Vocational and Career Tech Education in American High Schools: The Value of Depth Over Breadth

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Abstract

Vocational, or career tech, education is a growing part of the US high school curriculum. Yet, little research studies either factors that lead to enrollment in these courses or effects on college-going and work. We develop a framework for high school curriculum choice and evaluate how these decisions impact college attendance, completion and subsequent earnings in the NLSY97. Our results are consistent with a positive selection model where students sort according to skill and preferences. We find that while vocational courses marginally deter four-year college attendance, they have no impact on graduation. Moreover, we estimate a near two percent wage premium for each additional year of advanced vocational coursework, but no benefit (or harm) from basic vocational courses. We conclude that while vocational education plays an important role for non-college graduates, policy should focus on encouraging depth rather than breadth in vocational course-taking.

Keywords: Vocational education; Career and Technical Education; Wages; NLSY97.

JEL Classification Numbers: J24, I21.

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1 Introduction

Since the publication of *A Nation At Risk* in 1983, policy-makers and politicians have turned attention to a perceived educational decline of American youth. Stagnant high school graduation rates, declining test scores, and signs that many college entrants are ill prepared for college and the workforce have all contributed to this perception. Many states have responded to this alarm by increasing high school graduation requirements, typically specifying a minimum number of years spent studying academic subjects such as English, mathematics, science, and social studies.

These reforms have had the intended effects on curriculum: American high school graduates are completing more courses in these academic subjects, and more advanced academic coursework than they were three decades ago. However, much of these gains have come at the expense of vocational oriented, or career and technical, education (CTE).[1] In fact, between 1990 and 2009 the number of vocational credits earned by high school graduates dropped by 14%, or roughly two-thirds of a year of vocational education, continuing a trend from the previous decade (Hudson, 2013). This drop, shown in Figure 1, coincides with a 32% decline in real federal funding under the Perkins Act since 1985 (the largest funding source for vocational programs), despite large increases in federal funding for secondary school more generally (US DOE, 2014). This trend toward academic coursework has been praised by many who argue that vocational education in high school prepares students for "dead end" jobs and leaves them ill-prepared for college. An opposing camp points to (perceived) shortages in skilled professions, noting that not all students are college-bound and that for these students vocational training may be the difference between high and low paying jobs. While evidence exists on the relationship between high school vocational course-taking and later outcomes in the international context (Eichhorts et al., 2015; Zimmerman, et al., 2013), very little

[1] The field has moved towards the use of the the term "career and technical education", including in the title of the 2006 Perkins Act reauthorization, to differentiate current career-focused education from past vocational education. Throughout we use the terms "vocational education," "career-tech," and "CTE" interchangeably.

evidence exists in the U.S. context. In the following we evaluate these claims by assessing the relationship between vocational education in high school, postsecondary attainment and labor market outcomes using a nationally representative sample of U.S. high school students.

In our analysis we draw particular attention to factors that predict vocational course-taking (choices) and the ensuing impacts (outcomes) on college-going and wages. While the few existing studies have found largely positive impacts of vocational course-taking on earnings (Mane, 1999; Bishop & Mane, 2004, 2005; Meer, 2007), and mixed evidence on high school graduation and college attendance (Maxwell & Rubin, 2002; Agodini & Deke, 2004; Neumark & Rothstein, 2005, 2006; Cellini, 2006), these and others frame vocational course-taking as a "track" rather than as a marginal curriculum choice as is traditionally done for other subjects, particularly mathematics. Our analysis thus departs from previous work in several regards. First, we develop a framework for curriculum choice in which students make curriculum and college decisions in response to information about ability and preferences for vocational or academic (course)work. Second, we treat vocational course-taking as marginal decision, rather than a choice of "track", which our empirical evidence suggests is appropriate. Third, we observe students in the labor market to evaluate wage gains from additional vocational courses, allowing for differential returns to general vs. specialized vocational coursework. Lastly, we observe how returns vary across vocational fields, and by local labor market characteristics.

We use detailed longitudinal transcript and labor market information for respondents in the NSLY97 to examine these questions, exploiting a rich set of background and ability measures available to us. We ultimately find that more vocational courses are associated with higher wages, on the order of 1.5 to 2 log points for each year of vocational coursework, but that these returns are not uniformly distributed across all vocational course-takers. Separating vocational coursework into "higher" and "lower" levels, corresponding to introductory courses and specialized coursework within a vocational discipline, we find that wage gains are driven entirely by upper-level courses, largely in technical fields. We estimate no wage gain to an additional introductory level vocational course. In addition, we find that additional vocational courses deter the marginal college attendee, they have no effect on the likelihood of graduation. Analogously, we also find that while the labor market value of non-vocational coursework is entirely explained by increased college-going and graduation, the value of vocational coursework is unaffected by accounting for college enrollment and completion.

Our results corroborate a model of positive selection into high school course of study. Exploiting variation in graduation requirements to instrument for curriculum choice supports this, showing that gains accrue to students who select into vocational coursework, but that students induced into additional courses see no advantage. The policy implications from these findings are straightforward and two-fold. First, students appear to positively sort into vocational courses suggesting the commonly held belief that low ability or low effort students are funneled into vocational coursework is unlikely to be true (a negative selection story). Thus, policies that limit students' ability to take these courses, for example increasing requirements in other disciplines, may not be welfare enhancing. Second, the benefits of vocational coursework accrue to students who specialize, rather than those who take multiple vocational courses in several areas. Hence, CTE programs should allow for depth in any topic offered. Recent trends towards more specialized CTE concentrations or "pathways" (away from general, non-specialized coursework) may therefore be smart policy.

2 Background and Framing

2.1 Prior work

Compared with an expansive literature on the returns to additional years of schooling, there is relatively little evidence on the labor market consequences of high school curriculum in the U.S., and even less work on effects of vocational course-taking in particular. The value of vocational education has also been subject to debate in both developing and transitional economies, with prior research finding minimal to positive effects on education and labor market outcomes (Malamud & Pop-Eleches, 2010; Attanasio, et al., 2011; Eichhorst, et al. 2015). Those studies that evaluate the impact of vocational course-work largely treat vocational curriculum as a binary choice - students are either on the "academic" or "vocational" track - as opposed to evaluating the impact of an additional course as one might in, say, mathematics or English. For example, Meer (2007) examines the relationship between "track" (academic, general, business vocational, technical vocational) and earnings later in life. He finds evidence of comparative advantage: students currently on a "technical" vocational track would not gain from switching to an "academic" track, nor would those currently on the academic track benefit from more vocational education.

This is not the only study to find benefits to vocational coursework. Pooling data across several cohorts, Mane (1999) finds positive labor market payoffs to vocational coursework and demonstrates that these were increasing through the 1980s, particularly for non-college bound students. In newer research, Dougherty (2015) finds large high school graduation effects from students who are just accepted into career academies in Massachusetts compared with those who just miss the cutoff. sAnalyses using older cohorts have generally supported the same conclusions (Gustman & Steinmeier, 1982; Kang & Bishop, 1989; Bishop & Mane, 2005). Yet, selection is an issue in evaluating vocational programs and none of these studies use exogenous variation. Using the same data we do, Zietz & Joshi (2005) point out that participation in the vocational track is much more common among disadvantaged students. Recent studies commissioned by the US Department of Education as part of the national assessment of CTE required by Perkins reauthorization used various quasi-experimental methods applied to longitudinal student-level data from two locales (Philadelphia and San Diego), one state (Florida), and one nationally-representative high school cohort (ELS 2002). These studies found mixed evidence of the effects of CTE on secondary, postsecondary, and labor market outcomes (US DOE, 2014; Furstenberg Jr. & Neumark, 2005). Taken as a whole, evidence on the effects of vocational coursework is mixed.

A related body of work explores the effect of participation in "School-to-Work" (STW) programs on education and labor market outcomes using early waves of the NLSY97. This literature has evolved mostly in parallel to the above mentioned literature on high school curriculum and vocational education, which is surprising since School-to-Work programs can be seen as a close substitute, in purpose if not structure, to traditional vocational coursework. The results, again, are mixed. Neumark & Joyce (2001) find little effect of STW participation on "behavior associated with future college attendance", but find an effect on students' beliefs that they will complete high school and in beliefs about future labor market participation. Neumark & Rothstein (2005, 2006) find some positive benefits on college attendance and the likelihood of later employment, but that these accrue largely for males and for programs with direct links to the labor market (internships and cooperative education); they in fact find some negative effects from tech-prep. Cellini (2006) uses a sibling fixed effects model and focuses only on tech-prep, finding that participants are more likely to complete high school and attend a two-year college, resulting in a higher overall attainment, but that this comes at a cost of a decline in 4-year college attendance.

A separate literature has evolved which estimates the consequences of high school curriculum choice, much of which is summarized in Altonji, Blom, & Meghir (2012). In the U.S. much of this work focuses specifically on mathematics course-taking (Altonji 1995; Levine & Zimmerman, 1995; Rose & Betts, 2004; Goodman, 2012; Joensen & Nielsen, 2009), generally finding that more math has a positive association with earnings. Importantly, unlike the literature on returns to taking a particular "track", this literature treats each course as a decision on a continuum, allowing for marginal as opposed to discrete changes in curriculum choice. We build on this work by explicitly examining both high school curriculum choice and outcomes, with a focus on the number of vocational courses students choose to take.

Blending these two literatures, we treat curriculum as a continuum, a decision informed by Figure 2, which depicts cumulative distribution functions for the total number of vocational credits and the share of credits that are vocational for respondents in the National

Longitudinal Survey of Youth (1997). Figure 2 suggests (i) that vocational courses account for a non-trivial share of high school coursework – roughly 50 percent of students take 4 years worth of vocational coursework, (ii) that an overwhelming majority of students take at least one vocational course in high school, and (iii) that the distribution is smooth, rather than bimodal, as strong "tracking" would imply. We frame the decision to take vocational course as the result of students learning about their comparative advantage and preferences for vocational or academic (course-)work. In response to baseline expectations and received signals about "fit", students rationally decide whether to pursue a more vocational or academic focused curriculum as high school progresses. Students consider both human capital and informational consequences of their choices, as curriculum also provides information about labor market prospects. While several studies of college persistence and major choice have this dynamic flavor (e.g., Arcidiacono, 2004; Stinebrickner & Stinebrickner, 2011; Stange, 2012), this has been mostly absent from studies of high school curricula. Related, Malamud (2011) finds that exposure to a broader curriculum reduces job switches later in life (interpreted as "mistakes") by improving match quality at the expense of greater specialization.

2.2 Theoretical Framework

To frame our empirical analysis, we consider a stylized model of high school curriculum choice, college enrollment, college completion and labor market entry in which students are forward-looking but face uncertainty about their ability similar to Altonji (1995). We assume students are endowed with ability along two dimensions: academic ability α_a and vocational ability α_v. These endowed abilities are augmented by investments in human capital through curriculum choices manifested in the number of academic and vocational courses students take, A and V respectively. We define human capital stock K at time t as a function of ability and curriculum choice, including college:

$$K_t = k_{a,t}(\alpha_a, A), k_{v,t}(\alpha_v, V) \tag{1}$$

We assume academic ability (α_a) influences performance in academic subjects in high school and in college, and the likelihood of college graduation, while vocational ability (α_v) influences performance in vocational subjects in high school. Allowing for additional effects of α_j on $k_{\sim j,t}$ or on performance in opposite type courses does not change inference as long as they do not contribute equally, but simply suggests that there are complementarities. Neither component of ability is known at the start of high school, though students have prior beliefs, which depend on fixed characteristics (X) we assume are observed by the econometrician. Students learn about α_a and α_v via performance in academic and vocational subjects respectively manifested in grades conditional on covariates - i.e. grades relative to what would be expected. For instance, students that perform better in academic courses than their baseline characteristics would predict will revise their belief about α_a upward. These posterior beliefs then influence students' subsequent decisions about high school curriculum, graduation and college enrollment. Four-year college graduation then depends on academic capital, $pr(college) = g(k_a, X)$, including high school curriculum and ability, and covariates observable to the econometrician. We assume graduation from a two-year institution can depend on k_v as well.

We define the labor market as having multiple sectors, delineated by highest degree completed, which define the distribution from which workers draw wages. Both ability components impact productivity in the labor market, though the importance of each may vary by sector; that is, k_a may be more valuable in the college-educated labor market while k_v may be more valuable in the non-four-year college educated sector. Thus, (log) wage at time t in sector j depends on accumulated skills that are a function of ability and education – $k_{a,t}(\alpha_a, A)$ and $k_{v,t}(\alpha_v, V)$ – plus covariates such as work experience, year and local labor market conditions.

$$w_t^j = f(k_{a,t}, k_{v,t}, X) \tag{2}$$

for $j = \{$drop out, H.S., 2-yr college, 4-yr college$\}$.

During high school students receive utility which depends on curriculum (i.e. mix of academic and vocational coursework) and expected performance in the chosen curriculum. Utility during college depends on expected performance in college, covariates, and high school curriculum. Utility in the labor market depends only on log wages here, but might also include a hedonic preference for job type. Students sequentially choose high school curriculum (or dropout) and then whether or not to enroll in two- or four-year college to maximize the present discounted value of lifetime utility. Before each of these decisions, students update their beliefs about own academic and vocational ability.

The model delineates several tradeoffs in the choice of curriculum. First, high school vocational courses could have lower psychic costs than academic ones for students with high α_v (low α_a). Second, they could be productivity-enhancing for students that enter the non-(four-year) college job sector. Third, they could provide students with the opportunity to acquire more information about α_v, which should enable better decisions about college enrollment. Productivity in the non-college sector is an important factor in college enrollment decisions, yet many students may lack individual-specific information about this parameter. Exposure to vocational curriculum may be one way to acquire it.

However, vocational coursework could have drawbacks. If the vocational track is less rigorous, it may leave students ill-prepared for college and reduce the likelihood of graduating college among those that enroll. Additionally, vocational concentrators may experience reduced productivity in the college job sector if academic coursework is more productivity-enhancing than vocational among college graduates. Similarly, reduced collegiate performance may also mean that vocational students have a greater psychic cost of going to college than those on the academic track. Lastly, students on the vocational track will necessarily have less information about α_a than those that pursue the academic track. This may cause some to forego college (and the subsequent returns) who would benefit from enrolling.

One implication of the model is that providing the option of studying a vocational curriculum has ambiguous effects on many outcomes overall since the effects are likely to be quite heterogeneous. For students with diffuse priors about their abilities, exposure to vocational coursework could either increase or decrease college enrollment depending on whether estimates of α_a and α_v are revised upwards or downward. Regardless, the additional option should improve welfare even among those who reduce college enrollment rates because it reduces dropout (i.e. bad matches between students and college).

2.3 Predictions

We use this framework to derive predictions for our empirical analysis. Above we describe a story about selection, akin to a Roy-type model. Those students who expect higher returns to vocational coursework will be more likely to enroll in those courses. While this may seem obvious, it clarifies an important yet subtle point: studying curriculum choice does not lend itself well to the randomization framework often employed in educational research. Why? Imagine that we randomly assigned some students to vocational coursework and others not and did not allow for defiers, what should we expect? We should expect all compliers to be worse off if they had good information *ex ante*. Those who would have chosen a vocational track in the absence of the experiment (the always-takers) will see positive returns while those who would have otherwise enrolled in college-prep coursework (the compliers) should see negative returns compared with their counterfactual. In this framework, only those who would have made *ex ante* poor decisions would be made better off by having someone else (the experimenter) choose differently for them. The problem with this hypothetical experiment is that the econometrician does not know what students would have taken in the absence of random assignment. This would be akin to randomly or experimentally assigning college majors.

This thought experiment helps frame our predictions. These predictions result from two elements of our theoretical framework. First, that the value of college-prep coursework accrues though an increased likelihood of college attendance and graduation. Thus, we should observe that earnings gains from non-vocational coursework should be largely if not entirely explained by college-going. Second, that students have reasonably good information and self-select. Thus, we should observe that experimental variation in vocational course-taking, which we induce through graduation requirements as a supplemental test, should have zero effect on earnings. In our empirical exercises below we find that each of these predictions bears out.

3 Data Sources and Sample

3.1 The NLSY97 and Transcripts

We examine schooling and labor market activity for respondents in the National Longitudinal Study of Youth 1997 cohort (NLSY97). This data includes 8,984 individuals who were ages 12 to 18 when they were first interviewed in 1997. The survey is representative of all American youth at that time period and respondents have been followed annually with information on educational attainment, labor market experience and family formation. High school transcripts were collected from respondents' high schools in two waves by the National Opinion Research Center (NORC), who administers the NLSY. The first was conducted in 1999-2000 for 1,391 respondents who were no longer enrolled in high school at that time. Transcripts for 4,618 additional respondents were collected in 2004. In total, transcript data were collected for 6,009 respondents.

NORC used course catalogs to categorize all transcript course titles to a common scheme according to the Secondary School Taxonomy (SST-R). To create uniformity in credit taking, courses are converted into "Carnegie credits" where one Carnegie credit is defined as a course that meets every day for one period for an entire school year. Similarly, grades for each course were converted by NORC into a common (0-4) metric.[2]

[2]For the wage analysis we construct earned credits as those for which students either received a passing (non-F) or satisfactory mark in the course. For the course-taking analysis credits attempted are the credits a student would have earned had she passed the course. In cases where the number of Carnegie credits is not reported, we impute Carnegie credits as the modal number of credits that a particular student earned in courses in the same field. When a student lacks a comparable course, we then impute to the modal value of all students taking the same exact course title in the same grade in the full sample.

Importantly, this careful course coding allows us to disaggregate courses into "low" and "high" level courses. For vocational courses, lower level courses are those classified as "1st course" on transcripts. Upper level courses include courses beyond the introductory level, including: "2nd or later courses", "Specialty course", or "Co-op/Work Experience" in the transcripts. This disaggregation allows us to analyze the benefits of breadth – taking many courses in different fields , and depth – specializing in a particular vocational field. We conduct an analogous disaggregation for core courses (English, math, science and social studies) with the purpose of separating more and less difficult versions of a particular course within a subject. In this case, transcripts identify courses as either "basic", "regular", "Advanced and Honors", "Specialized" and "AP/IB". In this case, lower courses are "basic" or "regular" and higher courses are the remainder.

3.2 Sample definition

We restrict our sample to exclude those lacking transcripts in all years of high school, those who never completed 9th grade (for whom high school curriculum is not relevant), and respondents with extreme or illogical totals in their transcripts. Specifically, we exclude high school graduates who either (i) had fewer than four years of high school transcripts; (ii) had taken fewer than two courses in each of math, English, science and social studies; or (iii) had more than 36 or fewer than 20 total credits. For high school dropouts, the limiting conditions are necessarily more relaxed as any small number of credits can be consistent with dropout. Thus, for dropouts we restrict to those who (i) completed at least 9th grade; (ii) had taken at least one-half course in math, English, science and social studies; and (iii) had taken more than four total credits ever. The resulting "Analysis sample" used to study curriculum choice and postsecondary outcomes includes 4,414 respondents. Lastly, we restrict wage analysis to a "Wage sample" of 3,796 students whom we determined entered the labor market with a valid wage record (non-self employed) after and including age 23. To determine labor market entry we use monthly enrollment arrays from the NLSY97 and determine enrollment in each semester (fall, spring). We then define labor market entry as the first of four consecutive non-enrolled semesters that are followed by no more than one enrolled semester thereafter.[3]

Table 1 compares the Analysis and Wage samples to the full NLSY among a broad set of demographic characteristics. Comparing columns 1 and 2 shows that the Analysis sample is slightly more advantaged than the full NLSY, but that on average is reasonably representative of the NLSY in whole. Importantly, differences between the two are largely determined by whether NORC could retrieve transcripts, rather than any behavior of the respondent herself. A comparison of columns 2 and 3 shows that the Wage and Analysis samples are nearly identical with few respondents lost between the two. Our empirical exercises focusing on wages pool multiple observations for each individual over time, resulting in 20,572 person-year observations. Approximately one-third of our Analysis sample obtain a four-year college degree, one-third attend college without earning a degree, 8 percent earn a two-year degree, 17 percent obtain a high school diploma but no post-secondary education, and 6 percent do not graduate from high school.

3.3 The distribution of course-taking

Table 2 shows respondent demographics, their high school characteristics, high school course-taking behavior, post-secondary attainment and most recent (log) wage separately by tercile of vocational course-taking. We find that average course-taking patterns mask considerable variation; some students pursue a very academic curriculum while others take many vocational courses, even among high school graduates. Students in the highest tercile take more vocational courses than either high-level core courses or electives (panel C). Furthermore, students with a more vocational curriculum are less likely to pursue and graduate from college. 43 percent of students in the lowest vocational tercile complete a four-year degree compared with only 23 percent of those in the highest tercile (panel D). However, curriculum is clearly related to other factors likely to influence these outcomes; specifically, vocational concentra-

[3]We do not restrict wage observations by the number of hours worked, but in a robustness check we restrict to 30+ hour per week jobs and find nearly identical results.

tors are more likely to come from disadvantaged backgrounds and have lower AFQT scores (an aggregation of math and English components of Armed Services Vocational Aptitude Battery, or ASVAB, exam), a proxy for labor market skill. Yet, we find only modest evidence of a strong bias toward special education students, minorities, parental education or region. In fact, we even find that 12 percent of those in the top tercile of vocational course-taking also took gifted courses.

Figure 3 shows the distribution of credits taken by field. It is clear from this figure that not only is there considerable variation in vocational course taking compared with other core and non-core coursework, but also that the modal value is greater than zero. The extent of vocational coursework taken by U.S. high school students relative to traditional academic subjects, even among the most academically-oriented, has not been previously appreciated. Importantly, we interpret the smoothness of the distribution of vocational course-taking in Figures 2 and 3 as confirmatory evidence of our treatment of vocational education as a marginal decision as opposed to a discrete choice of "track".

Figure 4 depicts the average number of courses taken by our sample in each vocational category. The most common types of vocational courses taken are technology/industry, business and management, computer technology and keyboarding, and general (general labor market preparation – GLMP). (Table A1 in the Appendix describes the full list of vocational courses in the NLSY97.) Advanced vocational courses are offered and taken in each of these categories except for general labor market preparation and keyboarding. Given this substantial heterogeneity in high school curriculum, it is natural to investigate the sources and consequences of this variation.

4 Choices: Explaining Course-taking Behavior

4.1 Descriptive evidence: Course-taking

We now turn our attention to the predictors and temporal pattern of vocational course taking in high school. Figure 5 presents the average number of courses taken by subject, separately by grade. Though English and foreign language are taken with the same frequency at all grades – students take about one English credit (i.e. one full year) and 0.5 language credits per year, on average – others exhibit strong time trends. For instance, vocational courses are taken with much greater frequency in 11th and 12th grades, as students approach graduation and ostensibly have more control over their schedules. Social studies courses exhibit a similar, though weaker, trend. On the other hand, math and science course-taking drops considerably in 12th grade. This suggests that there exist opportunities for students' experiences early in high school to inform later curriculum choices, and that students specialization in vocational coursework has a distinct temporal aspect. This temporal pattern is an important feature of our conceptual model, where early course outcomes inform beliefs about ability and subsequent decisions.

Figure 6 plots the number of credits taken by subject area separately by AFQT quartile. Though total credits are comparable across AFQT scores, there exists substantial variation in subject mix. Vocational courses and foreign language courses exhibit the most noticeable relationship with AFQT. High AFQT students take about two-thirds as many vocational courses as low AFQT students and about three times as many foreign language courses. Higher AFQT students also tend to take more science courses. It is important to note that for most students the AFQT is administered during their high school careers – the mean and median respondent took the AFQT approximately at age 14.5 and nearly all had take the test by age 16 – thus we cannot rule out the impact of course-taking on the AFQT itself. On the other hand, the AFQT is likely not informed by the most salient tradeoff with vocational coursework: language courses. That is, the AFQT tests only mathematical and English language ability, not foreign language skill or science. Thus, if vocational courses pull students out of foreign language, science or social studies courses, we should expect to see no effect on AFQT, allaying concerns about timing.

4.2 Empirical specification: Course-taking

To examine predictors of vocational course taking more rigorously, we estimate reduced-form linear regression models using the number of credits taken in each subject, j, as the dependent variable. In each specification we focus on vocational courses taken in 10th-12th grade, as there are greater opportunities for students to choose vocational courses after freshman year and this allows us to model choice in grades 10-12 as a function of revealed ability (grades) in 9th grade.[4] Guided by the theoretical framework outlined earlier, we are interested in three classes of explanatory variables, which we enter into the model sequentially. First, the vector X_i includes observed characteristics of the student, such as gender, race, and family background as described in the summary statistics tables; the vector τ_t are 9th grade cohort fixed effects. Second, we include the AFQT score. Since we expect curriculum decisions to be influenced by new information about students' "fit" with academic or vocational heavy curricula, we also include measures of academic performance in math and English in 9th grade, $GPA_i^{core9^{th}}$, and a control for whether the math or English courses were high (difficult) or low level, $High/Low_i^{core9^{th}}$.[5] Though students have prior beliefs about their fit with different curricula, performance early in high school provides additional information with which expectations can be revised. Students that perform well in early core academic subjects might then pursue a more academic (or less vocational) curriculum. Our baseline specification is:

$$VocCredits_i = \gamma_0 + \gamma_1 X_i + \gamma_2 AFQT_i + \gamma_3 GPA_i^{core9^{th}} + \gamma_4 High/Low_i^{core9^{th}} + \tau_t + \varepsilon_i \quad (3)$$

[4]Results are similar if we include 9th grade course-taking in columns 1-2.

[5]Including math and English GPA's separately yielded empirically equivalent results.

The estimated parameters combine several of the structural parameters described in the dynamic model. In particular, the relationship between AFQT and number of vocational credits taken (γ_2) combines the effect of ability on expected performance in high school and college (which influences the flow utility from curriculum), on the likelihood of college graduation, and on labor market outcomes. Thus, the fact that high ability students are less likely to take vocational courses may be explained by any of these mechanisms.

We interpret γ_3 as the importance of new information revealed about "fit" with an academic curriculum in the form of 9th grade GPA. However, if GPA_i, conditional on other covariates, is known to individuals but not the econometrician, then this parameter may instead capture unobserved heterogeneity rather than learning about uncertain ability. Though our covariates are rich, we cannot entirely rule this explanation out with a reduced-form approach.

4.3 Results: Course-taking

Table 3 presents results for vocational course taking. As prior work has documented, we find that male students and those from disadvantaged backgrounds (mother has high school degree or less, low income, received public assistance) are more likely to take vocational courses. Vocational course-taking also decreases sharply with measured ability (AFQT). This is true even when high school dropouts are excluded in specification 4. To further verify our results, in Appendix Table A2 we re-estimate specification 4 first without cohort effects to demonstrate that there is no secular trend that is driving these results, and then again with state of birth fixed effects to demonstrate that with the exception of race, which is correlated with states, location is not driving our results either (we again verify this in our wage specifications to follow).[6]

As noted above, vocational course-taking has a strong temporal dimension: it is taken largely in 10th and 12th grade. Thus, information revealed during high school could poten-

[6]We use state of birth as an instrument for state of residence in high school to abstract from endogenous sorting.

tially influence course-taking decisions over time. We test this in specification (3), which includes 9th-grade GPA in math and English as a covariate plus controls for whether these courses were upper or lower level. We find that students performing poorly in these academic subjects, conditional on our rich set of covariates, are more likely to take vocational courses later in high school, even controlling for AFQT. That is, a one-point increase in 9th-grade math and English GPA decreases total vocational course taking by 0.14 of a one-year course. This represents a roughly 5 percent decrease in vocational course-taking off of a base of approximately 3 total vocational courses on average. This result is consistent with a key aspect of our theoretical framework, where students use early course performance to update their beliefs about their fit with the academic/college sector or vocational/non-college tracks, and these beliefs in turn influence course-taking.

The final two columns present estimates separately for low and high vocational coursework respectively. Results in these final two specifications reveal a subtle yet important distinction – that ability and freshman year GPA, in addition to many of the fixed demographic characteristics we observe concerning childhood circumstances, are far more predictive of taking low-level vocational courses than they are of upper-level or specialized vocational courses. In particular, we find that a negative signal of ability manifested in low grades in core courses in 9th grade, conditional on course level and AFQT, increases the number of low-level vocational courses in grades 10-12, but has no impact on taking upper level, or specialized, vocational courses. Put differently, low ability, or learning about low ability, leads students to take a broader array of vocational courses rather than to specialize in a particular type of vocational training. The importance of this result is underscored in subsequent analyses below demonstrating that (i) while lower level vocational courses deter students from college, upper level courses at worst do no harm, and (ii) that while upper level vocational courses benefit students in the labor market, low-level vocational courses have no impact.

5 Outcomes: College and the Labor Market

5.1 Empirical specification: College attendance and completion

We begin our analysis of the consequences of high school vocational coursework by observing the relationship between high school curriculum choice and both college attendance and completion. To do so, we first estimate three linear reduced form equations where the dependent variable, $College$, is a binary indicator of college attendance in a two-year college, a four-year college and then any college. We then repeat this exercise for college completion conditional on college enrollment. In both cases we condition on having completed high school though results are similar if not. Our main explanatory variables, $VocHigh_i$ and $VocLow_i$, measure the number of high and low vocational credits earned during high school. Since number of vocational credits is likely correlated with credits earned in other subjects, we control for a vector of credits earned in core (high and low) and elective subjects (language, art/music, PE, and "other" courses) as defined below.

$$\begin{aligned} College_i = \beta_0 + \beta_1 VocLow_i + \beta_2 VocHigh_i + \beta_3 CoreLow_i + \beta_4 CoreHigh_i + \beta_5 Elect_i \\ + \beta_6 X_i + \beta_7 AFQT_i + \tau_t + \epsilon_i \end{aligned} \quad (4)$$

While it is important to note that in most cases students taking upper level vocational courses take these after taking an introductory vocational course, as demonstrated above most students in fact take multiple vocational courses. Thus, implicitly, we are comparing students who choose to take several different introductory vocational courses with those who take their courses in a linear sequence. For example, on average students take just over two low level vocational courses (that is, two one-year courses) and one upper level vocational course.

5.2 Empirical specification: Wages

To examine labor market consequences of vocational course taking we stack wage observations and estimate reduced-form linear regression models that exploit cross-sectional variation in high school curricula. Our primary labor market outcome is the log of (real) hourly wage, which is observed at multiple ages and thus pooled across all observations for individuals in our wage sample. We begin by including only $VocHigh_i$ and $VocLow_i$ and then sequentially include additional covariates to observe how estimates change when non-vocational coursework $(Core_i, Elect_i)$, ability $(AFQT)$, and college attendance and completion $(Postsec_i)$ are accounted for. The inclusion of either of these types of controls (non-vocational courses and postsecondary outcomes) alters the interpretation of the estimated parameters and thus is an important modeling choice, a subject we discuss more thoroughly in the next subsection. Our preferred specification is then:

$$\begin{aligned} ln(wage)_{it} = \beta_0 + \beta_1 VocLow_i + \beta_2 VocHigh_i + \beta_3 CoreLow_i + \beta_4 CoreHigh_i + \beta_5 Elect_i \\ + \beta_6 X_i + \beta_7 AFQT_i + \psi Postsec_i + \tau_t + \theta_y + \phi_s + \epsilon_{it} \end{aligned} \tag{5}$$

Our controls (X_i) include all the demographic and high school characteristics listed in panels A and B of Table 2, as well as 9th grade cohort (τ_t) and secular wage-year indicators (θ_y). In the final specification we include a set of state of birth fixed effects (ϕ_s) to ensure that variation in course-taking is not driven by state level requirements or labor market conditions in high school.[7] All specifications account for the within-individual correlation across observations by clustering standard errors by individual.

[7] We use birthstate for two reasons. First, it avoids endogenous sorting of families across states. Second, it is measured more accurately than state of residence in high school.

5.3 An aside: Course substitution, postsecondary outcomes and the interpretation of parameter estimates

Since students' time is fixed, one substantive modeling choice is whether and how to control for the number of credits earned in other subjects. Without controls for other courses – i.e. core courses and electives – the parameters β_1 and β_2 in Equation 5 should be interpreted as the *ceteris paribus* change in log wage associated with an additional (high or low) vocational credit. Since each additional vocational course could be taken at the expense of another course (math, language, science, etc.), or what would otherwise be non-course time, the nature of the treatment likely varies across the population. The three panels in Figure 7 depict the implicit nature of the tradeoff between vocational and other types of courses. Vocational courses are most clearly traded off with electives (art/music, foreign language, physical education, and "other" courses). The correlation between vocational and core academic courses (English, math, science, and social studies) is also negative, but much weaker. Thus, the "average treatment" in the model without controls for other courses can be thought of as taking one vocational course but fewer electives.

Controlling for number of credits taken in other subjects alters this interpretation. As a thought experiment, imagine that we divided courses into three types: core, vocational and electives, and then for each respondent determined what *share* of total coursework each constituted. Including all three measures in our empirical specification would violate the full rank assumption (perfect collinearity) and one term would have to be omitted in the regression equation. Thus, holding course-taking in all other subjects constant, the parameters β_1 and β_2 should be interpreted as the outcome change associated with taking one more high or low vocational credit at the expense of what would otherwise be non-course time, controlling for selection on observables. That is, the full rank assumption relies empirically on variation in the total number of courses taken across students. In this case, the opportunity cost of an additional course depends on how students potentially use this marginal hour among available activities, such as study hall, paid or volunteer work, homework, or leisure. Furthermore, controls for course taking in other subjects may also account for additional forms of selection if course-taking in other subjects is a marker for traits influencing outcomes that also correlate with vocational course-taking.

Surprisingly, prior literature on the effects of course taking is mostly silent on this important conceptual issue, with the exception of Altonji (1995). His models include number of credits taken in eight subjects (English, social studies, math, science, foreign language, fine arts, industrial arts, and commercial), omitting time devoted to study halls, certain vocational courses, PE, and home economics. He concludes that "one would expect all the elements of [the coefficient vector] to be greater than or equal to 0," since the specification controls for any displacement effects on other course-taking. In examining the labor market effects of math courses, Rose and Betts (2004) do not mention non-math course taking (in vocational, other academic, or elective courses) as the primary opportunity cost of taking an additional math course. Their main empirical model includes the number of math courses in six different levels and thus each coefficient should be interpreted as the effect of taking more courses in one level of rigor holding constant the number of math courses in the other levels. In these models students are explicitly trading off math course-taking with time allocated to other subjects or non-school time – which of these, though, remains unclear. Subsequent specifications include number of courses in English, science, and foreign language, also using detailed curriculum categories. Interpreting the coefficients in these models is difficult because an additional year spent in upper-level English, for instance, may have a different opportunity cost against which the effect is measured than one spent in basic Biology. Goodman (2012) shows that curricular reforms have a moderate and significant impact on math course-taking, but also a modest insignificant impact on other course-taking. His two-sample instrumental variables estimates of the wage effects of math courses implicitly assumes that reforms cannot impact wages through these non-math courses either because reforms do not affect non-math course-taking or because such courses have no labor market impact. In our preferred model we follow in the spirit of Altonji (1995) and include a vector containing number of credits earned in all other subjects, but show similar specifications with only vocational credits included. In an ancillary set of regressions we model the share of courses taken in each subject, leaving electives as the omitted category, and including a continuous measure of the total number of courses taken. While directionality in each of these specifications is similar, leading to similar policy conclusions, for reasons mentioned above interpretation differs.

5.4 Results: College attendance and completion

Before examining labor market outcomes, Panel A of Table 4 shows conditional mean differences in postsecondary attendance and completion across high school course taking as described in Equation 4. We find that each additional year of introductory (low) vocational coursework decreases the likelihood of attending any postsecondary institution by 1.4 percentage points conditional on attending high school. Yet, we find that upper level vocational courses decrease four-year college attendance, but have no (or a positive) influence on two-year college enrollment; a result that corresponds with previous work. As expected, we find that students taking more core and elective credits are less likely to attend two-year colleges and more more likely to attend four-year colleges.

Repeating the same exercise in columns 4-6 for respondents who attended a two-year, four-year or any college as their highest grade attended suggests that there is no evidence that vocational courses decrease graduation rates for those enrolled. Taken together, these results suggest that vocational courses may deter the marginal student from college, but that there is no aggregate impact on graduation rates. Put differently, vocational courses appear to pull those students out of college who are less likely to graduate. Though noisy, this is suggestive of a learning process where vocational coursework provides students with possibly valuable labor market skills and additional information about their comparative advantage in the vocational or college labor market.

In Panel B of Table 4 we replicate our model using the *share* of credits accumulated in each field and include an additional control for the total number of credits accumulated (estimating the same model without $TotalCredits$ yields empirically similar results). In this case, as an actualization of the thought experiment described above, we omit the share of courses that were electives to satisfy the full rank requirement. Results are similar to Panel A. We find that while increasing the share of low vocational courses decreases college attendance for four-year schools, increasing the share of courses dedicated to specialized, or upper level, vocational course-work increases enrollment to two-year schools, but decreases four-year enrollment. Concerning college completion conditional on enrollment, we find that lower level vocational courses decrease four-year graduation rates, and find little impact of upper level vocational coursework. It is important to note here that attendance and completion are defined as by highest degree, therefore any students who attended a two year school and subsequently attended a four institution would be counted as four-year attenders and/or graduates, though the final columns (3) and (6) account for this in aggregate.

Finally, we draw attention to the coefficient estimates on core and elective course-taking. In particular that taking additional courses (or increasing shares) in these courses increases the likelihood of both college enrollment and completion. While this is not surprising, we highlight this result to tie our earlier theoretical prediction with the wage regressions we present below. In particular, that the labor market value of non-vocational coursework operates through college.

5.5 Results: Wages

We know that that the intensity of vocational courses in high school is negatively correlated with wages later in life; Panel C of Table 2 demonstrates this. This is not surprising as high school graduates who take more vocational courses tend to be lower-achieving and more disadvantaged, attributes that have independent effects on labor market outcomes. Thus, most factors influencing selection tend to create a negative bias. Table 5 presents our main findings on labor market outcomes, which control for many of these factors. While unconditional means demonstrate a negative relationship between low vocational credits and wages, controlling for background characteristics entirely accounts for this as we move from columns (1) to (2). Yet, the positive gains associated with an additional upper level vocational course remain positive, suggesting a nearly 2% increase with each additional course. Specification (3) includes AFQT with no change to results. Column (4) then controls for the number of credits earned in other subjects, separating elective and core academic subjects (math, English, science and social studies). This specification also distinguishes high- and low-level academic subjects (e.g. advanced algebra vs. basic math). Consistent with results in Rose and Betts (2004), advanced coursework is much more advantageous than basic coursework.

Comparing columns (2) and (4), the coefficient on advanced vocational work does not change, suggesting that vocational course-taking does not crowd out other courses, which also have impacts on wages (not conditioning on college). Alternatively, credits earned in other subjects may be a marker for academic ability which further controls for the negative selection bias. Since these factors may offset, we are not able to distinguish these two distinct channels. Controlling for all factors in column (5) has little impact of results other than reducing the gain to upper-level core courses by one-third.

In column 6 we add controls for post-secondary attainment. We find that the entirety of wage gains associated with core and elective coursework are explained by controlling for higher education. Yet, we find that the positive wage gains resulting from additional upper level vocational courses persist, suggesting a 1.6 log point wages increase for each additional year of upper level vocational coursework. We take this a suggestive evidence that our hypotheses are correct: the labor market value of vocational coursework accrues largely to non-college graduates, and that the labor market value of non-vocational coursework is entirely explained by its contribution to post-secondary attainment. Lastly, in column 7 we add state of birth fixed effects as a proxy for state of residence in high school to allay concerns of correlations between state economic conditions or industry concentration and the availability of vocational coursework, finding that results are unchanged.

In sum, our empirical exercises suggest a 1.6 percent wage increase from each additional year of upper level vocational coursework, yet no gain from increasing breadth in lower, or introductory, vocational courses, which we take as loose evidence of gains to specialization in high school labor market training. Moreover, these results persist conditional on a measure of non-technical labor market skill in the AFQT, a host of student level controls including parental income, state of birth, 9th grade cohort, parent's education, high school type and urban/rural designation in adolescence.

As a specification check, in Table 6 we repeat our preferred specification from Table 5 using an alternative specification modeling the share of courses taken rather than the count as we did in Panel B of Table 4. Again results largely confirm our preferred specification, but with a different interpretation. In Table 6 we estimate that a one percentage-point increase in the share of upper level vocational courses increases wages by one-half percent, even after accounting for our full set of controls. To put these results in comparable terms, we estimate the change in share associated with a one course increase by regressing the share of upper level vocational courses on the number of vocational courses taken, finding that one extra course is equivalent to a nearly four percent increase in the share of courses taken. Adding a full set of covariates to the regression has no impact on this estimate, suggesting that variation in total credits is not strongly correlated with the distribution of where credits are allocated. Since students in the wage sample take roughly 25 courses on average, where a one course increase is equivalent to a four percentage-point change, this confirms our intuition of a tradeoff with elective courses. Multiplying this four percentage-point increase by the 0.005 coefficient estimate suggests a two percent increase in wages - only marginally larger than the 1.6 percent increase estimated in the credit count model in Table 5, suggesting that these results do not rely entirely on functional form assumptions.

5.6 Exogenous variation in course-taking

Our theoretical framework implies that students select into vocational coursework. Thus, we do not interpret our results in Tables 5 and 6 as the causal effect of vocational coursework on wages. Rather, we interpret these as wage gains associated with completing additional courses. Why is this important and not trivial? For two reasons. First, it is important because the high school curriculum is becoming increasingly prescribed, meaning that increasing graduation requirements induce students who would have taken (upper level) vocational courses to take fewer in lieu of other coursework may not be welfare enhancing. Furthermore, states are moving toward a model of vocational coursework where students complete "pathways", usually a sequence of 3 courses aligned with skills in a specific industry or occupation. Thus, while CTE courses are being squeezed by other graduation requirements, CTE itself is focusing more on depth as opposed to breadth. Second, it is not trivial because it helps clarify a key misconception about vocational coursework: that it is a "dumping ground" for low ability or low effort students leading to "dead end jobs." This negative selection story, where low ability students are ushered into meaningless courses, would be unlikely to result in the positive estimates we find above.

To provide additional support for our argument we employ school-level graduation requirements as a source of variation in course taking. This allows us to purge selection from the gains associated with additional courses. The NLSY Geocode data provides researchers with school level graduation requirements as reported by NLSY97 respondents' schools in the same survey that collected their high school transcripts. These include courses required for graduation in English, mathematics, social studies and science, along with the total number of courses required. For this portion of our analysis we omit 439 respondents who have missing values for any of the graduation requirements, and an an additional 437 for whom the requirements were imputed at the state level by the NLSY as opposed to reported by the school; we verify that this does not drive results.

We have three hurdles to overcome to make claims from our instrument(s). First, that course requirements affect the outcome (wages) only through the measure they instrument for (course taking); i.e. that it is excludable. While there is no way to test this formally, we do not see how increasing, say, the number of required math courses would affect an individual's wage other than through additional math coursework (and thereby possibly fewer courses in other subjects). One counter argument might claim that by increasing the number of required math courses of *all* students would have negative effects on the price of mathematics skill in the labor market by shifting outward the supply of this type of skilled labor. While we believe this argument is reasonable, since we are comparing students within labor markets, this type of general equilibrium effect should be absorbed by local labor market controls.

Second is the monotonicity assumption, that the instruments work in the same direction for all individuals. In this case this would mean that increasing math requirements may induce some student to take more math (the compliers), and may leave some unaffected (always-takers), but induces no students to take fewer math courses. This is reasonable in the one instrument, one endogenous variable case, but might be more subtle in the multiple instrument, multiple IV case as we apply here. To illustrate, we begin with a simplified version of Equation 5 above where the high/low designations are collapsed into 3 course types as below,

$$\begin{aligned} ln(wage)_{it} = \beta_0 + \beta_1 Voc + \beta_2 Core + \beta_3 Elect + \\ \beta_4 X_i + \beta_5 AFQT_i + \psi Postsec_i + \tau_t + \theta_y + \phi_s + \epsilon_{it} \end{aligned} \tag{6}$$

We want to instrument for each of our endogenous variables, Voc, $Core$ and $Elect$, thus we need three instruments. We could estimate a model where we only include Voc but worry that this might violate the excludability assumption. That is, if we instrument for the number of vocational courses using math requirements, assuming increasing math requirements induces students to take fewer vocational courses, it would have to be the case that increasing math requirements only affect wages through reducing vocational course-taking. This is likely not the case since we would naturally expect an increase in math course-taking as well, which in turn could affect wages. Thus we include all three course categories and identify an equal number of instruments.[8] Then, our three first-stage equations are as follows:

$$Voc = \alpha_0 + \Pi X_i + \Gamma_V(ReqMath, ReqSoc, ReqTot) + \Delta Degree + \tau_t + \theta_y + \phi_s + \eta_{it} \tag{7a}$$

$$Core = \alpha_0 + \Pi X_i + \Gamma_C(ReqMath, ReqSoc, ReqTot) + \Delta Degree + \tau_t + \theta_y + \phi_s + \eta_{it} \tag{7b}$$

$$Elect = \alpha_0 + \Pi X_i + \Gamma_E(ReqMath, ReqSoc, ReqTot) + \Delta Degree + \tau_t + \theta_y + \phi_s + \eta_{it} \tag{7c}$$

The monotonicity assumption then presumes each course requirement affects each course category in the same direction. A violation would be, for example, if increasing math requirements led some students to take more vocational courses and others to take fewer (having no effect on any student is not a violation of monotonicity). Although theoretically possible, we cannot see why increasing the number of social studies and math requirements would result in someone taking more vocational courses since, mechanically, this reduces the available number of hours in a semester for additional coursework of any type.

Third, we need to show that our instruments affect our covariate of interest, which we do in our first-stage estimates. Predicted values from the first stage, $\widehat{\Gamma}_{(V,C,E)}$, are then used in the second-stage equation. Since we use multiple instruments, we report Angrist-Pischke F-statistics which account for the multiple endogenous variables and multiple instruments. Results from first-stage Equations 7a-c are shown in Table 7. Focusing on vocational course-taking in column 1, results indicate that increasing the total number of courses required for graduation increases vocational course-taking, while increasing the number of social-studies requirements decreases attendance in these courses. In each case the F-statistics are sufficiently high and over 20 in the case of vocational courses.

Table 8 shows results from Equation 6 using predicted values from the first stage for each course type. We begin by reestimating the full specification from our reduced form wage equation in column 1, this time collapsing the high/low designations leaving three categories:

[8] Although we have 5 potential instruments (English, math, science, social studies and total course requirements), using all of these on the full set of course measures including the high/low course designations was underpowered.

vocational, core and electives. As expected, we see some positive benefit from vocational coursework as a weighted combination of low and high vocational courses, and neither benefit nor harm from electives and core courses. We then repeat this specification in column 2 but limit to the IV sample to confirm that omitting respondents with missing or imputed state-level graduation requirements does not drive results. Lastly, in column 3, we show results from our IV specification. While noisy, we find that the sign on vocational coursework flips from positive to negative. This suggests that students compelled to take additional vocational courses (compliers) due to high total course graduation requirements coupled with relatively low social studies and math graduation requirements likely see no benefit from these additional courses. We take this as suggestive evidence of the positive selection story (although imprecise estimates cannot rule out positive effects). That is, students who choose to enroll in vocational coursework see earnings gains, while those induced to enroll due to graduation requirements see no benefit. This would be a likely result if those who are induced into vocational coursework due to graduation requirements enroll in entry level vocational classes.

One final concern is that graduation requirements might be correlated with school quality, even conditional on our robust set of controls. Since we compare within birth state, we are concerned with within state variation in requirements. It is reasonable to worry that more rigorous schools might have higher requirements, low performing schools seeking to increase college-going might increase requirements, or low performing schools might simply have lower requirements. Table 9 shows results from a regression on total and then math and social studies requirements on student characteristics and state and cohort fixed effects. We find little systematic variation. Hispanic, public school, and poorer students face lower requirements, but so to do students with more educated mothers. We find very little explanatory power from our covariates for math and social studies requirements. Since these factors are all controlled for in our first and second stage equations, we only need to worry about factors correlated with both course requirements and wages, conditional on our full vector of student characteristics (including family wealth, race, parental education, rural/urban, school type, having received public aid) in addition to controls for AFQT and ultimate degree completion and net of cohort and state of birth fixed effects.

5.7 Heterogeneity of Wage Gains

Lastly, we turn our attention to heterogeneity in wage gains. In Table 10 we address the role the local labor market students would experience after high school plays in the returns we observe in our reduced form specification. To do so, we re-estimate Equation 5 above including either contemporary State or MSA fixed effects (omitting state of birth FE), or a measure of the fraction of occupational employment requiring different levels of education. This measure of occupational employment is determined by the fraction of MSA employment that is in occupations requiring a BA, AA, high school diploma, or no high school diploma, obtained from the 2000 Occupational Employment Statistics program from the Bureau of Labor Statistics. For each NLSY respondent, this measure is taken from the MSA that respondent lived in during 12th grade (to avoid endogenously chosen post-schooling labor markets), provided in confidential NLSY geocode data obtained by special license. We find that in each case our estimates presented in Tables 5 and 6 are a lower bounds and that curriculum effects are quite robust to controls for the characteristics of the local labor market.

We extend this analysis in Table 11 by examining wage premiums by the type and characteristics of the metro area in which students attended high school. In columns (2)-(4) we repeat our main specification by MSA type, finding that returns are higher in urban areas. The final three columns (6)-(8) interact vocational course taking with the share of MSA employment that is in occupations requiring a BA degree.[9] We interpret this as a general index of the skill content of occupational employment. Though estimates are very imprecise, the point estimates are directionally consistent with the notion that advanced vocational coursework is more useful in areas that have more skilled employment, even

[9]The share of employment in occupations requiring a BA degree comes from the 2000 OES.

when attributes of MSA's are accounted for via fixed effects. That is, the within-MSA wage difference between students with one vs. no advanced vocational courses is larger in MSA's that have more skilled occupational employment than those with less-skilled employment. Interestingly, the opposite is true for introductory (low) vocational courses: these courses are less useful in MSA's with more skilled occupational employment.

Lastly, we decompose these observed wage gains by vocational field of study, though sample size constraints prohibit us from a full set of interactions between occupational field and high/low denomination. These results are shown in Table 12 where coefficients are ordered from the most to least frequented vocational courses. We find in the full specification (column 2) that gains are largest for credits earned in Health Care and Technology & Industry, and we find earnings are negatively associated with credits accumulated in the most general labor market prep courses (GLMP Industrial Arts and GLMP Other).[10] It is important to note that these two courses are the least frequented by students, averaging less than 0.02 credits in total. Alternately, Tech & Industry, which is associated with the largest gain along with Health Care, is also the most commonly frequented course, followed by Keyboarding, which has no labor market return - a non-trivial finding considering that computer access was far from universal in the late 1990's and early 2000's when NLSY respondents were in high school.

6 Conclusion and Policy Implications

We weigh in on a long-standing debate over labor market training in American high schools. Our analysis focuses on factors leading students to take vocational courses and how these courses affect transitions to college and the workforce. We couch our analysis within a selection framework where students learn about preferences for and skill in academic or vocationally oriented (course)work.

Using detailed course-taking and labor market information from the NLSY97, we find

[10]GLMP is General Labor Market Preparation.

that each additional year of *advanced* vocational coursework during high school is associated with a 1.6 percent increase in wages. This result is robust to an extensive set of individual controls for student background and ability, for any displacement effects on the completion of other courses, for effects on postsecondary attainment, and for controls for the occupational demands of the local labor market. Yet, we find that each additional course of introductory vocational coursework has no benefit (or harm) in the labor market. We interpret this finding as the value of depth over breadth.

Our analysis reveals several subtle yet sharp distinctions that lead to direct policy implications. First, we find that vocational coursework may have informational value enabling students to make more informed choices about their likely fit with college. Since taking more advanced vocational coursework is associated with lower four-year college enrollment rates but no reduction in college completion, this implies that students induced out of four-year college by a vocational secondary curriculum would likely not have completed a degree. Early exposure to vocational curriculum may thus facilitate better college enrollment decisions and fewer *ex-post* mistakes. Second, we demonstrate that while wage gains associated with non-vocational courses (core and electives) are entirely explained by college enrollment, wage gains from upper level vocational courses are unaffected by controlling for college enrollment and completion, suggesting that these courses do in fact impart valuable labor market skills. Lastly, we demonstrate that gains accrue to those students who select into vocational coursework. Those induced into additional courses due to graduation requirements see no benefit. These last two points speak directly to criticisms that vocational education is "preparing students for jobs that don't exist", or that it is a "dumping ground" for low ability students. The results we uncover do not support either of these conclusions.

How secondary schools should prepare students for post-graduation – college, the workforce, citizenry – remains a timely policy question. Many states are still altering their curriculum requirements, with most implementing higher academic standards often at the expense of vocational offerings. The promotion of national Common Core standards by many states continues this trend. Given the labor market benefits of vocational coursework for students that do not obtain a four-year college degree, a shift towards more rigorous academic standards may adversely affect some students that would be better served by vocational coursework.

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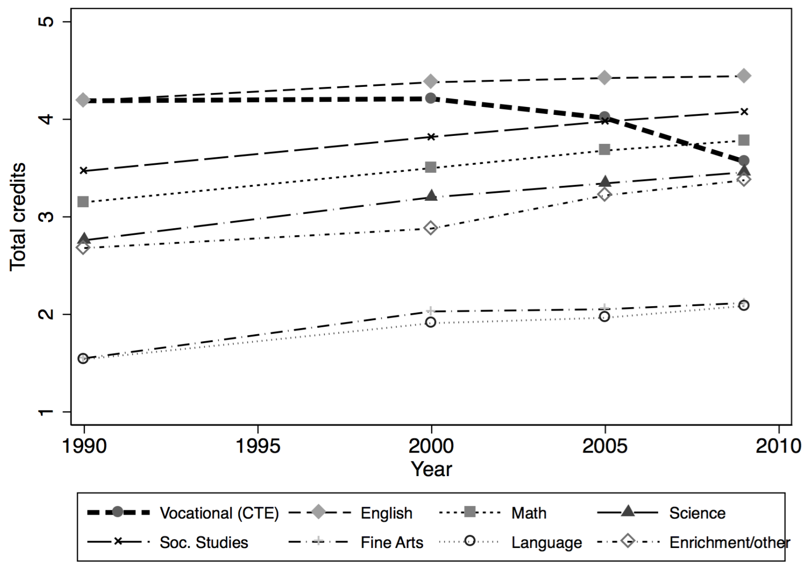
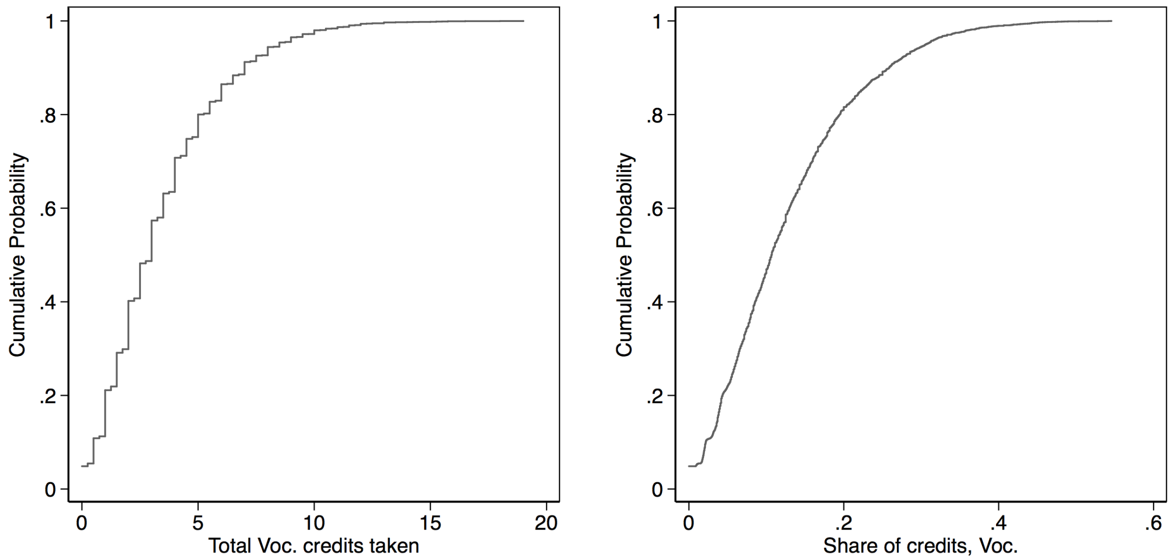
Figures and Tables

Figure 1: Course-taking by American high school students.



Source: Statistics taken by NCES from High School Transcript Study (HSTS), 1990, 2000, 2005, and 2009. Original table available at `http://nces.ed.gov/surveys/ctes/tables/h125.asp`. One credit is equal to a daily year-long course.

Figure 2: CDF of Vocational course-taking.

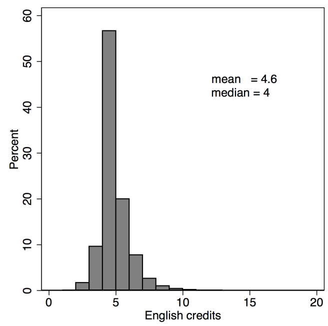


(a) Share courses vocational

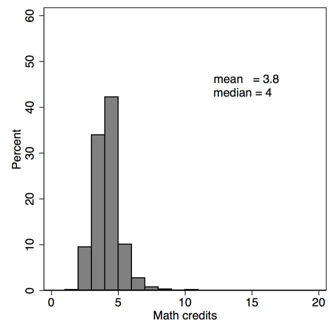
(b) Count of vocational courses

Notes: Figures show cumulative distributions of total and share (Voc/Total) courses taken. One credit is equal to one hour per day for a full academic year. N=4,414.

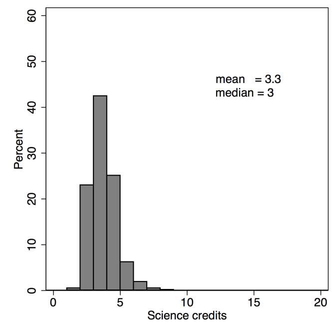
Figure 3: Credits taken in each subject.



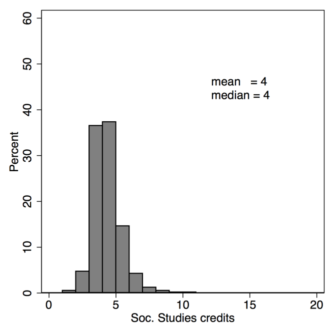
(a) English



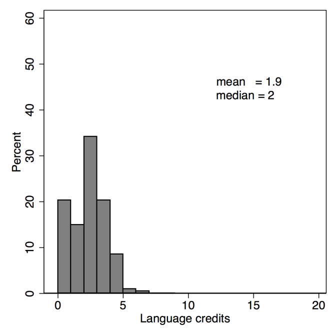
(b) Math



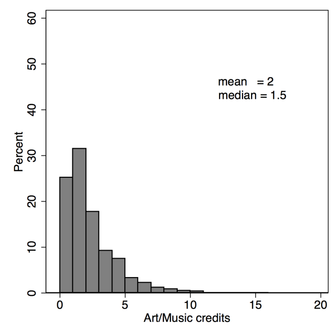
(c) Science



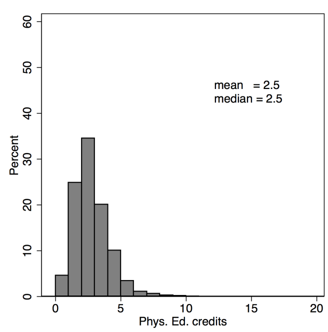
(d) Social studies



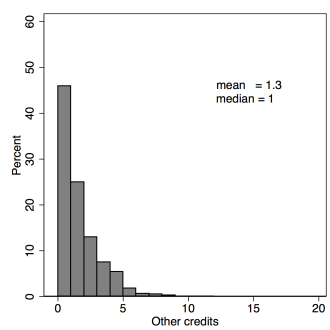
(e) Language



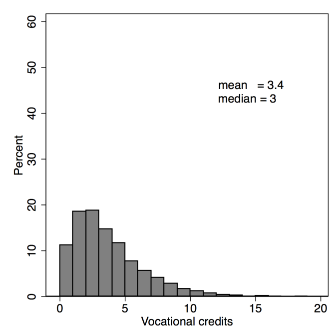
(f) Art/Music



(g) Phys. Ed.



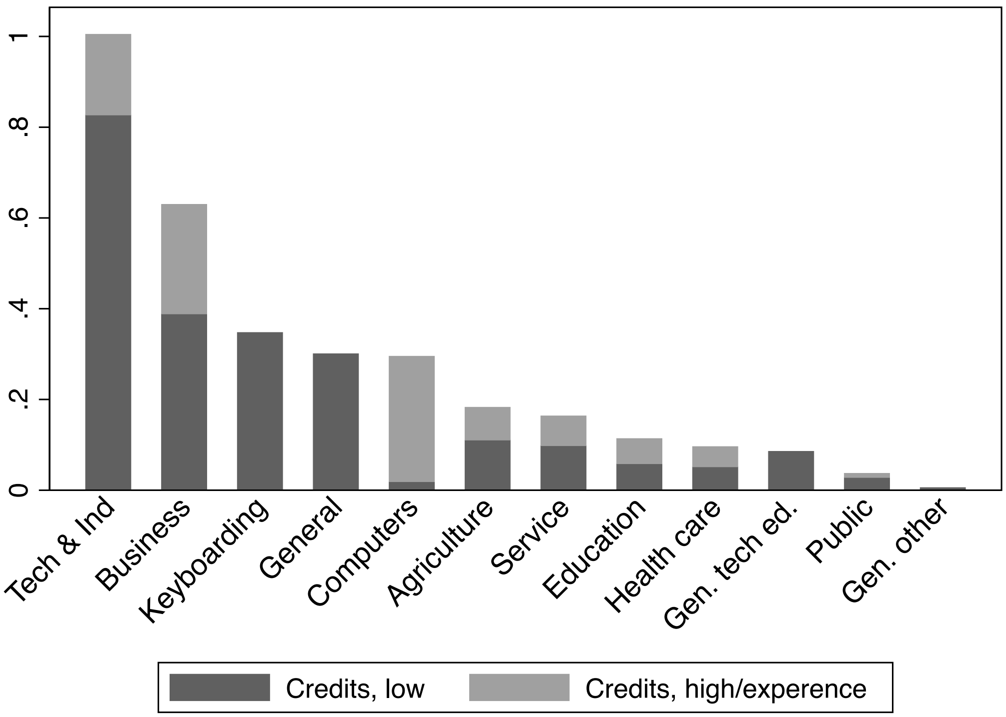
(h) Other



(i) Vocational

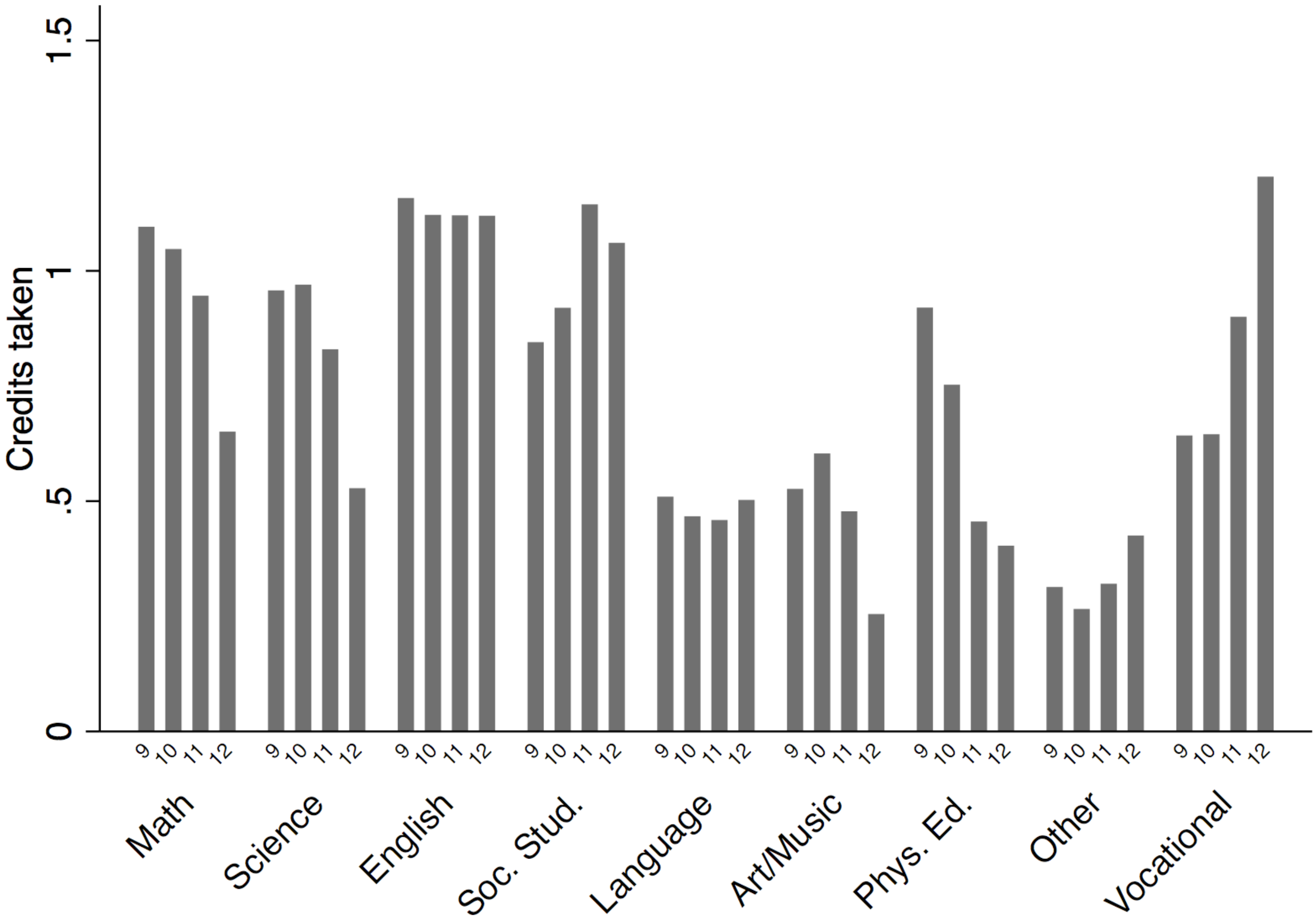
Notes: Figures show histograms of credits taken, defined as courses completed, even if it is an F or course that does not accumulate credit hours. One credit is equal to one hour per day for a full academic year. N=4,414.

Figure 4: Number of courses by low/high-experience, by type.



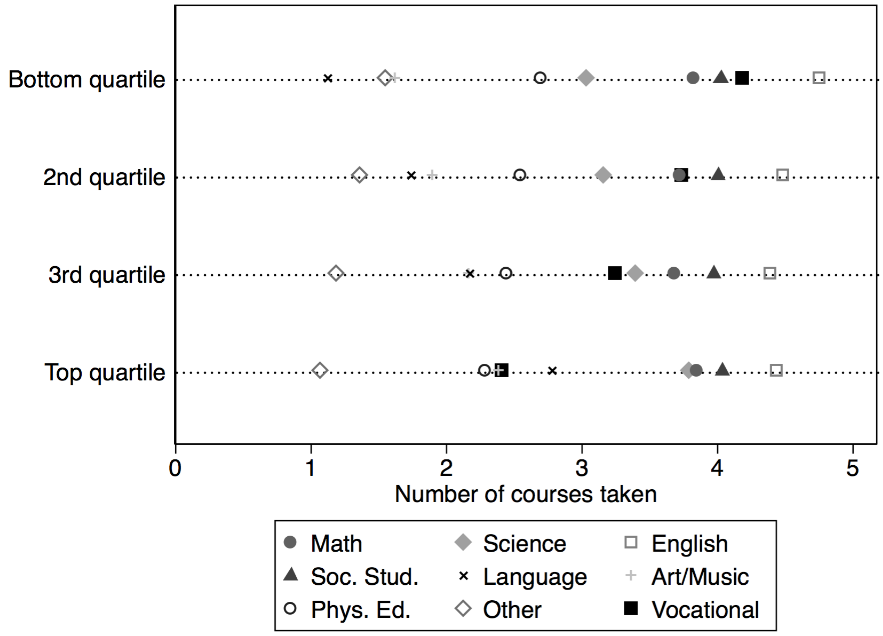
Notes: Figure shows number of carnegie credits earned in each type of vocational course. "Low" courses are entry level. "High/experience" are upper-level or internship/work-based experience courses. One credit is equal to one hour per day for a full academic year. N=4,414.

Figure 5: Number of credits taken by subject and grade.



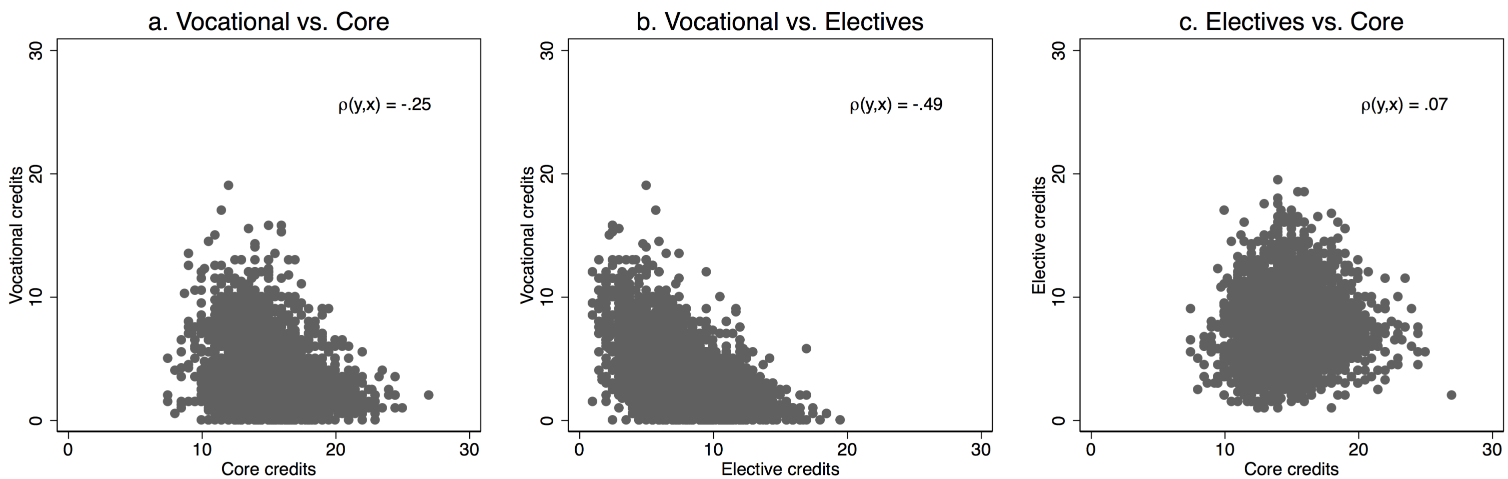
Notes: Students who dropout are only counted above in grades they attempted. One credit is equal to one hour per day for a full academic year. N=4,414.

Figure 6: Number of credits taken by subject and AFQT quartile.



Notes: Shapes mark average total number of credits taken in each subject, by AFQT quartile. One credit is equal to one hour per day for a full academic year. N=3,703 with non-missing AFQT.

Figure 7: Pairwise joint distributions of Core, Elective and Vocational credits accumulated for high school graduates.



Notes: Figures show scatterplots of total credits accumulated for high school graduates. Core courses include English, math, science and social studies. Electives include art/music, foreign languages, physical education and "other" courses. One credit is equal to a one hour per day full year course. N=4,414.

Table 1: Sample comparison.

	Full NLSY		Analysis sample		Wage sample	
	mean	(sd)	mean	(sd)	mean	(sd)
Demographics						
Male	0.50	(0.50)	0.48	(0.50)	0.49	(0.50)
Black	0.25	(0.43)	0.22	(0.42)	0.23	(0.42)
Hispanic	0.20	(0.40)	0.17	(0.37)	0.17	(0.38)
Other	0.04	(0.19)	0.04	(0.20)	0.04	(0.19)
Mom <HS	0.25	(0.43)	0.36	(0.48)	0.36	(0.48)
Mom >HS	0.10	(0.30)	0.17	(0.38)	0.17	(0.37)
Ever aid	0.28	(0.45)	0.37	(0.48)	0.39	(0.49)
South age 12	0.32	(0.47)	0.31	(0.46)	0.32	(0.47)
Pov. Ratio	1.49	(2.46)	2.49	(2.89)	2.42	(2.79)
Public HS	0.93	(0.26)	0.92	(0.28)	0.92	(0.27)
Gifted class	0.17	(0.37)	0.21	(0.41)	0.19	(0.40)
Bilingual	0.03	(0.18)	0.03	(0.17)	0.03	(0.17)
AFQT (Z)	0.00	(1.00)	0.00	(1.00)	-0.04	(1.00)
AFQT missing	0.45	(0.49)	0.16	(0.37)	0.16	(0.37)
Course-taking						
Voc low	1.41	(2.00)	2.28	(1.92)	2.32	(1.93)
Voc high	0.54	(1.14)	0.89	(1.29)	0.91	(1.31)
Core low	5.86	(5.03)	9.88	(2.65)	9.94	(2.61)
Core high	2.67	(3.27)	4.87	(3.20)	4.73	(3.13)
Electives	4.39	(4.08)	7.50	(2.69)	7.43	(2.69)
Attainment						
< HS	0.16	(0.37)	0.06	(0.23)	0.05	(0.22)
HS	0.18	(0.39)	0.17	(0.38)	0.19	(0.39)
Some college	0.30	(0.46)	0.34	(0.47)	0.33	(0.47)
2-year degree	0.07	(0.26)	0.08	(0.28)	0.08	(0.27)
4-year degree	0.28	(0.45)	0.35	(0.48)	0.34	(0.47)
Obs. (n)	8,984		4,414		3,796	

Notes: Analysis sample restricts to respondents with transcripts in all years of HS. Also restricts to those who attended 9th grade. Coursetaking restrictions are: took at least 2 of each core course for hs grads; took 1 of each core course if 10th grade+ dropout; took between 20 and 36 credits for grads; took at least 4 credits for dropouts. Wage sample consists of respondents who have a reported wage $>$ \$1.00/hr after labor market entry. Ever aid indicates if respondent's family ever received government aid. Public HS indicates if primary high school was public. Gifted indicates if responident ever took a "gifted" class. Attainment is degree ever completed. Core credits include Eng., Math, Science, Social Studies. Electives include Language, Art/Music, Phys. Ed. and Other. Low/High core indicates upper or lower level course within subject-grade. Low vocational indicates entry level course. High vocational indicates second course or higher, or an internship/experiential learning.

Table 2: Sample means by tercile of vocational course-taking.

	No Voc. Ed.		Lowest tercile		Middle Tercile		Top Tercile		All	
	mean	(sd)	mean	(sd)	mean	(sd)	mean	(sd)	mean	(sd)
A. Demographics										
Male	0.33	(0.47)	0.42	(0.49)	0.49	(0.50)	0.59	(0.49)	0.48	(0.50)
Black	0.17	(0.37)	0.20	(0.40)	0.24	(0.42)	0.25	(0.43)	0.22	(0.42)
Hispanic	0.12	(0.33)	0.18	(0.38)	0.18	(0.39)	0.15	(0.35)	0.17	(0.37)
Other	0.08	(0.27)	0.05	(0.21)	0.04	(0.20)	0.02	(0.15)	0.04	(0.20)
AFQT-Z	0.65	(0.93)	0.29	(0.97)	0.06	(0.93)	-0.15	(0.91)	0.11	(0.97)
AFQT, missing	0.14	(0.35)	0.16	(0.37)	0.17	(0.37)	0.16	(0.37)	0.16	(0.37)
Mom, <HS	0.30	(0.46)	0.33	(0.47)	0.36	(0.48)	0.40	(0.49)	0.36	(0.48)
Mom, HS	0.41	(0.49)	0.47	(0.50)	0.48	(0.50)	0.48	(0.50)	0.47	(0.50)
Mom, >HS	0.29	(0.45)	0.20	(0.40)	0.16	(0.37)	0.12	(0.33)	0.17	(0.38)
Poverty ratio (1997)	4.82	(3.98)	3.64	(3.10)	3.29	(2.72)	2.80	(2.34)	3.36	(2.88)
Ever public aid	0.33	(0.47)	0.36	(0.48)	0.40	(0.49)	0.51	(0.50)	0.41	(0.49)
South, age 12	0.27	(0.45)	0.28	(0.45)	0.31	(0.46)	0.37	(0.48)	0.31	(0.46)
Rural, age 12	0.09	(0.28)	0.10	(0.31)	0.12	(0.33)	0.17	(0.38)	0.13	(0.33)
B. HS characteristics										
Main HS public	0.84	(0.37)	0.87	(0.34)	0.94	(0.24)	0.97	(0.16)	0.92	(0.28)
Spec. Ed.	0.06	(0.23)	0.04	(0.19)	0.04	(0.20)	0.07	(0.25)	0.05	(0.21)
Bilingual Ed.	0.03	(0.17)	0.03	(0.18)	0.03	(0.18)	0.02	(0.15)	0.03	(0.17)
Any gifted courses	0.30	(0.46)	0.27	(0.44)	0.20	(0.40)	0.12	(0.33)	0.21	(0.41)
Ever private HS	0.15	(0.36)	0.13	(0.33)	0.05	(0.22)	0.02	(0.13)	0.07	(0.26)
C. Course taking										
Core courses, low	8.83	(2.97)	9.81	(2.88)	10.06	(2.58)	9.97	(2.27)	9.88	(2.65)
Core courses, high	6.41	(3.58)	5.41	(3.42)	4.69	(3.06)	4.08	(2.70)	4.87	(3.20)
Electives	9.69	(3.00)	8.49	(2.55)	7.42	(2.29)	5.87	(2.28)	7.50	(2.69)
Vocational low	0.00	(0.00)	1.01	(0.58)	2.26	(0.91)	4.41	(2.09)	2.28	(1.92)
Vocational, high	0.00	(0.00)	0.27	(0.42)	0.78	(0.81)	2.00	(1.78)	0.89	(1.29)
D. Outcomes										
< HS	0.07	(0.26)	0.06	(0.24)	0.06	(0.23)	0.05	(0.21)	0.06	(0.23)
HS	0.08	(0.27)	0.11	(0.32)	0.17	(0.38)	0.26	(0.44)	0.17	(0.38)
Some college	0.26	(0.44)	0.31	(0.46)	0.36	(0.48)	0.36	(0.48)	0.34	(0.47)
2-yr degree	0.05	(0.22)	0.08	(0.27)	0.08	(0.27)	0.10	(0.30)	0.08	(0.28)
4-yr+ degree	0.54	(0.50)	0.43	(0.50)	0.34	(0.47)	0.23	(0.42)	0.35	(0.48)
Last (log) wage	2.85	(0.55)	2.79	(0.48)	2.76	(0.49)	2.75	(0.49)	2.77	(0.49)
Obs.	234		1,604		1,356		1,220		4,414	

Notes: Core credits include Eng., Math, Science, Social Studies. Electives include Language, Art/Music, Phys. Ed. and Other. Low/High core indicates upper or lower level course within subject-grade. Low vocational indicates entry level course. High vocational indicates second course or higher, or an internship/experiential learning.

Table 3: Vocational courses taken, grades 10-12.

	(1)	(2)	(3)	(4)	(5)	(6)
		All Voc courses			Voc Low	Voc High
Male	0.599***	0.599***	0.559***	0.567***	0.349***	0.258***
	(0.065)	(0.064)	(0.065)	(0.066)	(0.051)	(0.037)
Black	-0.200**	-0.421***	-0.451***	-0.457***	-0.324***	-0.089
	(0.093)	(0.095)	(0.096)	(0.099)	(0.076)	(0.057)
Hispanic	-0.482***	-0.626***	-0.635***	-0.631***	-0.426***	-0.205***
	(0.094)	(0.098)	(0.097)	(0.101)	(0.080)	(0.055)
Other race	-0.705***	-0.743***	-0.728***	-0.718***	-0.399***	-0.332***
	(0.124)	(0.124)	(0.125)	(0.129)	(0.099)	(0.065)
Mom < HS	0.115	0.093	0.090	0.083	0.055	0.039
	(0.083)	(0.083)	(0.082)	(0.085)	(0.065)	(0.047)
Mom > HS	-0.463***	-0.399***	-0.398***	-0.420***	-0.273***	-0.148***
	(0.085)	(0.084)	(0.083)	(0.085)	(0.063)	(0.047)
Ever aid	0.354***	0.276***	0.255***	0.319***	0.288***	0.011
	(0.078)	(0.078)	(0.078)	(0.081)	(0.061)	(0.045)
South, age 12	0.342***	0.307***	0.325***	0.366***	0.330***	0.005
	(0.078)	(0.077)	(0.078)	(0.080)	(0.062)	(0.043)
Rural, age 12	0.241**	0.222**	0.217**	0.184*	0.201**	0.042
	(0.108)	(0.106)	(0.106)	(0.108)	(0.084)	(0.058)
Pov. ratio	-0.001***	-0.000***	-0.000***	-0.001***	-0.000***	-0.000*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Main HS Public	1.118***	1.066***	1.058***	1.082***	0.725***	0.298***
	(0.086)	(0.086)	(0.086)	(0.087)	(0.064)	(0.048)
Gifted	-0.715***	-0.461***	-0.340***	-0.357***	-0.246***	-0.103**
	(0.068)	(0.072)	(0.079)	(0.081)	(0.058)	(0.046)
Bilingual	0.023	-0.036	-0.023	-0.036	0.184	-0.243***
	(0.174)	(0.171)	(0.171)	(0.175)	(0.142)	(0.067)
AFQT-Z		-0.384***	-0.326***	-0.347***	-0.245***	-0.072***
		(0.042)	(0.044)	(0.046)	(0.035)	(0.027)
Core GPA_9			-0.139***	-0.154***	-0.122***	-0.016
			(0.038)	(0.039)	(0.031)	(0.021)
Math 9th, hi			-0.093	-0.084	-0.103	0.002
			(0.116)	(0.118)	(0.089)	(0.068)
Eng 9th, hi			-0.170*	-0.205**	-0.227***	0.028
			(0.087)	(0.088)	(0.063)	(0.050)
H.S. Grads only				✓	✓	✓
Year 9th	✓	✓	✓	✓	✓	✓
R^2	0.101	0.118	0.122	0.136	0.128	0.039
Obs. (n)	4,414	4,414	4,414	4,165	4,165	4, d165

Notes: One course (dep. var) is one full year. Math/Eng. high are indicators = 1 if respondent was in upper level Eng./Math courses in 9th grade. Cols 4-6 are restricted to HS grads only. Core credits include Eng., Math, Science, Social Studies. Electives include Language, Art/Music, Phys. Ed. and Other. Low/High core indicates upper or lower level course within subject-grade. Low vocational indicates entry level course. High vocational indicates second course or higher, or an internship/experiential learning.
($*p < 0.10, **p < 0.05, ***p < 0.01$.)

Table 4: Dep. vars. indicate 2 or 4 year college attendance or completion - conditional on completing high school.

Panel A: Number of credits

	(1) Attend 2yr	(2) Attend 4yr	(3) Attend any	(4) Earn 2yr	(5) Earn 4yr	(6) Earn any
Voc., low	-0.003	-0.005	-0.008**	-0.000	0.003	0.003
	(0.004)	(0.004)	(0.004)	(0.008)	(0.007)	(0.005)
Voc., high	0.007	-0.008	-0.001	0.014	0.010	0.009
	(0.006)	(0.005)	(0.005)	(0.011)	(0.009)	(0.007)
Core credits, low	-0.015***	0.033***	0.018***	0.002	0.012**	0.017***
	(0.004)	(0.004)	(0.003)	(0.008)	(0.006)	(0.005)
Core credits, high	-0.029***	0.050***	0.021***	0.022**	0.029***	0.038***
	(0.003)	(0.003)	(0.003)	(0.009)	(0.005)	(0.004)
Elective credits	-0.007**	0.022***	0.015***	-0.003	0.014***	0.014***
	(0.003)	(0.003)	(0.002)	(0.007)	(0.004)	(0.004)
AFQT-Z	-0.040***	0.130***	0.090***	0.038*	0.055***	0.070***
	(0.009)	(0.009)	(0.008)	(0.020)	(0.014)	(0.011)
R^2	0.093	0.277	0.155	0.079	0.116	0.147

Panel B: Share of credits

	(1) Attend 2yr	(2) Attend 4yr	(3) Attend any	(4) Earn 2yr	(5) Earn 4yr	(6) Earn any
Share Voc. low*100	0.001	-0.007***	-0.006***	0.001	-0.003*	-0.003*
	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.001)
Share Voc. high*100	0.004**	-0.008***	-0.004***	0.005*	-0.002	-0.002
	(0.001)	(0.001)	(0.001)	(0.003)	(0.002)	(0.002)
Share core low*100	-0.002**	0.003**	0.000	0.001	-0.001	0.001
	(0.001)	(0.001)	(0.001)	(0.003)	(0.002)	(0.001)
Share core high*100	-0.006***	0.008***	0.002*	0.006**	0.004**	0.007***
	(0.001)	(0.001)	(0.001)	(0.003)	(0.002)	(0.001)
Total credits	-0.013***	0.028***	0.014***	0.003	0.016***	0.019***
	(0.002)	(0.002)	(0.002)	(0.005)	(0.004)	(0.003)
AFQT-Z	-0.040***	0.129***	0.089***	0.038*	0.054***	0.069***
	(0.009)	(0.009)	(0.008)	(0.020)	(0.014)	(0.011)
R^2	0.093	0.279	0.156	0.078	0.117	0.148

Controls and observations apply to both tables.

If attended college				✓	✓	✓
Controls	✓	✓	✓	✓	✓	✓
State FE	✓	✓	✓	✓	✓	✓
N	4165	4165	4165	917	2491	3408

Notes: Sample is limited to HS graduates. Core credits include Eng., Math, Science, Social Studies. Electives include Language, Art/Music, Phys. Ed. and Other. Low/High core indicates upper or lower level course within subject-grade. Low vocational indicates entry level course. High vocational indicates second course or higher, or an internship/experiential learning.Controls include: gender, race, mother's education, rural or South at age 12, family poverty ratio in 1997, public primary high school, any gifted courses, bilingual education, and year entered 9th grade.
($*p < 0.10, **p < 0.05, ***p < 0.01$.)

Table 5: Dependent variable is log (real) hourly wage.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Voc low	-0.018***	-0.002	0.001	0.001	0.002	0.001	0.002
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Voc high/exper.	0.016***	0.018***	0.019***	0.019***	0.019***	0.016***	0.016***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
AFQT-Z			0.062***		0.047***	0.033***	0.029***
			(0.008)		(0.008)	(0.008)	(0.008)
Core credits, low				0.000	-0.000	-0.007**	-0.005*
				(0.003)	(0.003)	(0.003)	(0.003)
Core credits, high				0.020***	0.015***	0.003	0.005*
				(0.003)	(0.003)	(0.003)	(0.003)
Elective credits				0.001	-0.001	-0.005**	-0.004*
				(0.002)	(0.002)	(0.003)	(0.003)
None						-0.089***	-0.082***
						(0.026)	(0.026)
Some college						-0.002	-0.005
						(0.015)	(0.015)
2-yr degree						0.072***	0.068***
						(0.025)	(0.025)
4-yr degree						0.184***	0.180***
						(0.019)	(0.019)
State FE							✓
Controls		✓	✓	✓	✓	✓	✓
R^2	0.007	0.208	0.218	0.218	0.223	0.243	0.257
N	20,572	20,572	20,572	20,572	20,572	20,572	20,572
n	3,796	3,796	3,796	3,796	3,796	3,796	3,796

Notes: Sample is wage sample. Wages are in real $2010. Controls include: gender, race, mother's education, rural or South at age 12, family poverty ratio in 1997, public primary high school, any gifted courses, bilingual education, year entered 9th grade, year of wage record and MSA status when wage was recorded. A one-unit change in credits is equal to a one hour, one year course.Core credits include Eng., Math, Science, Social Studies. Electives include Language, Art/Music, Phys. Ed. and Other. Low/High core indicates upper or lower level course within subject-grade. Low vocational indicates entry level course. High vocational indicates second course or higher, or an internship/experiential learning.
($*p < 0.10, **p < 0.05, ***p < 0.01$.)

Table 6: Dependent variable is log hourly wage, course-taking defined in shares of total.

	(1)	(2)	(3)	(4)	(5)	(6)
Share Voc. low*100	-0.004***	-0.000	0.001	0.001	0.001	0.001*
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Share Voc. high*100	0.004***	0.005***	0.005***	0.005***	0.005***	0.005***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Share core low*100	-0.004***	-0.001	-0.001	-0.000	-0.001	-0.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Share core high*100	0.005***	0.005***	0.004***	0.003***	0.002**	0.003***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Total credits					-0.003*	-0.002
					(0.002)	(0.002)
Birth state FE						✓
Highest degree				✓	✓	✓
AFQT			✓	✓	✓	✓
Controls		✓	✓	✓	✓	✓
R^2	0.047	0.219	0.224	0.244	0.244	0.255
N	20,572	20,572	20,572	20,572	20,572	20,572
n	3,796	3,796	3,796	3,796	3,796	3,796

Notes: Shares are the share of total courses taken in each subject group multiplied by 100. Share of courses that are electives is the omitted category. Sample is wage sample. Wages are in real $2010. Controls include: gender, race, mother's education, rural or South at age 12, family poverty ratio in 1997, public primary high school, any gifted courses, bilingual education, year entered 9th grade, year of wage record and MSA status when wage was recorded. A one-unit change in credits is equal to a one hour, one year course.Core credits include Eng., Math, Science, Social Studies. Electives include Language, Art/Music, Phys. Ed. and Other. Low/High core indicates upper or lower level course within subject-grade. Low vocational indicates entry level course. High vocational indicates second course or higher, or an internship/experiential learning.
($*p < 0.10, **p < 0.05, ***p < 0.01$.)

Table 7: First stage multiple IV regression.

	Voc. credits	Core credits	Elective credits
Total course requirements	0.158***	-0.006	0.108***
	(0.028)	(0.016)	(0.024)
Math requirements	0.138	0.528***	0.024
	(0.114)	(0.098)	(0.114)
Soc. Stud. requirements	-0.344***	0.101	0.184*
	(0.102)	(0.088)	(0.102)
Controls	✓	✓	✓
AFQT	✓	✓	✓
Highest degree	✓	✓	✓
Birth state FE	✓	✓	✓
Angrist-Pischke F-stat	27.10	31.16	13.87
N	15,338	15,338	15,338

Wages are in real $2010. Controls include: gender, race, mother's education, rural or South at age 12, family poverty ratio in 1997, public primary high school, any gifted courses, bilingual education, year entered 9th grade, year of wage record and MSA status when wage was recorded. A one-unit change in credits is equal to a one hour, one year course.
($*p < 0.10, **p < 0.05, ***p < 0.01$.)

Table 8: Second stage multiple IV regression.

	(1) OLS	(2) OLS	(3) IV
Vocational credits	0.006**	0.008**	-0.037
	(0.003)	(0.003)	(0.026)
Core credits	0.000	0.001	0.047
	(0.003)	(0.003)	(0.047)
Elective credits	-0.004	-0.004	0.021
	(0.003)	(0.003)	(0.033)
Controls	✓	✓	✓
AFQT	✓	✓	✓
Highest degree	✓	✓	✓
Birth state FE	✓	✓	✓
R^2	0.252	0.260	0.104
Obs. (n)	20,572	15,338	15,338

Wages are in real $2010. Controls include: gender, race, mother's education, rural or South at age 12, family poverty ratio in 1997, public primary high school, any gifted courses, bilingual education, year entered 9th grade, year of wage record and MSA status when wage was recorded. A one-unit change in credits is equal to a one hour, one year course.Credits in column 3 are taken from predicted first stage estimates.
($*p < 0.10, **p < 0.05, ***p < 0.01$.)

Table 9: Correlates of course requirements.

	(1) Total requirements		(2) Math + Soc. Stud. reqs	
Male	-0.093	(0.096)	-0.036	(0.029)
Black	0.102	(0.137)	0.051	(0.042)
Hispanic	-0.349**	(0.151)	0.102*	(0.052)
Other race	-0.318	(0.253)	-0.050	(0.096)
Mom<HS	-0.028	(0.120)	0.016	(0.036)
Mom>HS	-0.375**	(0.148)	-0.025	(0.042)
Ever aid	-0.108	(0.111)	0.003	(0.034)
Rural, age 12	0.914***	(0.164)	-0.001	(0.043)
Poverty ratio	-0.001***	(0.000)	-0.000	(0.000)
Main HS Public	-0.657***	(0.224)	-0.066	(0.056)
Cohort FE	✓		✓	
Birthstate FE	✓		✓	
Observations	2,832		2,832	

Dependent variable is number of total or math + social studies graduation requirements. Sample omits respondents with missing requirements or had NLSY imputed state-level requirements. Robust standard errors in parentheses.
($*p < 0.10, **p < 0.05, ***p < 0.01$.)

Table 10: Wage regression with labor market controls.

	State FE		ED distribution		MSA/State FE	
	(1)	(2)	(3)	(4)	(5)	(6)
Voc., low	0.004	0.001	0.005	0.003	0.007**	0.004
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Voc., high	0.021***	0.017***	0.020***	0.017***	0.022***	0.018***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Core, low	-0.001	-0.008**	-0.002	-0.009***	0.000	-0.006*
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Core, high	0.017***	0.004	0.013***	0.002	0.016***	0.005
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Electives	0.000	-0.005*	0.000	-0.005*	0.002	-0.003
	(0.003)	(0.003)	(0.002)	(0.003)	(0.003)	(0.003)
BA share in MSA			1.054***	1.085***		
			(0.263)	(0.257)		
AA share in MSA			-4.007***	-3.539***		
			(0.909)	(0.890)		
HS share in MSA			0.745**	0.892***		
			(0.353)	(0.345)		
Not MSA			0.373	0.485*		
			(0.257)	(0.250)		
Degree indicators		✓		✓		✓
Fixed effects	State	State			MSA+state	MSA+state
Controls	✓	✓	✓	✓	✓	✓
R^2	0.236	0.255	0.23	0.249	0.259	0.277
N	20,198	20,198	20,172	20,172	20,172	20,172
n	3,726	3,726	3,717	3,717	3,717	3,717

Notes: Wages are in real $2010. Controls include: gender, race, mother's education, rural or South at age 12, family poverty ratio in 1997, public primary high school, any gifted courses, bilingual education, year entered 9th grade, year of wage record and MSA status when wage was recorded. A one-unit change in credits is equal to a one hour, one year course.Core credits include Eng., Math, Science, Social Studies. Electives include Language, Art/Music, Phys. Ed. and Other. Low/High core indicates upper or lower level course within subject-grade. Low vocational indicates entry level course. High vocational indicates second course or higher, or an internship/experiential learning.Controls include: gender, race, mother's education, rural or South at age 12, family poverty ratio in 1997, public primary high school, any gifted courses, bilingual education, and year entered 9th grade.
($*p < 0.10, **p < 0.05, ***p < 0.01$.)

Table 11: Wage Regressions by Type and Education Needs of Local Labor Market.

	By metro area type				By labor market education needs			
	All	Not MSA	MSA	P/CMSA	No FE	No FE	State FE	MSA FE
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Voc low	0.002	0.007	0.006	0.000	0.002	0.024	0.036	0.033
	(0.003)	(0.006)	(0.005)	(0.007)	(0.004)	(0.024)	(0.024)	(0.024)
X BA share in MSA						-0.091	-0.135	-0.116
						(0.098)	(0.100)	(0.097)
Voc high/exper	0.019***	0.006	0.026***	0.022***	0.025***	-0.007	-0.019	-0.017
	(0.005)	(0.007)	(0.008)	(0.008)	(0.006)	(0.035)	(0.034)	(0.033)
cX BA share in MSA						0.133	0.185	0.177
						(0.145)	(0.142)	(0.139)
BA share in MSA					0.992***	1.069***	1.292***	
					(0.160)	(0.280)	(0.325)	
Fixed effects							State FE	MSA FE
Controls	✓	✓	✓	✓	✓	✓	✓	✓
R^2	0.22	0.232	0.227	0.200	0.224	0.225	0.239	0.258
N	20,572	4,470	9,310	6,392	15,702	15,702	15,702	15,702
n	3,796	804	1,686	1,227	2,913	2,913	2,913	2,913

Notes: Wages are in real $2010. Controls include: gender, race, mother's education, rural or South at age 12, family poverty ratio in 1997, public primary high school, any gifted courses, bilingual education, year entered 9th grade, year of wage record and MSA status when wage was recorded. A one-unit change in credits is equal to a one hour, one year course.Core credits include Eng., Math, Science, Social Studies. Electives include Language, Art/Music, Phys. Ed. and Other. Low/High core indicates upper or lower level course within subject-grade. Low vocational indicates entry level course. High vocational indicates second course or higher, or an internship/experiential learning.
($*p < 0.10, **p < 0.05, ***p < 0.01$.)

Table 12: Dependent variable is log (real) hourly wage.

	(1)	(2)	Mean voc. credits earned
Core credits, low	0.001	-0.005*	
	(0.003)	(0.003)	
Core credits, high	0.017***	0.006*	
	(0.003)	(0.003)	
Elective credits	-0.000	-0.005*	
	(0.002)	(0.003)	
Tech. & Industry	0.017***	0.014***	1.02
	(0.004)	(0.004)	
Business/Management	0.013**	0.009*	0.64
	(0.005)	(0.005)	
GLMP Keyboarding	0.010	0.005	0.35
	(0.012)	(0.012)	
GLMP General	-0.007	-0.008	0.30
	(0.007)	(0.007)	
Computer Tech.	0.005	0.002	0.30
	(0.009)	(0.009)	
Agriculture	0.018**	0.015*	0.19
	(0.009)	(0.008)	
Service	-0.001	-0.003	0.17
	(0.005)	(0.005)	
Edu. & Child Care	-0.008	-0.009	0.12
	(0.010)	(0.009)	
GLMP Tech. Ed.	-0.014	-0.016	0.09
	(0.015)	(0.015)	
Health care	0.017*	0.016*	0.09
	(0.009)	(0.009)	
Pub. & Protect. Svcs.	-0.014	-0.017	0.04
	(0.012)	(0.012)	
GLMP Ind. Arts	-0.056**	-0.052**	0.02
	(0.025)	(0.025)	
GLMP Other	-0.019	-0.019	0.01
	(0.015)	(0.013)	
Highest degree		✓	
AFQT	✓	✓	
Birthstate FE	✓	✓	
All controls	✓	✓	
R^2	0.223	0.243	
N	20,495	20,495	
n	3,786	3,786	

Notes: Wages are in real $2010. Controls include: gender, race, mother's education, rural or South at age 12, family poverty ratio in 1997, public primary high school, any gifted courses, bilingual education, year entered 9th grade, year of wage record and MSA status when wage was recorded. A one-unit change in credits is equal to a one hour, one year course.
($*p < 0.10, **p < 0.05, ***p < 0.01$.)

Table A1: Vocational course types in the NLSY97.

1. Basic Keyboarding/Typewriting (GLMP).
2. Industrial Arts (GLMP).
3. Career Preparation/General Work Experience (GLMP).
4. Technology Education (GLMP).
5. Other (GLMP).
6. Agriculture and Renewable Resources.
7. Business:
Business Services; Marketing and Distribution; Business Management.
8. Health Care.
9. Public and Protective Services.
10. Transportation and Industry:
Construction trades; Material Moving; Mechanics and repair
Precision Production (Drafting/Graphics/Printing/Metals/Wood/Plastics).
11. Computers and technology:
Computer Technology, Communication Technology; Other technology
12. Service:
Personal and Other Services; Food Service and Hospitality
13. Child Care and Education

Notes: GLMP is General Labor Market Preparation, as opposed to specific "occupational education" courses.

Table A2: Vocational courses taken, grades 10-12, robustness check.

	(1)	(2)	(3)
Male	0.567***	0.561***	0.566***
	(0.066)	(0.066)	(0.065)
Black	-0.457***	-0.448***	-0.287***
	(0.099)	(0.099)	(0.101)
Hispanic	-0.631***	-0.625***	-0.407***
	(0.101)	(0.101)	(0.113)
Other race	-0.718***	-0.716***	-0.476***
	(0.129)	(0.129)	(0.137)
Mom $<$ HS	0.083	0.085	0.094
	(0.085)	(0.085)	(0.085)
Mom $>$ HS	-0.420***	-0.419***	-0.384***
	(0.085)	(0.085)	(0.085)
Ever aid	0.319***	0.313***	0.308***
	(0.081)	(0.081)	(0.080)
South, age 12	0.366***	0.363***	0.401***
	(0.080)	(0.080)	(0.111)
Rural, age 12	0.184*	0.185*	0.244**
	(0.108)	(0.108)	(0.115)
Pov. ratio	-0.001***	-0.001***	-0.001***
	(0.000)	(0.000)	(0.000)
Main HS Public	1.082***	1.087***	1.047***
	(0.087)	(0.088)	(0.091)
Gifted	-0.357***	-0.368***	-0.327***
	(0.081)	(0.080)	(0.081)
Bilingual	-0.036	-0.026	-0.018
	(0.175)	(0.175)	(0.180)
AFQT-Z	-0.347***	-0.341***	-0.371***
	(0.046)	(0.045)	(0.045)
Core GPA 9	-0.154***	-0.156***	-0.159***
	(0.039)	(0.039)	(0.039)
Math 9th, hi	-0.084	-0.083	-0.084
	(0.118)	(0.118)	(0.116)
Eng 9th, hi	-0.205**	-0.204**	-0.162*
	(0.088)	(0.088)	(0.089)
State FE	No	No	Yes
Year 9th	Yes	No	Yes
R^2	0.136	0.136	0.174
Obs. (n)	41,65	4,165	4,165

Notes: One course (dep. var) is one full year. Math/Eng. high are indicators = 1 if respondent was in upper level Eng./Math courses in 9th grade. Cols 4-6 are restricted to HS grads only. Core credits include Eng., Math, Science, Social Studies. Electives include Language, Art/Music, Phys. Ed. and Other. Low/High core indicates upper or lower level course within subject-grade. Low vocational indicates entry level course. High vocational indicates second course or higher, or an internship/experiential learning.
($*p < 0.10, **p < 0.05, ***p < 0.01$.)