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Double your major, double your return?

Alison F. Del Rossi[a,*], Joni Hersch[b]

[a]Department of Economics, St. Lawrence University, Canton, NY 13617, USA
[b]Vanderbilt University Law School, 131 21st Avenue South, Nashville, TN 37203, USA

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Abstract

We use the 2003 National Survey of College Graduates to provide the first estimates of the effect on earnings of having a double major. Overall, double majoring increases earnings by 2.3% relative to having a single major among college graduates without graduate degrees. Most of the gains from having a double major come from choosing fields across two different major categories. Graduates who combine an arts, humanities or social science major with a major in business, engineering, science or math have returns 7–50% higher than graduates with a single major in arts, humanities or social science. But such double major combinations have returns no higher than single majors in business, engineering, science or math. Majors combining business and science or math have returns more than 50% greater than the returns to having a single major in these fields.
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1. Introduction

There is considerable literature that estimates the returns to different college majors, finding that the returns to different college majors vary substantially.[1] However, such studies examine the effect on earnings of only one college major. Currently about one quarter of college graduates have more than one undergraduate major.[2] Recent anecdotal evidence (Lewin, 2002; Gomstyn, 2003) suggests the share of college students choosing a double major is increasing, and some students are seeking three or even four majors.

Similar to having graduate degrees, double majoring might be expected to increase earnings by providing students with an additional credential that indicates accrual of more skills or that signals

*Corresponding author. Tel.: +1 315 229 5449; fax: +1 315 229 5819.
E-mail addresses: adelrossi@stlawu.edu (A.F. Del Rossi), joni.hersch@vanderbilt.edu (J. Hersch).

[1]See, for example, Daymont and Andrisani (1984), Loury and Garman (1993), Eide (1994), Brown and Corcoran (1997), Loury (1997), and Graham and Smith (2005). These papers find the highest returns to engineering, business, math, computer science, and certain science fields relative to degrees in arts, humanities, and education, although the ranking of relative returns varies with the level of detail of the categories.

[2]Using data from the National Center for Education Statistics (available at http://nces.ed.gov/ipedspas/), we find an average of 23.3% double majors from 2001 through 2005. We find a similar share of double majors in the 2003 National Survey of College Graduates data analyzed in this paper.

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some inherent characteristic of the individual that is positively correlated with productivity. But whether college graduates who have a double major actually have higher earnings than those with a single major is unknown. Indeed, having a double major could have an adverse effect on earnings. Meeting the requirements for multiple fields could result in too little depth within one's main field and a decrease in the breadth of general knowledge, as free electives are supplanted by courses meeting requirements for second majors.

From a student's point of view, there are likely to be intangible benefits to adding a second major, such as the enjoyment of a "fun" major that provides relief from a more practical major, but a key reason cited by students for seeking a double major is an increase in expected earnings. This paper uses data from the 2003 National Survey of College Graduates (2003 NSCG) to provide the first estimates of the effects on earnings of having a double major relative to a single major in college, as well as to examine the effects on earnings of combinations of majors. This paper thereby adds to the literature on education that examines returns to degrees and returns to choice of major, and provides to students, faculty, and administrators unique information about whether a double major does increase earnings.

2. Empirical specification and description of the data

In order to examine the impact of having a double major on earnings we estimate a conventional earnings equation augmented by indicators of single and double majors. Define Y_i as earnings and ln (Y_i) as the natural log of earnings. The earnings equation takes the general form:

$$\ln(Y_i) = X_i\beta + S_i\gamma + D_i\delta + \varepsilon_i.$$

X_i is a vector of individual i's demographic and job-related characteristics that are expected to affect earnings, and S_i is a vector that includes indicators for an additional bachelor's degree and various graduate degrees. In our first empirical specification, D_{i} is an indicator variable for whether or not an individual has a double major. In our second empirical specification, D_{i} is a vector of indicators for single major categories and double major combinations. β, γ and δ are the corresponding coefficient parameters to be estimated, and ε_i is the error term.

We use data from the 2003 NSCG, which is part of an ongoing National Science Foundation data collection program known as SESTAT (Scientists and Engineers Statistical Data System).[3] The 2003 NSCG sampled over 100,000 individuals under age 76 who held a bachelor's or higher degree in any field as of April 1, 2000. The survey provides fairly extensive employment information, including annual earnings and employment characteristics. Of particular importance for our purposes is the reported information on primary field and second major, if any. While other nationally representative datasets contain information on field of highest degree, only the surveys included in the SESTAT system and the Baccalaureate and Beyond Longitudinal Study 1993/1994 (B&B 93/94) record fields for a second major associated with the respondent's college degree.[4] We use the 2003 NSCG rather than the B&B 93/94 because of its much larger sample size, broader graduation year range, and longer period over which to observe labor market outcomes. The NSCG oversamples fields that are of particular interest to the SESTAT program, but which have smaller populations (e.g., women or minorities in engineering). We control for the oversampling using probability weights provided in the 2003 NSCG, and all means and regressions reported correct for sampling weights.

Our variables on double majors and fields of study for bachelor's and higher degrees are derived from a question on the 2003 NSCG asking for information on up to three degrees. For the most recent degree, the second most recent degree, and for the first bachelor's degree, respondents report the year the degree was awarded, the type of degree, the primary field of study, and if applicable, second major. We classify individuals as having a double major if they report both a primary field and a different second major for their first bachelor's degree. For each degree, respondents select the best code for their fields of study from a list of over 140

[3]The 2003 NSCG data is available from SESTAT at http://sestat.nsf.gov/cddl.html, and the survey instrument can be found at http://www.nsf.gov/statistics/srvygrads/#avail.

[4]The primary datasets used to examine the impacts of undergraduate education on earnings are the National Longitudinal Study of the High School Class of 1972, the High School and Beyond Senior Cohort, the Survey of Income and Program Participation, and the B&B 93/94. The B&B 93/94 is a nationally representative sample of approximately 10,000 college students graduating in 1992/1993 who were interviewed 1 year after graduation. Using the B&B 93/94, Joy (2003) estimates earnings regressions, controlling for primary major only.

educational fields. We group these education codes into five categories of majors: arts/social science, which includes arts, humanities, social science and other majors; business, which includes economics; education; engineering; and science/math, which includes math, computer science, and science majors.[5]

The 2003 NSCG provides most of the key labor market and demographic variables typically used in earnings regressions. The dependent variable is the log of total annual earnings in 2002. We control for tenure and tenure squared in the regressions.[6] Actual work experience is not reported. We control for age and age squared as a proxy for potential experience. It is particularly important that age as a proxy for experience is not affected by double majoring. Using the 2003 NSCG sample, we find that the students with double majors do not take longer to achieve their first bachelor's than those without double majors, with both groups having about a 6 year difference between high school and college graduation. This is true whether or not a person achieves a graduate degree. Consequently, we consider age to be as reliable a proxy for experience as any other approximation of actual experience.[7]

We define indicators for class of worker, stratified into self employed, private employer, and government employer (including military employees). An indicator variable for whether principal employer is located in the South is also included. Demographic information included in the earnings regressions are indicator variables for sex, race, whether Hispanic or Latino, and whether married or living in a marriage-like relationship. We include an interaction of the male and married indicator variables as it is well documented that only males receive a significant marriage premium (e.g., Hersch & Stratton, 2000).

We also control for whether the individual has a second bachelor's degree (as distinct from a double major). In addition, we include mutually exclusive indicators for highest post-bachelor's degree. For those whose highest degree is a master's degree, we use two indicators to identify those with a master's degree in business administration (MBA) or in other business-related fields of accounting, financial management or business/managerial economics, and those with a master's degree in a non-business field. We include an indicator for those whose highest degree is a Ph.D. For those whose highest degree is a professional degree other than an MBA, we use three indicators to identify those whose highest degree is a medical degree, a law degree (JD/LLB), or any other professional degree. Those in the 'any other professional degree' category have degrees in fields such as pharmacy, clinical psychology, religion, and theology.

The 2003 NSCG yielded 100,402 completed interviews. We restrict our analysis to respondents who report information about their first bachelor's degree and who are employed full time, have not previously retired from any position, are not currently enrolled in a full time degree program, and have total annual earnings greater than $10,000. We also drop the small number of individuals who report 'other' as their type of employer as there is no information that identifies their type of employer.[8]

The wage regressions are estimated using the full sample as well as estimated stratifying the sample into two groups, those whose highest degree is a bachelor's degree and those who have a graduate

[5]We group into the arts/social science category some majors that are less easy to classify, including architecture, communications, home economics, journalism, library science, parks/recreation/leisure/fitness, and social work, as well as 'other' fields. There are 441 individuals in our sample (0.7%) who chose "other field not listed" as either their first or second major; eliminating them from the sample does not affect the findings. A table showing the matching of all 2003 NSCG major codes to our major categories is available upon request from the authors.

[6]Because we use total annual earnings for 2002 and tenure corresponds to current principal job, those with tenure less than 1 year will not be reporting tenure with employer that corresponds to the reported total annual earnings, but this is not a concern for those with tenure greater than 1 year with the same employer. Including an indicator variable for those with tenure less than 1 year or excluding those observations has very little effect on our regression results.

[7]Estimates of the returns to different majors could be biased if actual experience is systematically related to college major. Using the 1993 National Survey of College Graduates, which includes data on actual full time experience, we regress years of experience on age, age squared and five categories of undergraduate major. We find full time experience varies by less than 1 year for all categories except for engineering majors, who have 1.2 years more full time experience than the excluded majors of arts, humanities and social sciences. Thus, it is unlikely that our results are affected by the exclusion of actual experience.

[8]There are 2616 individuals for which no first bachelor's degree information is available. The employment and earnings restrictions reduce the sample size as follows: 16,969 are not employed in the survey week; 8213 are not full time workers; 226 list 'other' type of employer; 2803 individuals have previously retired from another position; 975 are full time students; 797 observations are missing earnings; and 978 have earnings less than $10,000.

degree. The final full sample size used for our analysis is 66,825 observations, with 36,497 whose highest degree is a bachelor's degree and with 30,328 individuals who have a graduate degree. 24% of the full sample has a double major for their first bachelor's degree. Those who achieve a graduate degree are somewhat more likely to have a double major than those whose highest degree is a bachelor's – 26% as compared to 23% having a double major.

3. Types of majors

Table 1 reports the distribution of majors for the full sample and separately by type of highest degree for individuals who have single majors in Panel A and for individuals who have double majors in Panel B. Because the order in which two majors are reported by survey respondents does not necessarily signify any hierarchy as students are required to meet the requirements for both majors, and because double majors should affect earnings due to the interaction of fields rather than additively, our regressions control for combinations of double majors. The five categories of majors we use result in 15 combinations of double majors, and the distribution of these combinations is given in Panel B of Table 1.

The largest category of single major is arts/social science majors, followed by business and science/math. As indicated in Panel B of Table 1, it is common for students to double major within college or discipline, and there are some combinations of double majors that are much less likely than other combinations. For instance, among those who have double majors, 27% have both majors within the arts/social science group, and 14% have two business majors. Across the 15 possible

Table 1
Distribution of majors[a]

Panel A. Single majors

Single major category	Full sample	Highest degree bachelor's	Graduate degree
Arts/social science	31.34%	29.94%	33.85%
Business	24.39	29.74	14.73
Education	12.09	10.27	15.38
Engineering	10.85	10.66	11.21
Science/math	21.33	19.39	24.83
Observations	50,788	28,152	22,636

Panel B. Double majors

Double major combination	Full sample	Highest degree bachelor's	Graduate degree
Two arts/social science	26.85%	24.14%	31.06%
Arts/social science and business	10.99	12.80	8.18
Arts/social science and education	9.92	9.49	10.59
Arts/social science and engineering	0.75	0.83	0.63
Arts/social science and science/math	6.09	4.96	7.85
Two business	13.54	17.19	7.90
Business and education	0.73	0.97	0.37
Business and engineering	1.30	1.71	0.67
Business and science/math	4.79	5.71	3.37
Two education	8.13	7.24	9.52
Education and engineering	0.17	0.18	0.15
Education and science/math	2.14	1.93	2.47
Two engineering	2.21	2.44	1.86
Engineering and science/math	1.86	1.83	1.90
Two science/math	10.51	8.59	13.50
Observations	16,037	8,345	7,692

[a]Percents are generated from weighted means of indicator variables for each major category.

combinations, only 39% have two majors that cross college or disciplinary category, combinations that would be more likely to lead to acquisition of widely different skills or knowledge bases. Institutional barriers, such as differing core requirements for different colleges, may discourage students from choosing two majors that cross college boundaries.

There are some differences in the pattern of majors across highest degree type. In general, individuals who have single or double majors in business are less likely to achieve a graduate degree, while single or double majors involving science/math are more likely to have a graduate degree. Single education majors are also more likely to be found in the graduate degree sample, which no doubt reflects the requirements of some states that teachers seek master's degrees. For both subsamples, two arts/social science majors is the top choice of double major combination. For individuals with just a bachelor's degree, two business majors and the combination of arts/social science and business are the next most frequently chosen.

4. Earnings regressions results

Column 1 of Table 2 reports earnings regressions for the full sample, controlling for any double major and including indicator variables for other post-bachelor's degrees. In column 2, we report regression results for the sample with highest degree bachelor's. Regression results for those with post-bachelor's degrees, controlling for type of graduate

Table 2
Ln(earnings) regressions with double major indicator[a]

Independent variable	Full sample	Highest degree bachelor's	Graduate degree
Degrees			
Double major	0.014* (0.007)	0.023** (0.010)	0.005 (0.011)
Additional BA degrees	0.023 (0.016)	0.025 (0.019)	0.019 (0.028)
MBA/master's in business field	0.388*** (0.014)		0.314*** (0.015)
Master's degree in non-business field	0.103*** (0.007)		
Doctorate	0.288*** (0.012)		0.187*** (0.013)
Medical degree	0.767*** (0.019)		0.694*** (0.020)
JD/LLB degree	0.534*** (0.021)		0.461*** (0.021)
Any other professional degree	0.201*** (0.056)		0.107* (0.056)
Employer characteristics			
Tenure	0.020*** (0.001)	0.020*** (0.002)	0.020*** (0.002)
Tenure squared × 100	−0.034*** (0.004)	−0.031*** (0.006)	−0.036*** (0.007)
Self employed	0.143*** (0.011)	0.160*** (0.014)	0.115*** (0.018)
Private employer	0.208*** (0.006)	0.225*** (0.008)	0.180*** (0.010)
South	−0.035*** (0.007)	−0.035*** (0.009)	−0.035*** (0.010)
Demographics			
Male	0.128*** (0.013)	0.151*** (0.017)	0.074*** (0.021)
Age	0.057*** (0.003)	0.056*** (0.004)	0.068*** (0.004)
Age squared × 100	−0.060*** (0.003)	−0.061*** (0.004)	−0.067*** (0.004)
Married	0.020** (0.009)	0.014 (0.013)	0.028** (0.013)
Male-married	0.206*** (0.015)	0.216*** (0.020)	0.198*** (0.024)
Hispanic	−0.167*** (0.012)	−0.198*** (0.016)	−0.100*** (0.019)
Black	−0.089*** (0.010)	−0.119*** (0.013)	−0.028* (0.015)
Asian	−0.036*** (0.011)	−0.060*** (0.016)	0.022 (0.014)
American Indian/Alaska native	−0.060* (0.035)	−0.063 (0.040)	−0.059 (0.074)
Native Hawaiian/Pacific Islander	−0.088** (0.038)	−0.080* (0.044)	−0.120* (0.072)
More than one race	−0.064*** (0.023)	−0.049* (0.029)	−0.087** (0.036)
Constant	9.158*** (0.060)	9.204*** (0.079)	8.969*** (0.092)
Observations	66,825	36,497	30,328
R^2	0.25	0.17	0.30

*Significant at 10%.
**Significant at 5%.
***Significant at 1%.
[a]Robust standard errors from weighted regression given in parentheses.

degree, are reported in column 3. Before discussing the impacts of education and major on earnings, we note that the effects of demographic and job characteristics are similar to those found throughout the literature (e.g., Brown & Corcoran, 1997).

Of primary interest is the effect of having a double major on earnings. In the full sample, the results indicate that having a double major significantly increases earnings, with earnings 1.4% higher than for those without a double major. However, as columns 2 and 3 indicate, the premium for a double major is limited to those whose highest degree is a bachelor's degree, with a premium of 2.3%. Even though the rate of double majoring is higher among those who achieve graduate degrees, having a double undergraduate major does not increase earnings controlling for level and/or field of the post-bachelor's degree. The most likely reason is that the highest degree has the primary influence on earnings. Indeed, because all studies examining returns to specific majors control only for field of highest degree or examine returns only for individuals without graduate degrees, it is unknown whether college major has an independent influence generally on earnings once highest degree field is included in the earnings regression.[9]

Also of interest in Table 2, having an additional bachelor's degree has no significant effect on earnings, but the returns to graduate degrees are substantial with MBAs and professional degrees having the greatest impact on earnings:[10] for the full sample, an MBA has a 47% return, a medical degree more than doubles one's earnings, a law degree has a 71% return, and any other professional degree has a 22% return.[11]

In Table 3, instead of the double major indicator variable, we control for choice of field or fields with indicator variables that correspond to the single major categories and double major combinations given in Table 1. These categories are mutually exclusive, and the excluded category in the regressions is a single major in arts/social science. Thus the coefficient estimates provide the percentage difference in earnings between having a particular single major or double major combination compared to having a single major in arts/social science. The regressions in Table 3 also control for the additional variables shown in Table 2, which we do not report as the results are very similar to those given in Table 2.

As shown in Table 3, majoring in engineering produces the highest return for those with a single major, with a return of about 33%. For those with a bachelor's degree only, having only one major in business has the next highest return for a single major, 17% higher than a single arts/social science major. For those who have a graduate degree and one undergraduate major, a single major in science/math yields the second highest return of 16% more than a single arts/social science major. Having a single major in education results in a penalty relative to having a single major in arts/social science of 12% for those without a graduate degree, but this penalty is reduced to 4% for those who achieve a graduate degree.

As noted in the introduction, how double majoring affects earnings is a priori unclear and may vary by the combination of majors. We find that having two majors within the same group rarely leads to higher earnings than having a single major in that group. For those with graduate degrees, there are no significant differences to such double major combinations relative to single majors. For those with a bachelor's degree as their highest degree, doubling within business or education results in additional returns: having two business majors provides returns that are 10 percentage points higher than returns to a single major in business, while those with two education majors have returns that are 5 percentage points higher than those who have a single education major. Aside from those two cases, graduating with one or two majors within the same general area yields about the same relative returns. Notably, having two engineering majors or two science/math majors has no increased return relative to having a single engineering or single science/math major.

In contrast, there are often gains to achieving double majors that are not closely related. Pairing

[9]Within specific professions, college major may increase earnings. Craft and Baker (2003) find that lawyers who major in economics as undergraduates earn 13% more than lawyers with other undergraduate majors, and economics is the only major that has a significant effect on earnings.

[10]Returns to graduate degrees appear smaller in column 3 than column 1 because the returns in column 3 are relative to the excluded category of master's degree in a non-business field.

[11]Percent returns to an indicator variable in a semi-log equation are found by subtracting one from the exponential of the coefficient of an indicator variable and multiplying by 100. For example, the percent return to a law degree is calculated as $[\exp(0.534)-1]\times 100 = 71\%$. Comparisons of returns across different indicator variables (e.g., different major categories) are based on differences in these calculated percent returns rather than on differences in the estimated coefficients.

Table 3
Ln(earnings) regressions, controlling for single major categories and double major combinations[a]

Independent variable	Full sample	Highest degree bachelor's	Graduate degree
Single major category			
Single business	0.155*** (0.011)	0.158*** (0.014)	0.125*** (0.021)
Single education	−0.088*** (0.012)	−0.123*** (0.017)	−0.037** (0.016)
Single engineering	0.285*** (0.012)	0.281*** (0.016)	0.298*** (0.017)
Single science/math	0.144*** (0.010)	0.146*** (0.014)	0.152*** (0.014)
Double major combination			
Two arts/social science	0.006 (0.015)	0.016 (0.021)	−0.001 (0.020)
Arts/social science and business	0.180*** (0.023)	0.179*** (0.028)	0.184*** (0.039)
Arts/social science and education	−0.045** (0.019)	−0.079*** (0.028)	0.008 (0.021)
Arts/social science and engineering	0.244*** (0.075)	0.169** (0.078)	0.404** (0.157)
Arts/social science and science/math	0.099*** (0.026)	0.069* (0.041)	0.138*** (0.033)
Two business	0.226*** (0.021)	0.242*** (0.024)	0.172*** (0.040)
Business and education	0.049 (0.063)	0.066 (0.072)	0.070 (0.132)
Business and engineering	0.310*** (0.056)	0.305*** (0.068)	0.312*** (0.084)
Business and science/math	0.244*** (0.030)	0.236*** (0.035)	0.253*** (0.060)
Two education	−0.045*** (0.017)	−0.064*** (0.023)	−0.015 (0.024)
Education and engineering	0.162 (0.137)	0.119 (0.189)	0.278* (0.142)
Education and science/math	0.022 (0.032)	0.034 (0.052)	0.015 (0.033)
Two engineering	0.343*** (0.034)	0.337*** (0.043)	0.362*** (0.051)
Engineering and science/math	0.341*** (0.031)	0.377*** (0.043)	0.312*** (0.040)
Two science/math	0.120*** (0.017)	0.141*** (0.024)	0.109*** (0.025)
Observations	66,825	36,497	30,328
R^2	0.27	0.20	0.32

*Significant at 10%.
**Significant at 5%.
***Significant at 1%.
[a]Robust standard errors from weighted regression given in parentheses. Each regression also includes a constant and additional control variables shown in Table 2.

one of the higher paying majors of business, engineering or science/math with either an arts/social science major or an education major has a positive impact on earnings compared to having a single major in those less lucrative fields. Likewise, individuals who pair a major in education with a major in business, engineering, or science/math do better than those with single majors in education, as indicated by marginal returns to those combinations that are not significantly different from returns to single majors in arts/social science (rather than the negative returns to a single education major). From the other perspective, joining an arts/social science major or an education major with either business, engineering, or science/math results in no positive significant gain relative to having a single major in those higher paying fields. In fact, the combination of education and science/math has a lower return than a single major in science/math for both subsamples, reflecting a higher percentage choosing an education rather than another occupation.

There are, however, some gains to students who combine two different higher paying majors. The combination of business and science/math has a higher return than either major individually, 10–16 percentage points higher than having a single business major and 11–12 percentage points higher than having a single science/math major for the two subsamples, respectively. When comparing the double combination of engineering and science/math to a single science/math major, the double major has returns that are 30 percentage points (for bachelor's degree recipients) to 20 percentage points higher (for graduate degree recipients) than returns for a single major in science/math. This combination of engineering and science/math yields returns that are 13 percentage points higher than engineering alone for the sample whose highest degree is a bachelor's degree, but there is no difference in these returns for the sample with graduate degrees. The gain from having a double major that includes an engineering field is mostly one directional,

with the gains in comparison to single majors in non-engineering fields.

The literature has found varying returns to major by gender. Our estimates (available on request) show results by gender that are largely similar to the overall results. However, there are some interesting differences in the returns to different single and double major combinations. For example, females have higher returns than males to engineering and science/math majors, for single majors and most double major combinations including those fields. Brown and Corcoran (1997) and Loury (1997) find as we do that female engineering majors receive higher relative returns than male engineering majors. Two other notable differences are that males whose highest degree is a bachelor's do not receive the reduction in the education penalty from combining a major in arts/social science with an education major, and females with two arts/social science majors earn more than single arts/social science majors but only for the bachelor's degree sample.

Our evidence that single majors and double majors in more technical fields yield higher returns than other majors is consistent with the literature on the effects of single majors on earnings. See, for example, Daymont and Andrisani (1984), Loury and Garman (1993), Eide (1994), Brown and Corcoran (1997), and Loury (1997). Using broader categories of major, Graham and Smith (2005) find that individuals with a degree in science and engineering (which includes computer science, math, life science, physical science, social science and engineering fields) have higher earnings than those without a degree in those fields. Our results show that the positive impact on earnings of having quantitative skills shown by previous studies on single majors is key to the positive return to having a double major.

We performed three sensitivity tests for our results. One, as noted earlier, the sampling procedure oversamples certain majors, including engineering and other science fields. As a result, unweighted regressions that include only an indicator for double major and no control for major field yield somewhat different results than the weighted regressions reported in Table 2. However, unweighted regression results that control for major, corresponding to Table 3, are nearly identical to results when sample weights are used. This suggests that accounting for sample composition either by weights or controls for major is necessary. Two, in the reported results, we do not control for occupation group due to the high correlation of major and occupation. Including indicator variables for occupations yields the same pattern of results as presented in Table 3, but the magnitudes of the coefficients on major fields are smaller.

Finally, ideally we would control for the selection of choosing to double major. Our attempt to use instrumental variables estimates to control for the endogeneity of the double major decision were not useful. The most likely instruments available in the dataset are parents' education and high school region. The F test for the excluded instruments never exceeded 3.0, indicating that these are exceedingly weak instruments. This is probably not surprising, as it is hard to imagine what factors would affect the decision to double major that do not also affect earnings.

Thus, as with the literature generally on returns to different majors, we are unable to distinguish between earnings increases due to signaling or increased productivity from double majors.[12] However, our results suggest that signaling is not the sole explanation. If there is no variation in marginal returns to different double major combinations, but simply having any double major increases earnings, then a signaling hypothesis is supported. We find that earnings vary across double major combinations, with some combinations conferring no value and others considerable benefit. Moreover, the fact that there are generally greater increases in returns to combinations involving majors from two different technical areas than from combinations with two similar technical majors further suggests that the variation in skills provided by specific combinations of majors may have a productivity effect rather than merely a signaling effect.

5. Additional labor market outcome measures

For some double major combinations, there appears to be little difference in earnings compared to having a single major. Nevertheless, there may be other ways in which labor market outcomes of college graduates with double majors differ from those of graduates with single majors. The 2003 NSCG allows examination of how several other work-related variables differ across single and

[12] Brown and Corcoran (1997) present a clear discussion of this issue.

Table 4
Characteristics of principal job by type of major for those with bachelor's degrees only[a]

	Job closely related to highest degree	Work-related training in past year	Recently changed job and/or employer	Very satisfied with job
Individuals with a single major	47.6%	60.8%	24.7%	45.6%
Individuals with a double major	43.3	66.4	25.2	42.0
Single major category				
Arts/social science	35.3	58.1	26.8	45.3
Business	43.7	57.1	25.4	44.7
Education	64.9	74.9	17.7	52.9
Engineering	54.5	57.8	24.7	42.3
Science/math	59.8	64.6	24.2	45.3
Double major combination				
Two arts/social science	30.8	64.8	28.1	35.8
Arts/social science and business	33.8	63.6	23.7	43.7
Arts/social science and education	45.4	71.4	21.0	41.1
Arts/social science and engineering	42.3	60.4	22.2	40.8
Arts/social science and science/math	37.1	65.7	30.0	41.1
Two business	48.5	63.3	27.8	43.8
Business and education	45.4	53.5	18.6	52.1
Business and engineering	45.7	69.5	26.1	53.5
Business and science/math	49.9	64.4	27.1	39.0
Two education	68.2	81.4	16.1	54.4
Education and engineering	27.5	64.9	5.8	41.7
Education and science/math	37.8	71.6	27.6	42.6
Two engineering	53.1	60.3	24.6	40.8
Engineering and science/math	58.6	66.6	26.2	43.1
Two science/math	52.7	66.9	23.2	42.7

[a]All values adjust for sampling weights.

double major status. We report differences in these variables only for individuals whose highest degree is a bachelor's degree in order to focus solely on the effects of undergraduate single and double major choices rather than the effects of graduate and professional degrees.

Having two majors could result in opportunities for a better match in the job market. Column 1 of Table 4 reports on how well individuals feel their highest degree matches their principal job. In comparing answers to this question across single major categories and double major combinations, there is no clear pattern. Depending on the combination, those with a double major can have a higher or lower likelihood than those with a single major that their principal job is closely related to the highest degree.[13]

Column 2 of Table 4 shows that individuals with double majors are more likely than individuals with single majors to undertake work-related training. The share of individuals with within-field double majors who pursue training is greater than the share for individuals with a single major in that field. The percent who report work-related training is also higher for people with double majors involving arts/social science, engineering, or science/math, than for people with single majors in those fields. The share of education majors who have had training is higher than most other majors. These results suggest that part of any premium to double majoring may be a return to additional training.

Column 3 in Table 4 reports on job mobility. The share of individuals who changed jobs and/or employers in the 2 year time period prior to the survey is about 25% for both single and double major recipients. College graduates with an

[13]For all columns in Tables 4 and 5, we perform multiple-comparison tests of differences in means across major categories. In the text below, we make note of differences across categories that are statistically significant based on Bonferroni-adjusted significance levels. While the tables report weighted means, the

(*footnote continued*)
multiple-comparison tests are based on unweighted means because the tests cannot be performed using probability weights.

education major once again appear to differ from individuals with most other single and double major combinations: education majors are less likely to have changed jobs or employers, while there are few differences across other major categories.

In the last column of Table 4, we examine whether there is a difference in job satisfaction across double major status. The share of individuals who are very satisfied with their principal job is smaller for those with double majors – 42% versus 46% for those with single majors. Although most double major combinations have a smaller share of respondents who are very satisfied with their principal job compared to single major categories, very few of the differences across categories are statistically significant. One exception is that a greater share of those with a single major in arts/social science are very satisfied with their principal job than those with two arts/social science majors. Also, individuals with a single education major report greater job satisfaction than individuals with other single majors and greater job satisfaction than individuals with double major combinations not involving education.

Finally, we follow up on the question raised in the previous section of whether or not those who achieve double majors have different levels of skills or abilities compared to individuals with single majors. Due to the lack of variables that could measure or proxy ability or skills in the 2003 NSCG data, we examine this issue indirectly through the Department of Labor's Occupational Information Network (O*NET) database. This database provides rating scales on various job characteristics and worker attributes by occupation. All measures are rated on a scale of 1–7, where a higher number indicates that workers report a higher level of the skill or ability is needed to perform their current job. We derive O*NET measures for a set of skills and abilities for each individual by matching their reported 2003 NSCG occupation to the standard occupational classification (SOC) given in the O*NET database.[14]

The O*NET variables we use are described in the notes to Table 5, which reports means of these variables by single major category and double major combination for those whose highest degree is a bachelor's. Mirroring the results on earnings, the field that generally has the highest abilities and skills measures is the highest paying field of engineering. On the other hand, the low-paying field of education ranks high in terms of originality, negotiation, and social perceptiveness measures. For those who have a double major within the same category, the O*NET measures are usually slightly higher than for those with a single major in a category, but the differences in unweighted means are generally not statistically significant. These results are consistent with the lack of additional earnings from having a second major within the categories of arts/social science, engineering and science/math.

Similarly, the differences in skills across other single and double major combinations is supportive of our findings on returns to other double major combinations. Having a double major pairing engineering or science/math with arts/social science yields higher mean skills ratings compared to having a single major in arts/social science for all but negotiation and social perceptiveness skills. Also, means of mathematical reasoning, originality, and critical thinking are higher for individuals with the combination of business and arts/social science than for individuals with a single arts/social science major. In contrast, mean mathematical reasoning skills are lower for individuals with double majors combining science/math with arts/social science or with education compared to single majors in science/math.

Recall that the combination of business and science/math has a higher return than either major individually. Mean skills, except for negotiation, are significantly higher for this double major than for single business majors, but are not consistently higher or lower than for single science/math majors. Likewise, the combination of engineering and science/math earns greater returns than either single major. Compared to a single engineering major, there are no significant differences in skills for the engineering and science/math combination except for critical thinking. Compared to a single major in science/math, this combination shows significantly higher means except for social perceptiveness which, interestingly, is significantly lower.

In sum, having a double major does not raise job satisfaction rates or lower job mobility, nor does it generally increase the likelihood that a person's job

[14]For more detailed information, see the Occupational Information Network (O*NET) Resource Center at http://www.onetcenter.org/content.html#cm1. The data used in this analysis are from O*NET 10.0, downloaded from http://www.onetcenter.org/database.html.

Table 5
Abilities and skills by type of major for those with bachelor's degrees only[a]

	Mathematical reasoning	Oral expression	Originality	Written expression	Critical thinking	Negotiation	Social perceptiveness
Single major category							
Arts/social science	2.23	4.05	2.93	3.41	4.16	3.18	3.96
Business	2.74	4.07	2.83	3.47	4.15	3.21	3.71
Education	2.12	4.06	3.11	3.44	4.39	3.58	4.55
Engineering	3.42	4.42	3.59	3.97	4.68	3.65	3.83
Science/math	2.53	4.28	3.09	3.75	4.61	3.23	4.25
Double major combination							
Two arts/social science	2.20	4.07	2.95	3.44	4.18	3.24	4.05
Arts/social science and business	2.60	4.10	2.90	3.47	4.12	3.30	3.80
Arts/social science and education	2.22	4.03	2.95	3.42	4.26	3.38	4.25
Arts/social science and engineering	2.88	4.10	3.10	3.52	4.33	3.18	3.61
Arts/social science and science/math	2.47	4.20	3.06	3.62	4.44	3.27	4.12
Two business	2.85	4.15	2.89	3.55	4.20	3.35	3.78
Business and education	2.38	4.05	2.77	3.50	4.12	3.15	3.98
Business and engineering	2.76	4.10	2.99	3.51	4.17	3.27	3.66
Business and science/math	2.84	4.16	3.10	3.60	4.46	3.28	3.83
Two education	2.20	4.10	3.17	3.50	4.48	3.70	4.68
Education and engineering	2.20	3.74	2.64	2.94	3.94	2.98	3.58
Education and science/math	2.17	4.09	2.93	3.46	4.35	3.39	4.34
Two engineering	3.54	4.53	3.66	4.09	4.70	3.71	3.89
Engineering and science/math	3.49	4.52	3.71	4.05	4.94	3.74	3.98
Two science/math	2.70	4.27	3.15	3.73	4.62	3.34	4.09

[a]The O*NET variables above are defined as follows: mathematical reasoning is the ability to choose the right mathematical methods or formulas to solve a problem; oral expression is the ability to communicate information and ideas in speaking; originality measures the ability to come up with unusual or clever ideas about a given topic/situation or about how to solve a problem; written expression is the ability to communicate information and ideas in writing; critical thinking is using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions or approaches to problems; negotiation measures the skills of bringing others together and trying to reconcile differences; and social perceptiveness measures awareness of others' reactions and understanding why they react as they do. All values adjust for sampling weights.

is closely related to the person's highest degree. There is a pattern of differences in skills and abilities that often parallels the differences in returns to majors, but this pattern does not resolve the issue of whether the added returns to double majoring arise from selection of those with greater ability or arise because double majoring enhances skills. If selection is the key determinant of double majoring, then we would expect consistently higher skill levels for jobs held by all double majors compared to single majors. However, the skill requirements of jobs, as reflected in O*NET ratings, appear to vary more by the type of major, independent of whether the major is part of a double major or not. In combination with the finding that the return to double majoring varies by combinations of majors, with the largest incremental returns to pairs of disparate majors that broaden skills, it is unlikely that the double major premium derives solely from selection.

6. Conclusions

Using data from the 2003 NSCG, we show that having a double major yields a statistically significant benefit of 2.3% to earnings of individuals whose highest degree is a bachelor's degree. In contrast, simply achieving any double major has no effect on earnings among those who earn a graduate degree. Our results indicate that not all double major combinations are equal. Most of the gains from having a double major come from choosing fields across two different major categories. As has been found for single majors, marginal returns are highest for double majors involving more quantitative or technical fields. Gains are especially high for those individuals with double majors that combine a business, engineering, or science/math major with a major from a less technical field, but these gains appear to be in one direction. That is, there are no positive, significant differences in returns between a

single major in business, science/math or engineering and a double major pairing one of these majors with a major in arts/social science or education. Substantial gains do exist for students with double majors that combine the different skills from business and science/math majors. For students who have a major in the highest paying field of engineering, there is little benefit to having a second major, except perhaps having a second major in science/math if one does not earn a graduate degree.

University administrators and advisors are considering limiting the number of majors students can undertake or discouraging students from pursuing double majors. Our analysis has shown that on average it does not take students longer to complete their bachelor's degree when they pursue double majors. There is also no evidence that having a double major lowers earnings, and there is strong evidence that some combinations lead to higher returns than single majors. Specifically, encouraging arts/social science and education students to pursue additional majors that raise or demonstrate their technical skills, such as business or science/math, can lead to significantly higher returns to their undergraduate degrees. Higher education policymakers should consider these gains in their discussion of whether or not to raise barriers for students trying to pursue double majors.

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