in the years 1977–1978 and 1978–1979 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).

[41] We employ a similar method to derive the number of students in apprenticeship programs. Given enrollments of about 100,000 and 70,000 students in apprenticeships in 1973–1974 and 1974–1975, 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.

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.

B. Effect of Vocational Training

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 these data, the number of students completing the first and second levels 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.[42] These estimates suggest that among secondary-educated individuals, the average decrease in vocational training was 0.8 years. 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 can express an estimate of this effect as follows[43]:
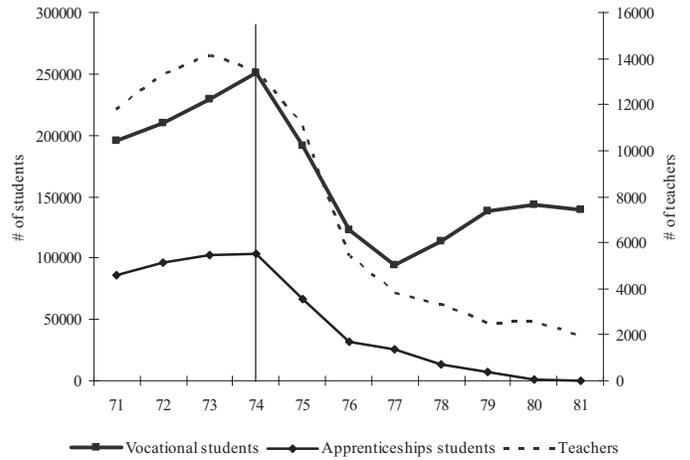
$$
E[outcome_i | V_i]
$$
$$
= \frac{E[outcome_i | AFTER_i = 1] - E[outcome_i | AFTER_i = 0]}{E[V_i | AFTER_i = 1] - E[V_i | AFTER_i = 0]}.
$$
(3)

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 calcula-

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[42] Those calculations suggest that approximately 50% of the students with vocational training in 1958 were affected by the policy, and about 45% of these students entered vocational schools after completing the first stage of lyceum schools. Since about 65% of secondary-educated students received vocational training in 1958, the number of students completing vocational school after the first level of lyceum education decreased by 18 percentage points.
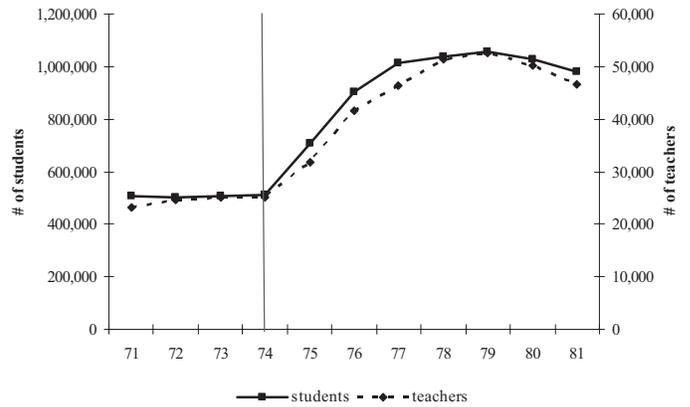
[43] See Imbens and Angrist (1994) for the assumptions that underlie estimates of LATE. In particular, we need to assume a version of their monotonicity requirement if we wish to allow for nonconstant treatment effects.

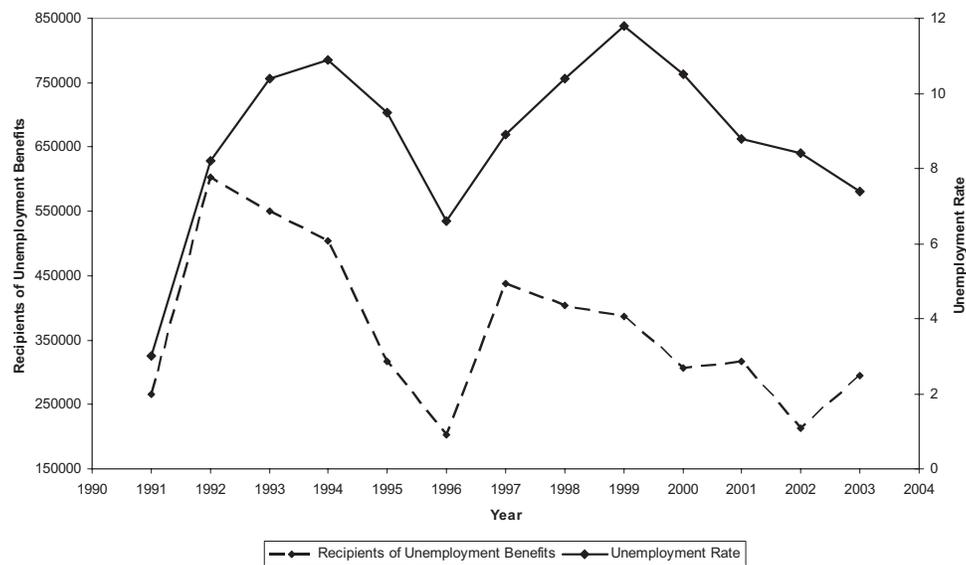FIGURE A1.—ENROLLMENT IN VOCATIONAL SCHOOLS AND APPRENTICESHIPS, BY SCHOOL YEAR

tions above, we can conclude that the effect of an additional year of vocational training instead of general education on labor market outcomes approximately 1.25δ. 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.

FIGURE A2.—ENROLLMENT IN LYCEUMS BY SCHOOL YEAR

Source: INSSE.

FIGURE A3.—RECIPIENTS OF UNEMPLOYMENT BENEFITS AND UNEMPLOYMENT RATE IN ROMANIA, 1991–2003

Source: INSSE Web site.

TABLE A1.—ROBUSTNESS CHECKS FOR MAIN OUTCOMES (COEFFICIENTS ON AFTER)

	Manual 1992 (1)	Craftsmen 1992 (2)	Unemployed 2002 (3)	Nonemployed 2002 (4)	Log Wages (5)
A: Alternative Samples					
Baseline	−0.023**	−0.034**	−0.001	0.004	−0.010
	[0.007]	[0.010]	[0.009]	[0.011]	[0.045]
All men	−0.024**	−0.031**	−0.008	−0.011	0.042
	[0.007]	[0.010]	[0.009]	[0.010]	[0.058]
B: Alternative Windows					
1-year window	−0.041**	−0.041**	−0.109	0.011	0.016
	[0.010]	[0.012]	[0.017]	[0.016]	[0.042]
2-year window	−0.033**	−0.042*	−0.004	0.029*	0.063
	[0.012]	[0.017]	[0.012]	[0.011]	[0.059]
4-year window	−0.023**	−0.029**	0.008	−0.001	−0.044
	[0.006]	[0.009]	[0.009]	[0.010]	[0.040]
C: Alternative Trends					
Linear	−0.020**	−0.033**	0.000	0.001	0.015
	[0.003]	[0.005]	[0.005]	[0.005]	[0.021]
Quadratic	−0.023**	−0.029**	0.006	−0.002	−0.033
	[0.004]	[0.007]	[0.007]	[0.008]	[0.031]
Quartic	−0.024**	−0.044**	0.004	0.024*	0.007
	[0.008]	[0.013]	[0.011]	[0.011]	[0.054]
D: Placebo Year Cutoffs					
1957	0.005	0.021	0.006	−0.018	−0.075
	[0.008]	[0.012]	[0.007]	[0.010]	[0.045]
1958	0.09	0	−0.001	0.014	0.009
	[0.010]	[0.013]	[0.010]	[0.011]	[0.045]
1959	−0.023**	−0.034**	−0.001	0.004	−0.010
	[0.007]	[0.010]	[0.009]	[0.011]	[0.045]
1960	0.004	0.02	0.005	0.003	−0.016
	[0.007]	[0.014]	[0.010]	[0.010]	[0.047]
1961	0.005	−0.005	0.010	−0.002	0.094*
	[0.007]	[0.013]	[0.012]	[0.014]	[0.044]

Note: Robust standard errors clustered by month of birth in brackets. ** and * indicate statistical significance at the 1% and 5% level, respectively. Binary outcome variables are estimated using a linear probability model. Panels A, B, and D include a cubic polynomial in month of birth fully interacted with AFTER. All regressions include calendar-of-month dummies (except regressions using 1-year window due to colinearity). Columns 1 and 2 use data from the 1992 census; columns 3 and 4 use data from the 2002 census, and column 5 uses data from the 1995–2000 Romanian LSMS. Demographic controls for the 1992 and 2002 census regressions include ethnicity, region of birth, and an indicator for urban or rural area of birth. Controls for the LSMS regressions include ethnicity, region of birth, and dummies for year of survey.