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Evidence on the returns to secondary vocational education

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Abstract

Vocational education in high schools has frequently been stigmatized as an anachronistic, dead-end path for students. We use data from the National Education Longitudinal Survey of 1988 to examine claims that students on a vocational track would benefit from a more academically rigorous education. Clearly, selection bias confounds attempts to untangle the effects of academic tracking on income after high school. Using an econometric framework that accounts for this bias, we find evidence of comparative advantage in tracking.

Jel classification: I20; I21; I29; J24; J31

Keywords: Educational economics; Salary wage differentials; Vocational education

1. Introduction

In a recent editorial, the New York Times (High School Reform, Round 1, 2005) praised President Bush's plan to cut a federally financed vocational program. The editorial board argued that these programs "prepare students for low-skill jobs that no longer exist." However, the Bureau of Labor Statistics reports that real wages for white collar workers rose 1.5% between 1997 and 2002, while real wages for blue collar workers increased 4.8% over the same time span. Certain fields have seen even greater gains, particularly for apprentice workers; automobile mechanics' apprentices have seen a 7.8% increase, plumbers' apprentices wages have increased 18.6%, and carpenters' apprentices wages have risen 22.7%. Yet, like the New York Times, many researchers feel that secondary vocational education is obsolete and schools should concentrate on fostering general academic skills. Jacobs and Grubb (2003) state that the "institutional transformation of education over the 20th century has resulted in a general consensus that specific vocational preparation should not be a part of high school." Goodlad (1984) and Adler (1983) refer to vocational education as anachronistic and even discriminatory. On the other hand, as Neuman and Ziderman (1999) note, "[a]dvocates of vocational schooling see it, variously: as an effective means of supplying national manpower skills needs; as an appropriate educational alternative to general secondary schooling for students of weaker academic ability; as a framework for improving life-outcomes of unemployed youth and other social groups with special needs."

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Evidence showing that vocational graduates have lower income than students who pursue other paths is meaningless without context. After all, it is just as plausible that these students earn less because of unobservable characteristics that are correlated with track choice as it is that vocational education is somehow diminishing their earnings potential. Simply because those who are currently on the academic or general track earn more than vocational students does not mean that shifting vocational students to those tracks would increase their income. Moreover, many previous studies have been hampered by focusing on vocational education as a single entity, as opposed to a varied track that covers everything from mechanical subjects to business studies. This paper divides vocational education into "technical" and "business" tracks and strives to create counterfactual estimates, conditional means that show what a student who chose, for example, the technical track would have earned had they actually chosen the academic track.

Section 2 examines some of the previous literature on this subject. Section 3 describes the data, which are drawn from two waves of the National Education Longitudinal Survey of 1988. Section 4 details the selection model with a multinomial logit first stage that is used to account for selection bias. Section 5 presents our results. We estimate the effect of track choice on income without accounting for selection bias. We then turn to a selection model and construct counterfactual estimates that provide evidence of comparative advantage; that is, those most suited for a particular track are already on it, and, for the most part, would not benefit from shifting. Finally, Section 6 concludes the paper and provides suggestions for future research.

2. Previous literature

Previous work in this field has directly examined the effect of secondary vocational education, often finding little or no economic benefit (Gustman & Steinmeier, 1983; Meyer & Wise, 1979; Neuman & Ziderman, 1999, inter alia). Hotchkiss (1993) examines the first job after high school and concludes that "secondary vocational training in the United States is not effective in raising one's wage." Neuman and Ziderman (1999), using Israeli data, find that for "workers who had attended secondary school and did not proceed to higher education, only a small earnings difference was found between the vocational and academic streams." Gustman and Steinmeier (1982) do not find any evidence that "vocational training for male students in high school produces any special skills that are valued by firms beyond those that are produced by a general high school education." Kang and Bishop (1989), on the other hand, find that vocational courses increase wages for men.

Mane (1999) compares the short- and medium-run returns to vocational course taking for students who graduated high school in 1972, 1980, and 1992, and finds that these returns grew much higher after the 1970s. Bishop and Mane (2004) examine literature on the effects of secondary vocational education and find evidence that this return has been growing, possibly because "the skill needs of business were growing and shifting very rapidly during the 1980s and 1990s," and because this type of education has become more effective. Bishop and Mane's comprehensive study uses the same data set as this paper and finds positive effects on income for vocational study. These results complement the findings in this study regarding comparative advantage in track choice. They find that both computer and non-computer vocational coursework are associated with higher earnings 8 years after high school graduation. However, they address selection bias by including "as many personal and school characteristics as possible," along with state-level variables. This method may not completely ameliorate the problem. State-level variables add information about labor market conditions that should more precisely pinpoint the returns to vocational coursework. Yet many other variables included in the regression may also suffer from endogeneity bias, such as college attendance and marital status, thus biasing the overall result. A number of the variables used in this attempt to eliminate omitted variables bias have questionable value, such as whether the student smokes in the 8th grade, or the number of books in the student's home. A selection model is a more appropriate method for investigating this question.

Many studies attempt to account for ability, but there are clear pitfalls to simply including these controls. Willis and Rosen (1979) note that "merely partitioning observed earnings into schooling and ability components does not use any of the restrictions imposed on the data" by, in our case, different track choices; that is, a selection model provides a more accurate estimate of the return to schooling. Gamoran (1998) writes that unobserved differences among students as well as imperfect measures of ability will lead to biased results that overestimate the effects of academic tracking. Gamoran and Mare (1989) rightly note that "[s]tandard models may fail to disentangle track effects from preexisting differences among students;" in our case, this would lead to underestimating the return to vocational education. We strive to avoid these biases.

Kulik (1998) writes that "there is an achievement gap at the start of high school between students who elect different programs." Some argue that tracking only serves to reinforce these differences, but Slavin (1990) counters that students in different tracks differ too much in aptitude to make any such comparisons meaningful. In the same vein, Gamoran and Mare (1989) note that it is likely that "students differ in their academic goals and in the environment in which they learn best." Kulik's conclusion is telling:

> These regression comparisons are inadequate, however, and their results are misleading. It is important to note that the groups being compared differ profoundly in educational aspirations at the start of high school. Students usually follow college-prep programs because they intend to go to college; students often follow vocational programs because they do not intend to go to college. The goals of the two groups seem almost by definition to be non-overlapping.

Gamoran (1998) argues that academic courses may "nurture general cognitive abilities," which in turn make workers more productive. Moreover, there may be a stigma attached to vocational education. Arum and Shavit (1995) point out that "[p]otential employers, who want to cut training costs by recruiting fast-learning employees, may interpret the choice of a vocational track as evidence of a lower level of general aptitude." On the other hand, such signals may indicate particular skill or temperment for such work (Arum & Shavit, 1995). In a similar vein, self-selection into a vocational track as opposed to a general one may serve as a signal of determination and focus. The Department of Education (2000) finds that vocational concentrators were more likely than general track students to obtain 2-year certificates and degrees on time, even though they were also more likely to be employed while studying. Arum and Shavit argue that while vocational education may inhibit future educational and occupational plans for some students, "vocational education teaches students marketable skills and attitudes that can help them find skilled jobs and reduce their risk of unemployment or employment as low-paid unskilled workers."

3. Data

The data for this project are drawn from the 1992 and 2000 waves of the National Education Longitudinal Survey of 1988 (NELS:88). NELS:88 sampled eighth graders in 1988, with follow-ups in 1990, 1992, 1994 and 2000. In 1992, the sample was updated to represent the high school class of 1992. The 1992 wave also sampled school administrators, providing data that is of great interest. We do not address income data from 1994 as a large part of the sample was still in postsecondary schooling, whereas by 2000 most sample members were 8 years out of high school. Unfortunately, NELS:88 does not sample area and regional vocational schools. This is worrisome, as many of those who are targeted for or select into vocational education, and therefore who may most benefit from it, are not included in the sample. This may bias estimates of the return to vocational education downwards.

The initial sample consists of 12,144 individuals. Those with missing covariates, transcript data, and income in the 2000 wave are dropped, leaving 9070 observations. 39 income outliers whose values seem anomalous are also dropped, as are 530 observations reporting zero income. Dropping those observations which have missing values for the exogenous selectors used in this paper would leave only 4524 respondents. This would not be a sufficient number to divide the vocational track into technical and business components, a key contribution of this paper. The majority of these variables are administrator-reported and have high, non-overlapping non-response rates. In order to preserve the larger sample, we create dummy variables corresponding to the missing observations. There is no reason to believe that these observations with missing data are different from the others, since, except for socioeconomic status, the non-response originates with the school's administrators rather than the respondents themselves. None of these missing variables is correlated in any meaningful way with our income variable or track choice.[1] We also drop 1644 students whose

[1]The highest correlation, 0.057, is between being on the technical track and missing the indicator for offering Advanced

transcripts report not achieving the National Assessment of Educational Progress's definition of general (often called "academic"), academic (often called "rigorous academic" or "college preparatory"), or vocational tracks. The requirements of the general track (12 total Carnegie units in English, social studies, math, and science) and the vocational tracks (three total Carnegie units in a specific vocational field) are quite low, below the graduation requirements of many states. It stands to reason that those who do not achieve them are fundamentally different from the balance of the sample and, if included, may confound the estimates. Using the NAEP track definitions, we divide our sample into general, academic, technical, and business tracks. The technical track consists of those who achieve three or more Carnegie units in agricultural, technical, trade, and health-related fields, while the business track includes those with three or more Carnegie units in business and office, marketing, and occupational home economics fields. The results do not differ greatly when students concentrating on health-related vocational education are placed on the business track. Kang and Bishop (1984) provide support for a division along these lines; they find that there are differential effects to vocational course taking, depending on the type of classes.

We are left with 6857 observations, of whom 4050 are on the general track (59.1%), 1714 are on the academic track (25.0%), 583 are on the technical track (8.5%), and 510 are on the business track (7.4%). Students who fulfill the requirements for both a vocational and either the general or academic track are listed as being on the particular vocational track. Twenty-seven respondents who fulfill the requirements for both the business and technical track are assigned to the technical track; assigning them to the business track does not alter the results. Including those who met the standards for both a vocational and the academic track in the academic track does not alter the nature of the results in any significant way. Moving those who meet the standards for both a vocational and the general track to the general track leaves too few observations for meaningful estimation. Of the students on the business track, 55.5% are business concentrators, 11.2% are occupational home economics concentrators, 10.6% are marketing and distribution concentrators, and the balance are in general vocational classes. On the technical track, the vast majority of students (70.0%) are trade and industry concentrators, with most of the rest in agriculture (24.0%). Technical and health concentrators make up the balance.

A description of the variables used in our estimation, along with weighted summary statistics, can be found in Table 1. Income data are reported in 1999 dollars and parental education data use the parent with higher reported education. Table 2 contains summary statistics broken down by track type.

4. Econometric specification

In order to account for selection bias in track choice and its subsequent effects on income, we use a multinomial logit selection model that is described in Bourguignon, Fournier, and Gurgand (2004).[2] Their model generalizes Dubin and McFadden's (1984) original extension of the Heckman (1979) selection model.

Bourguignon et al. (2004) relax an assumption about the correlation structure in the Dubin–McFadden model. For brevity, only the framework of this more robust model will be reproduced here

$$\begin{aligned} Y_i &= X\beta_i + \mu_i, \\ S_j^* &= Z\delta_j + \eta_j, \\ j &= 1 \ldots M, \end{aligned} \tag{1}$$

where Y_i is log income for each individual, observed for category i of M alternatives (general, academic, technical or business track) if $S_i^* > \max_{j \neq i} S_j^*$. The individual subscript is suppressed. X contains covariates for race, gender, region, and parental education, while Z contains these variables along with socioeconomic status, whether vocational courses are offered at the school, whether the school has a formal vocational department, whether the school offers Advanced Placement classes, and indicators for the proportion of the previous year's class that attended a 2- or 4-year college. X does not include variables such as work experience or achieved education since these covariates may not

(*footnote continued*)
Placement classes. The large majority of these correlations are under 0.03.

[2]The paper is available at http://www.crest.fr/pageperso/lmi/gurgand/selmlog.htm, along with a version of the Stata ado file used for estimation.

Table 1
Weighted summary statistics

Variable	Description	Mean	Standard deviation
General	Respondent's transcript indicates general track in 1992	0.5776	0.4940
Academic	Respondent's transcript indicates academic track in 1992	0.2513	0.4338
Technical	Respondent's transcript indicates technical track in 1992	0.1017	0.3023
Business	Respondent's transcript indicates business track in 1992	0.0693	0.2540
LnInc99	Log income in 1999	10.03	0.7315
Hispanic	Respondent is Hispanic	0.0792	0.2701
Black	Respondent is black	0.1108	0.3139
White	Respondent is white	0.7628	0.4254
Male	Respondent is male	0.5239	0.4995
Neast	Respondent lives in the northeast census region	0.2024	0.4018
Midwest	Respondent lives in the midwest census region	0.2706	0.4443
West	Respondent lives in the west census region	0.1684	0.3743
ParHS	Respondent's best-educated parent had a high school degree by 1992	0.1775	0.3821
ParSomeColl	Respondent's best-educated parent attended some college by 1992	0.4148	0.4927
ParColl	Respondent's best-educated parent had a college degree by 1992	0.1860	0.3891
ParPro	Respondent's best-educated parent had a professional degree by 1992	0.1553	0.3622
VocSchl	Vocational classes were taught in the school	0.6380	0.4806
MissVocSchl	VocSchl variable is missing	0.1601	0.3667
FullTeach	Respondent's school had full-time vocational education teachers	0.7816	0.4132
MissFullTeach	FullTeach variable is missing	0.1004	0.3005
OfferAP	School offered Advanced Placement classes	0.7749	0.4176
MissOfferAP	OfferAP variable is missing	0.0291	0.1680
QtrFour	Quarter or more of 1991 graduating class went to a four-year school	0.6838	0.4650
MissQtrFour	QtrFour variable is missing	0.1196	0.3245
QtrTwo	Quarter or more of 1991 graduating class went to a two-year school	0.2650	0.4414
MissQtrTwo	QtrTwo variable is missing	0.1380	0.3449
Missing SES	Socioeconomic status is missing	0.1010	0.3013

only be endogenous, but, as Willis and Rosen (1979) point out, "it is more in the spirit of the choice framework of the model to allow these "current" events to be captured indirectly via their correlations with included variables in order to estimate expected or anticipated results."

If the unobservables that drive track selection also affect income, then the error terms μ_i and $\eta_1 \ldots \eta_M$ will not be independent, rendering least squares estimates of a standard income equation inconsistent. Bourguignon et al.(2004) show that, under the assumption that μ_i, the error of the track i income equation, and a normal transformation of each η_j, represented as η_j^*, are linearly related (which is true, for example, under the assumption that μ_i is normal and μ_i and η_j^* are bivariate normal), it is straightforward to correct for selection bias. The expectation of μ_i can be written as

$$E[\mu_i|\eta_1 \ldots \eta_M] = \sigma_i \sum_{j=1}^{M} r_j^* \eta_j^*, \tag{2}$$

where σ_i is the standard deviation of μ_i and r_j^* is the correlation between μ_i and each η_j^*.

$$E[\mu_i|S_i^* > \max_{j \neq i} S_j^*] = \alpha_G^i M_G^i + \alpha_A^i M_A^i + \alpha_T^i M_T^i + \alpha_B^i M_B^i. \tag{3}$$

Under this assumption, a multinomial logit first stage can be used to create selection parameters as in (3), for each s signifying track, and G, A, T, and B corresponding to the general, academic, technical, and business tracks, respectively. The superscripts represent the track being estimated, while the subscripts refer to the element of the correction term corresponding to that particular track. Each α is composed of σ_i and r_j^* as in (2). The M terms are the conditional expectations of η_j^*, estimates of which are computed numerically. This framework is well suited to our purposes in that it not only provides adequate selectivity correction, but can be used to form counterfactuals. Namely, this model allows us to examine what Y would have been for

Table 2
Weighted summary statistics by track

Variable	Description	General track	Academic track	Technical track	Business track
	Number of Observations	4050	1714	583	510
LnInc99	Log income in 1999	9.995	10.13	10.10	9.892
		(0.764)	(0.6464)	(0.7502)	(0.6693)
Hispanic	Respondent is Hispanic	0.0847	0.0709	0.0485	0.1087
		(0.2785)	(0.2568)	(0.2150)	(0.2150)
Black	Respondent is black	0.1153	0.0995	0.1064	0.1211
		(0.3194)	(0.2994)	(0.3086)	(0.3265)
White	Respondent is white	0.7491	0.7853	0.8079	0.7297
		(0.4336)	(0.4108)	(0.3943)	(0.4445)
Male	Respondent is male	0.5159	0.4694	0.8444	0.3168
		(0.4998)	(0.4992)	(0.3628)	(0.4657)
Neast	Respondent lives in the northeast census region	0.1847	0.2574	0.2033	0.1497
		(0.3881)	(0.4373)	(0.4028)	(0.3571)
Midwest	Respondent lives in the midwest census region	0.2656	0.2439	0.3151	0.3441
		(0.4417)	(0.4296)	(0.4650)	(0.4281)
West	Respondent lives in the west census region	0.2078	0.1227	0.1029	0.1026
		(0.4058)	(0.3282)	(0.3041)	(0.3038)
ParHS	Respondent's best-educated parent had a high school degree by 1992	0.1688	0.1160	0.3241	0.2579
		(0.3746)	(0.3204)	(0.4684)	(0.4379)
ParSomeColl	Respondent's best-educated parent attended some college by 1992	0.4171	0.3924	0.4455	0.4326
		(0.4931)	(0.4884)	(0.4974)	(0.4959)
ParColl	Respondent's best-educated parent had a college degree by 1992	0.1890	0.2415	0.0739	0.1240
		(0.3915)	(0.4281)	(0.2619)	(0.3299)
ParPro	Respondent's best-educated parent had a professional degree by 1992	0.1663	0.2089	0.0264	0.0585
		(0.3724)	(0.4066)	(0.1606)	(0.2349)
VocSchl	Vocational classes were taught in the school	0.6336	0.6045	0.6755	0.7403
		(0.4819)	(0.4891)	(0.4686)	(0.4389)
MissVocSchl	VocSchl variable is missing	0.1630	0.1589	0.1795	0.1117
		(0.3694)	(0.3657)	(0.3841)	(0.3153)
FullTeach	Respondent's school had full-time vocational education teachers	0.7795	0.7397	0.8619	0.8335
		(0.4147)	(0.4389)	(0.3453)	(0.3729)
MissFullTeach	FullTeach variable is missing	0.0989	0.1077	0.1046	0.0798
		(0.2986)	(0.3100)	(0.3063)	(0.2713)
OfferAP	School offered Advanced Placement classes	0.7852	0.7902	0.7161	0.7204
		(0.4107)	(0.4073)	(0.4513)	(0.4492)
MissOfferAP	OfferAP variable is missing	0.0255	0.0299	0.0458	0.0313
		(0.1576)	(0.1704)	(0.2093)	(0.1744)
QtrFour	Quarter or more of 1991 graduating class went to a four-year school	0.6889	0.7301	0.5828	0.6209
		(0.4630)	(0.4441)	(0.4935)	(0.4856)
MissQtrFour	QtrFour variable is missing	0.1122	0.1216	0.1607	0.1140
		(0.3156)	(0.3269)	(0.3675)	(0.3181)
QtrTwo	Quarter or more of 1991 graduating class went to a two-year school	0.2986	0.2093	0.2051	0.2751
		(0.4577)	(0.4070)	(0.4041)	(0.4470)
MissQtrTwo	QtrTwo variable is missing	0.1304	0.1461	0.1718	0.1216
		(0.3368)	(0.3534)	(0.3776)	(0.3271)
SES 2nd Quart	Respondent's family is in 2nd socioeconomic status quartile in 1992	0.2328	0.2198	0.2536	0.2576
		(0.4227)	(0.4142)	(0.4355)	(0.4377)

Table 2 (*continued*)

Variable	Description	General track	Academic track	Technical track	Business track
SES 3rd Quart	Respondent's family is in 3rd socioeconomic status quartile in 1992	0.2395	0.2745	0.1558	0.1923
		(0.4269)	(0.4464)	(0.3630)	(0.3945)
SES Top Quart	Respondent's family is in top socioeconomic status quartile in 1992	0.2243	0.3105	0.0514	0.1224
		(0.4172)	(0.4628)	(0.2209)	(0.3281)
Missing SES	Socioeconomic status is missing	0.1116	0.0718	0.1139	0.0992
		(0.3150)	(0.2582)	(0.3180)	(0.2993)

someone who chose, for example, the technical track if they had actually chosen the academic track. For that case, we wish to find

$$E[Y_A|S_T^* > \max_{j\neq T} S_j^*] = E[X\beta_A|S_T^* > \max_{j\neq T} S_j^*] + E[\mu_A|S_T^* > \max_{j\neq T} S_j^*]. \quad (4)$$

Using the assumption of a linear relationship between the error terms in (1), this can be rewritten as

$$E[Y_A|S_T^* > \max_{j\neq T} S_j^*] = E[X\beta_A|S_T^* > \max_{j\neq T} S_j^*] + \alpha_G^A M_G^T + \alpha_A^A M_A^T + \alpha_T^A M_T^T + \alpha_B^A M_B^T. \quad (5)$$

The coefficients α are drawn from the estimates of the hypothetically chosen track (in this case, academic), while the selection terms M are drawn from the estimates of the actually chosen track (in this case, technical). In this manner, we can compare alternative outcomes for the subgroups that choose each track. Evidence of comparative advantage can be seen if the income from a counterfactual choice is lower than that from the actual choice. This finding would imply that ability varies on multiple dimensions and different types of students benefit from different tracks.

An alternate selection specification that uses the multinomial logit first stage is Lee's (1983) model, which makes very strict assumptions regarding the error structure between the first and second stages. As Bourguignon et al. (2004) explain, the main implication of these assumptions is that the "unobservable determinants of the choice of [an] alternative against any other alternative should be correlated in the same direction with the unobservable determinants of [that] outcome." This seems antithetical to our model. As a hypothetical example, assume that the unobservables that make one more likely to choose the technical track over the academic track consist of academic ambition and are negatively correlated with the unobservables for the technical track income equation, which consist of mechanical abilities. Lee's model would assume, then, that the unobservables that drive students to choose the technical track over the general track, such as interest in learning a trade, would be negatively correlated with those same unobservables regarding mechanical abilities. Moreover, the Lee assumption implies that these correlations are identical when the first stage is estimated using the multinomial logit model. Altogether, these assumptions do not seem accurate in our case and would render the results meaningless.

5. Analysis

5.1. Preliminary issues

Most previous studies divide students into three tracks (academic, general, and vocational), but this is a source of contention. Arum and Shavit (1995) argue that, while "this simplification is an appropriate technique for examining curricular effects on levels of educational attainment, it tends to distort the analysis of occupational outcomes, since different vocational programs prepare students for distinct types of employment opportunities." Due to a limited sample size, dividing programs more finely than "technical" and "business" is not feasible. This precludes us from directly examining the training–job match question; namely, the argument that vocational training is only useful when it feeds into a job with relevant skills. However, splitting vocational education into two fairly distinct types enables us to more thoroughly explore its benefits.

Another issue is the use of self-reported versus transcript-reported tracks. Gamoran (1987) notes that "student track perceptions may be exactly what is called for… Because high school students typically have some choice in the courses they select, students' perceptions of their curricular programs are likely to govern their learning opportunities as much if not more than the school's view." However, Rosenbaum (1980) points out that students "often misperceive their tracks" and that this can "be an obstacle that frustrates their plans." The former observation is borne out by the data; a significant number of students who report themselves as being on the academic track have not, in fact, achieved the necessary credits to be considered on that track. We feel that actual achievement is most likely to have an effect on future occupations and income; therefore, we use transcript-reported track in the senior year. Bishop and Mane (2004) concur, stating that "since it is the number and types of courses taken which are influenced by school policy, studies of the impact of vocational education need to employ objective measures of participation and not self-assessments of track." While Vanfossen, Jones, and Spade (1987) point out that "vocational-track students who reach 12th grade constitute a more able and more select subset of those who had initially been placed on that track," using an earlier measure not only ignores those who change tracks but requires reliance on less complete transcript data. Gamoran (1987) finds evidence that "senior track positions carry greater significance" than earlier choices, further vindicating this decision.

5.2. Exclusionary restrictions

In order to identify the model, it is helpful to include exogenous variables that affect track choice but not outcome variables directly in addition to the non-linearity inherent in this framework. To that end, we use the following variables, with associated dummies for missing observations, in the first stage of the selection model:

- Whether vocational classes are taken at the school, as reported by administrators.
- Whether the school has full-time vocational teachers, as reported by administrators.
- Whether the school offers Advanced Placement courses, as reported by administrators.
- Whether more than a quarter of the previous year's graduating high school class went on to a 2 year college, as reported by administrators.
- Whether more than a quarter of the previous year's graduating high school class went on to a 4 year school, as reported by administrators.
- Socioeconomic quartile, a composite variable in the NELS dataset comprised of information on parental income, education, occupation, and standard of living.

These variables, including the missing observation dummies, are jointly significant (χ^2 with 42 d.f. $= 177.76$; p-value $= 0.000$) in the first stage of the selection model, where track choice is on the left-hand side. With the exception of the Advanced Placement indicator, each individual variable combined with its missing indicator counterpart is significant as well. Such mechanical tests of suitability are insufficient, though; a theoretical justification must be made.

Card (2000) notes that, in education, "variables from the supply side are an obvious source of identifying information for estimating demand-side parameters." If vocational classes are taken at the school as opposed to a district or regional center, students can be expected to be more likely to follow the vocational track. After all, it is far more difficult to take specialized classes if they are only offered away from the school. Full-time vocational teachers may be an indicator of the accessibility and quality of vocational education at that school and thus an influence on the propensity to follow that track. The availability of Advanced Placement classes is likely to influence students to follow the academic track, since these courses are tailored to the college-bound. Their mere presence also serves as an indication of the overall academic atmosphere of the school, which—while exogenous to a single individual—may affect the student's perspective on track choice. This also holds true for the indicators regarding college attendance for the class of 1991, the class previous to the one observed in this data set. If a significant proportion of older students go to college, it can be expected to enhance awareness and desirability of the college preparatory track.

These factors can plausibly be argued to be indicators of a school's quality, which may, in turn, affect income. However, none of the above variables are significant with their missing counterpart in the naïve regression for log income; all the variables together are jointly insignificant as well (F-test with

10 and 6832 d.f. = 1.27; p-value = 0.2404). Once actual track choice (and demographic variables) are controlled, income is not affected by these indirect mechanisms.

Finally, the composite family socioeconomic status variable provides a source of information about the student's background, which is likely to influence track choice. Wealthier, better educated parents in higher-status occupations are likely to push their children onto the college preparatory track, *ceteris paribus*. One can posit that parental variables affect income in a manner other than directly through education choice. However, when socioeconomic status quartile (and its missing counterpart) is included in this regression, the variables are just jointly insignificant at the 5% level (F-test with 4 and 6838 d.f. = 2.18; p-value = 0.0682). More importantly, the individual effects are relatively small. The indicator for top SES quartile (compared to bottom SES quartile) is 8.3% with a standard error of 6.8%; by comparison, the coefficient on the gender indicator for male is 30.3% and that on being white is 10.8%. The second and third quartile coefficients are smaller.

While the channels through which SES is transmitted intergenerationally are far from clear (Charles & Hurst, 2002; Oreopoulos, Page, & Stevens, 2003, inter alia), one might expect that these measures have a significant effect on income 8 years after high school graduation. If so, they should be included in the second stage of the model. Parental socioeconomic status in 1992 is significant in the regression for log income in 2000, but the substance of our results regarding comparative advantage in track selection, discussed below, is unchanged. Full results are available upon request.

The weighted multinomial logit first stage of the selection model is reported in Table 3.

5.3. Log income

We first turn to the effects of track choice on income. A prima facie examination of the data shows that those on either vocational track earn substantially less than those on the academic track. From the naïve regression with no selection correction in Table 4, we see that being on the technical track is associated with a significant 11.4% lower income relative to being on the academic track, but the difference with the general track is an insignificant 1.9%. The business track is associated with 15.8% lower earnings than the academic track and

Table 3
First stage of selection model: Multinomial logit

	Academic	Technical	Business
SES 2nd Quartile	*1.435*	*0.578*	0.915
	(0.166)	*(0.0756)*	(0.141)
SES 3rd Quartile	*1.743*	*0.397*	0.897
	(0.216)	*(0.0624)*	(0.162)
SES Top Quartile	*1.944*	*0.367*	1.001
	(0.282)	*(0.0961)*	(0.249)
Missing SES	0.965	*0.664*	0.775
	(0.136)	*(0.107)*	(0.148)
VocSchl	1.037	1.449	*1.742*
	(0.0838)	(0.194)	*(0.265)*
MissVocSchl	*0.697*	1.018	0.666
	(0.0880)	(0.220)	(0.169)
FullTeach	0.850	*2.678*	0.875
	(0.0843)	*(0.634)*	(0.170)
MissFullTeach	0.882	*2.636*	0.860
	(0.115)	*(0.723)*	(0.224)
OfferAP	1.010	0.796	0.802
	(0.0807)	(0.0908)	(0.0980)
MissOfferAP	1.254	0.757	0.892
	(0.274)	(0.227)	(0.316)
QtrFour	*1.221*	*0.730*	*0.686*
	(0.103)	*(0.0809)*	*(0.0845)*
MissQtrFour	1.400	*2.443*	*3.163*
	(0.348)	*(1.018)*	*(1.621)*
QtrTwo	*0.690*	*0.611*	0.881
	(0.0513)	*(0.0698)*	(0.106)
MissQtrTwo	1.197	0.689	0.561
	(0.246)	(0.262)	(0.262)
Hispanic	1.146	*0.522*	1.193
	(0.206)	*(0.154)*	(0.351)
Black	0.807	0.736	0.763
	(0.138)	(0.199)	(0.224)
White	0.989	1.423	0.999
	(0.143)	(0.336)	(0.256)
Male	*0.813*	*5.846*	*0.474*
	(0.0484)	*(0.661)*	*(0.0502)*
Neast	*1.234*	1.209	0.815
	(0.102)	(0.156)	(0.128)
Midwest	*0.767*	1.021	1.199
	(0.0616)	(0.119)	(0.151)
West	*0.524*	*0.511*	*0.378*
	(0.0513)	*(0.0814)*	*(0.0678)*
ParHS	0.806	*0.698*	0.747
	(0.137)	*(0.118)*	(0.145)
ParSomeColl	0.973	*0.546*	*0.538*
	(0.166)	*(0.0974)*	*(0.110)*
ParColl	1.043	*0.241*	*0.357*
	(0.198)	*(0.0602)*	*(0.0956)*
ParPro	0.942	*0.104*	*0.195*
	(0.189)	*(0.0356)*	*(0.0639)*

The left-hand side variable is a categorical for the chosen track: general, academic, technical, or business. The comparison category is general track. Relative risk ratios are reported. Estimation is weighted and bootstrapped with 1000 repetitions. Those significant at the 5% level are italicized.

Table 4
Least squares estimates

Variable	Coefficient
Academic track in 1992	*0.1328*
	(*0.0290*)
Technical track in 1992	0.0192
	(0.0829)
Business track in 1992	−0.0255
	(0.0397)
Hispanic	−0.0084
	(0.0748)
Black	−0.0125
	(0.1011)
White	0.1097
	(0.0626)
Male	*0.3051*
	(*0.0353*)
Neast	0.0716
	(0.0387)
Midwest	0.0752
	(0.0489)
West	−0.0018
	(0.0420)
ParHS	−0.0426
	(0.0553)
ParSomeColl	0.0004
	(0.0511)
ParColl	0.0347
	(0.0549)
ParPro	0.1084
	(0.0603)
Constant	*9.707*
	(*0.0768*)

The left-hand side variable is log income in 1999. Estimation is by weighted) least squares. Robust standard errors are in parentheses, and those significant at the 5% level are italicized.

2.6% lower earnings than the general track, though this latter difference is not statistically significant. It remains to be seen, though, whether those who were on the technical and business tracks would have done better had they chosen an alternate path.

Using our multinomial logit selection model to account for these unobservable differences, we can create counterfactual scenarios to go along with the actual predicted outcomes. The results of the models are in Table 5, while the conditional means are reproduced in Table 6. For consistency, the conditional means for the actual outcomes are drawn from the selection model. As would be expected if the model is correctly specified, they reproduce the naïve results almost exactly.

We construct counterfactual estimates using the error structure as described in Section 4. For example, to create the counterfactual academic income for those on the technical track, we use the α coefficients from the academic track column of Table 5 and the corresponding M selection terms from the technical specification. Due to the presence of estimated coefficients in the creation of the counterfactual conditional means, we cannot easily surmise the correct standard deviations. Using the naïvely computed standard errors as reported in Table 6, we find quite significant differences in all the counterfactual comparisons discussed below. Even though the standard errors should be somewhat larger if the estimation method was taken into account, the differences are large enough that we do not expect that correcting this measure would alter our results in any meaningful way.

These results can be taken as evidence of comparative advantage; namely, those that are most suited to the technical track tend to gravitate towards that choice and are best off there. Log income for those on the technical track would have been 3.7% less had they been on the academic track, 3.8% less had they been on the general track, and 10.9% less had they been on the business track. On the other hand, those on the business track have a log income that is 7.1% and 10.1% lower than the one they would have had on the general and academic tracks, respectively. They do, however, see a comparative gain of 11.0% over an alternative choice of the technical track. This seems to indicate that students who follow a non-technical vocational path would benefit from increased academic rigor, and perhaps suffer from developing specific white collar skills, as opposed to general cognitive skills. Nevertheless, they tend to be unsuited for the technical track, providing further evidence of the importance of different types of ability.

Log income for those on the academic track would be 18.0% less had they been on the technical track and 15.9% less had they been on the business track. This is not surprising, since students who concentrate on college preparatory material are probably unsuited to more labor-intensive work or more limiting types of office work. The general track counterfactual log income for those on the academic track is 3.5% lower, a much smaller than that for the vocational tracks, as would be expected if students on the academic track benefit from developing general skills. Consistent with the argument that students are not well served by developing specific white collar skills (as opposed to a trade), the counterfactual log income for the business track

Table 5
Selection model for log income by track

Variable	General track	Academic track	Technical track	Business track
Hispanic	0.2249	−0.1603	0.1266	0.0371
	(0.2289)	(0.1068)	(0.2168)	(0.1170)
Black	0.0047	−0.0636	−0.3441	0.1180
	(0.2328)	(0.1035)	(0.3799)	(0.1255)
White	0.0995	−0.0236	0.1212	0.1301
	(0.2064)	(0.0732)	(0.1608)	(0.1010)
Male	*0.4320*	0.0743	*0.8541*	*0.2417*
	(*0.1586*)	(0.0747)	(*0.3778*)	(*0.0871*)
Neast	0.0817	−0.0099	−0.0295	0.1011
	(0.1145)	(0.0577)	(0.1152)	(0.0660)
Midwest	*0.1874*	−0.0393	−0.0358	*0.1959*
	(*0.0792*)	(0.0596)	(0.1522)	(*0.0592*)
West	0.0382	−0.0913	0.2937	0.0925
	(0.1965)	(0.0979)	(0.1753)	(0.0947)
ParHS	−0.1480	−0.0675	0.2033	−0.0258
	(0.1195)	(0.1021)	(0.1598)	(0.0922)
ParSomeColl	−0.0307	−0.0414	0.0068	0.0742
	(0.1306)	(0.1088)	(0.1635)	(0.0953)
ParColl	−0.0639	0.0268	0.1235	0.0826
	(0.2102)	(0.1335)	(0.2651)	(0.1247)
ParPro	−0.1322	0.1529	0.4332	0.1351
	(0.3038)	(0.1467)	(0.3407)	(0.1484)
α_G	−0.9251	0.2891	0.8024	0.7050
	(1.8155)	(0.9271)	(1.6124)	(0.5921)
α_A	−1.2596	0.2032	−1.3565	0.3964
	(1.3952)	(0.2836)	(1.1817)	(0.9462)
α_T	−0.9059	−0.1039	−0.1259	0.2548
	(1.3554)	(0.7364)	(0.4332)	(0.9646)
α_B	−0.1338	0.6403	−0.6188	0.8396
	(0.3208)	(0.6324)	(1.4991)	(0.8045)
Constant	*8.778*	*10.181*	*9.376*	*9.564*
	(*1.3175*)	(*0.493*)	(*0.701*)	(*0.3341*)

The left-hand side variable is log income in 1999 for those on a particular track. Estimation is weighted and bootstrapped with 1000 repetitions. Standard errors are in parentheses and those significant at the 5% level are italicized.

is 7.4% lower than the observed general track log income, a significant difference.

Those on the general track, however, would expect a significant 9.5% higher log income if they had chosen the technical track. This may be an indication that students who are less likely to be college bound or less well-matched for jobs that require more education would benefit from more technical education. Due to error on their own part or through societal pressure and lack of opportunities, these students are avoiding from a path that may greatly benefit them.

5.4. Demographic comparative advantage

It is of great interest to ascertain whether certain demographic groups gain relatively more from different tracks. To that end, conditional means for both actual and counterfactual outcomes are calculated for a number of different groups, with full results available upon request. Men benefit far more from the technical track than women do. Women, in fact, have a higher counterfactual wage for the academic and general tracks than the actual expected wage. It should be noted, though, that there are only 94 women in the sample on the technical track. The expected technical income premium for those on the general track is significantly larger for men than for women and the expected technical income loss for those on the academic track is significantly smaller. Examining the gender coefficient in Table 5 confirms this finding. This coefficient is not significant for the academic track, while it is quite large and significant

Table 6
Conditional mean of log income in 1999

	Conditional mean	Standard deviation
General track	9.985	0.1962
Academic track given general track was chosen	10.14	0.1409
Technical track given general track was chosen	10.93	0.4756
Business track given general track was chosen	9.245	0.2648
Academic track	10.13	0.128
General track given academic track was chosen	9.775	0.201
Technical track given academic track was chosen	8.302	0.530
Business track given academic track was chosen	8.520	0.323
Technical track	10.11	0.3681
Academic track given technical track was chosen	9.730	0.1312
General track given technical track was chosen	9.723	0.1503
Business track given technical track was chosen	9.007	0.4625
Business track	9.862	0.2457
Academic track given business track was chosen	10.86	0.2455
General track given business track was chosen	10.57	0.3590
Technical track given business track was chosen	8.778	0.3469

The first result of each section gives the conditional mean for that track. The following lines give the counterfactual conditional mean, constructed as described in Section 4. The standard deviations do not account for the estimated coefficients used to construct the conditional means and are therefore imprecise.

for the general and business tracks, and in particular the technical track.

Whites tend to benefit more from the technical track than blacks as well. Blacks have a significantly higher counterfactual wage for the academic track than the actual expected wage and the general track expected wage is insignificantly different. Moreover, their premium (in absolute terms) over the business track is significantly lower than that of white students. The technical wage for white technical students is 4.0% higher than the expected academic wage, as compared to 1.3% lower for blacks. The counterfactuals for blacks on the business track indicate that these students would be far better served by focusing on the academic or general tracks. This may be due to different perceptions of the abilities of those on the technical track. Following the arguments in Arum and Shavit (1995), whites may be perceived as taking technical courses because of mechanical skills and ambition in related fields, whereas blacks may be falsely perceived as being underachievers shunted to a "lower" track.

Altogether, it seems that technical education is best serving those who are already committed to it, while those on the business track would be better served by focusing on more general skills. This is by no means a proposition that white males be pushed towards the technical track to the exclusion of others, merely an observation that certain demographic groups seem to benefit from different educational plans.

5.5. *Alternative specifications*

We estimate a number of variations on our basic model in order to assess the robustness of the results. Full results from this section are available upon request.

5.5.1. *Public school only*

It can reasonably be argued that students in private schools differ in unobservable ways from students in public schools. Parents may be choosing a private school with regard to their child's ability, meaning that the exclusionary restrictions discussed above are not as valid. Moreover, from a policy perspective, it may be more interesting to examine track choice solely for public school students. To that end, we estimate the model for the 5864 respondents meeting the criteria described in Section 3 who attended a public school. The results do not differ qualitatively from the main specification, providing additional support for the exclusionary restrictions. However, there are some shifts in magnitude. Actual technical track log income is now 1.4% higher than expected academic track log income for those on the technical track, though this difference is still significant; the premium over expected general track log income is increased to 5.1%, also significant. The advantage of those on the academic track over expected technical track log income is reduced to 8.2%, from 18.0%, though this amount remains highly significant. As for the business track, the disadvantage relative to counterfactual general track log income falls to a significant 2.3%, from 7.1%, while the advantage relative to the counterfactual technical track log income rises to 19.3%, from 11.0%. The overall conclusions remain unchanged: there is strong evidence of comparative advantage in track choice.

5.5.2. *Specific occupations*

We include indicators corresponding to occupations that can be assumed to be well suited to vocational education in the two-stage models. While this specification is plagued by the same selection bias issues that affect track choice, this exercise can be viewed as an attempt to account for the job–training match. The occupations included in the business indicator include, among others, secretaries, business support services, and computer operators, while occupations included in the technical indicator include construction, manufacturing, and repair services. Each category forms approximately 14% of the sample. 34.4% of those on the technical track have an occupation included in the technical indicator, while 18.9% of those on the business track have an occupation included in that indicator. Both variables are positive and significant in the naïve specification. The technical occupation indicator is associated with an 11.6% (standard error: 3.4%) increase in wages, while the business occupation indicator is associated with an 11.2% (standard error: 3.7%) increase; these coefficients are statistically indistinguishable from each other. In the two-stage estimates, the technical indicator is small (3.4%, standard error: 5.6%) and has no significant effect on the wages of those who chose the academic track. However, the business indicator is positive and significant (12.5%, standard error: 4.5%). While those with a strong academic background should be expected to perform well in business-oriented occupations, this premium is not much larger than that found in the naïve specification, controlling for track choice. For the general track, the technical indicator is positive and significant (11.3%, standard error: 4.3%), but it is not significantly greater than the insignificant business indicator (8.9%, standard error: 5.2%). Again, however, these premiums are not very different than those found in the naïve specification. As expected, the technical occupation indicator is very large and significant for those on the technical track (20.7%, standard error: 7.7%), while the business occupation indicator is not significant (11.9%, standard error: 15.3%), and again is not very different from the premium found in the naïve specification. Also, as expected, the business occupation indicator is very large and significant for those on the business track (18.3%, standard error: 6.9%), while the technical occupation indicator is not significant and, again, not very different from the naïve specification (11.2%, standard error: 7.8%). The nature of the counterfactual estimates is unaltered by the inclusion of this indicator. This result provides some confirmation for the job–training match hypothesis, in that even after controlling for a number of other factors, occupational choice provides an unusually large premium for those on the related track.

5.5.3. *Ability controls*

In their seminal study of selection bias in education, Willis and Rosen (1979) include ability controls in the second stage of estimation. While the pitfalls of this method have been discussed above, it is still instructive to attempt it. We include indicators corresponding to the quartiles of a composite standardized test including reading and math taken by all respondents in 1988. These measures were taken in the eighth grade, before students had chosen their secondary school tracks and therefore before this choice could have influenced their perceptions, abilities, or plans. Including these ability controls alters the counterfactual results in only two significant ways; the hypothetical technical track income for those who actually chose the business track is now higher than the true outcome, and the hypothetical academic track income for those who actually chose the general track is now slightly lower than the true outcome. Both differences are significant; the latter provides more evidence for comparative advantage, while the former provides more evidence for the importance of learning trade skills. It is important, though, to note the limitations of these measures. Mechanical ability and dexterity, which are not measured by standardized tests, may be more important to those who choose the technical track and apply their training to more manually oriented occupations.

6. Conclusion

We have used the National Educational Longitudinal Survey of 1988 to examine the returns to secondary vocational education in the United States. Using methods that account for self-selection in track choice, we find that those on the technical track are not likely to earn more had they chosen differently. Moreover, students on a general or non-college-preparatory track are likely to benefit from at least some technical education. The evidence points to comparative advantage in track selection: those on the technical track are best off there, and those on the academic track are best off following that path. The average student on the business track is, for the most part, better served by focusing on more general education.

This study only examines gross effects of track. With additional data, it would be possible to divide vocational education more finely than the relatively crude "technical" and "business" tracks examine the differential returns in that manner. This would also allow further research into the hypothesized training–occupation match premium, for which we found some preliminary evidence. Moreover, investigating the marginal effect of both academic and vocational credits may be of use as well. It is possible that there are incremental benefits to vocational education.

Vocational programs may have the added benefit of dropout prevention; Kulik (1998) writes that "[t]he evidence shows that vocational programs help keep students in high school. Without vocational programs, more at-risk students would drop out of school each year than currently do." This question is also fraught with selection bias and deserves further attention.

The path of income over time is of great interest as well. It may be that later in life, the vocational premium is diminished and that a life-cycle income maximizing strategy is different from the one found here. Due to the nature of our data, we are only able to examine income not long after high school graduation.

The effect of the information revolution on vocational education is worth mentioning. As formerly high-skill technology jobs become accessible to those with less education, vocational education should adapt so as to help those students who most benefit from it. As Jacobs and Grubb (2003) state, "to prepare students for high-paid, challenging employment, vocational education must take account of the "knowledge revolution."" In any case, whether it serves as a "safety net" or an alternate path for those with different skills and interest, vocational education should not be stigmatized as a lesser or demeaning option.

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