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The Impact of Dual Majors on Income based on the American Community Survey

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Abstract

Although the cost of higher education in the United States has risen in the past time, it is still a high-return investment. This article uses the latest American Community Survey (ACS) data on college majors to analyze the dual majors for undergraduate and he impact of income. The research results show that dual majors have advantages when compared with a single low-income major, but there is no advantage when compared with a single high-income major; therefore, choose a second major that is more profitable than the first major. Having a dual major with a lower market value will damage future economic prospects. The income of a college graduate with a dual major will be between these two separate majors. Therefore, in an economic sense, it may be preferable to study by switching to a high-income major than to study an additional major. Of course, students choosing a dual major is not only to increase wages and income but also for personal interest in interdisciplinary learning.

Keywords: *Dual majors, Salary income, Income premium*

1. Introduction

Although the cost of higher education in the United States has risen rapidly in the past few decades, many studies have shown that higher education is still a high-return investment [1]. In the United States, because about two-thirds of high school graduates Students and their families no longer only pay attention to whether they can go to university, but pay more attention to issues such as where to go to university and what major to study. Based on research findings of American universities, university quality [2][3] and Undergraduate majors [4][5] are the primary factors affecting the future development of this graduate. The wage gap between different majors has even narrowed the wage gap caused by the quality of different institutions. [6] Generally, business, science/ Undergraduates majoring in mathematics and engineering have obvious income advantages, while other professional fields such as humanities, arts, education, history, etc. have lower incomes. To increase their competitive advantage in the labor market or satisfy diversified learning interests, double Majors have gradually become a popular choice for many undergraduates. In the United States, 10%~23% of undergraduates choose to study dual majors. Although there have been a series of studies in the academic community to test the income difference between different undergraduate majors, [7] for double majors The research is still very limited. Only a few studies have found that dual-professional graduates earn 1% to 3% higher salaries than single-

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professional graduates, and this difference is most significant among those with a bachelor's degree as the highest degree [8][9].

Based on existing research, this article has made the following innovations. First, this article uses a large unused sample of data American Community Survey (ACS) to examine the income premium of dual majors. The data is from the United States The annual micro survey was initiated by the Census Bureau in 2000. It aims to provide more timely data supplements for the census once every ten years. The sample size is about 3 million per year, covering 1% of the population of the United States. More importantly, the data has been added to the undergraduate majors since 2009. There is no previous study using this data to estimate the impact of dual majors. ACS has a large sample size, which provides the possibility to test the differences between dual majors in different ages, genders, and race/ethnic groups. At the same time, the large sample size of ACS allows researchers to investigate the income gap between very specific professional fields, which was impossible to achieve in the previous dual professional studies that used college graduate surveys (the sample size is usually 10,000 to 20,000 people) as the sample. of. For example, due to the limitation of sample size, researchers have to merge specific majors into a wide range of disciplines (such as liberal arts, science, engineering, business, etc.). But with ACS, all 173 specific professions can be included in the model. It is very important to control specific majors rather than broad subject areas, because, within the same broad subject area, the economic returns between different majors may vary greatly. For example, in business, actuarial science, accounting, and finance tend to have higher or even higher wages than other majors. Another example is in the field of engineering, where the income level of petroleum engineering, chemical engineering, and electronic engineering is significantly higher than that of other engineering majors.

Second, when measuring the income premium of dual majors, it is very important to define a benchmark for reference. For this reason, this article uses the average economic return rate of each major to define the two majors in the dual majors as high-income majors and low-income majors respectively, to compare graduates with dual majors with only a single high (low) income major. The income difference between the graduates, for example, for a graduate with a dual major in mathematics/English, since the average economic return rate of the math major is higher than that of the English major, the mathematics major is defined as the student's high-income major, and the English major is defined as the student's low-income major. This article is interested in: What is the income premium for graduates of dual majors compared with graduates of single majors in high-income majors (mathematics) or low-income majors (English)? This article finds that using different reference benchmarks, the income premiums of the two majors are quite different. Compared with the income of students with only one high-income major, double major students will experience obvious economic losses. This article also found that the income premium of dual majors is related to the order of majors reported by respondents. When the high-income major is the reported first major, compared with students whose high-income major is the second major, the income premium brought by double majors is higher.

Finally, by combining majors with different economic return levels, this article explores the economic return model of dual majors. Based on the ranking of the economic rate of return of each major, all majors are divided into three major groups of a high, medium, and low income, and then the wage income differences between different professional combinations are compared. This method can generate a clear gradient on the effects of dual majors, while fully taking into account the combination of different majors. The results of this article can inspire students who are facing the choice of dual majors, and at the same time

provide useful suggestions for colleges and universities to correctly guide students in professional planning.

2. Double major

Although researchers have admitted that a considerable proportion of American college students have dual majors, their estimates of specific numbers vary due to different data. The data commonly used by researchers includes two important surveys of American college graduates: Baccalaureate and Beyond (B&B) and National Survey of College Graduates (NSCG).

B&B is a nationally representative follow-up survey of college graduates. While conducting a student survey, the data collected the transcripts of the interviewed students, which contains the professional information of the students. This official statistics, not self-reported information, provides accurate data on the proportion of graduates with dual majors. Overall, in the 2008-2009 academic year, approximately 10.2% of college graduates obtained double majors. In addition, approximately 21.6% of university graduates have completed the requirements for minors outside of their professional field of study.

In another nationally representative survey of NSCG, regarding the first undergraduate degree of university graduates, the survey question is: "What are your major and second major (if any)?" Weighted according to NSCG 2010 after the sample data, 21.7% of college graduates have a second major, which is better than B.

Whether it is about 10% shown by B&B or more than 20% shown by NSCG, dual majors are undoubtedly an important choice for many college students, although its actual benefits are still unclear. On the one hand, college students hope to gain an advantage in the labor market by having an additional major. In an online survey of nine elite universities in the United States, T. Pitt and SA Tepper found that more than 68% of respondents claimed that they hope to increase competition in the labor market through dual major's force. Based on a student survey conducted by Northwestern University in the United States, B. Zafar also found that students choosing dual majors are a strategy to enhance their prospects in the labor market [10]. On the other hand, the unique perspective cultivated through dual-professional study may also become a student's advantage when applying for graduate school. However, dual majors also have potentially negative effects. The bi-professional study may squeeze students' time to participate in meaningful extracurricular activities, and may also limit the breadth of students' elective courses, thereby limiting students' opportunities for all-around development. However, the research of Pete and Teppel found that dual-professional learning did not affect students' participation in extracurricular activities, club leadership, volunteer activities, and cooperation with teachers to conduct research. But because their research only uses nine elite universities as samples, their conclusions are not suitable for generalization to all universities.

The impact of majors is multifaceted, but existing studies only focus on the economic effects of dual majors. In the United States, A.F. Rossi and J. Hersch used NSCG's 2003 data to provide the earliest estimates of the double-professional income premium. They found that for all graduates with a bachelor's degree or above, students with double majors earn 1.4% higher than those with a single major, and this income advantage is even higher in the group of graduates with the highest degree of undergraduate education, reaching 2.3%. However, in the group of graduates with a bachelor's degree or above, dual majors do not have a significant income advantage. Also based on NSCG 2003 data, S. W. Hemelt found that the

salary premium for dual majors was 3.2%. Neither of these two studies found significant differences between men and women.

Many researchers have also found that the impact of dual majors on income is also different due to different combinations of majors. Rossi and Hedge found that compared with double majors in the same discipline, interdisciplinary double majors will bring greater economic benefits, even though the vast majority of double major combinations are in the same subject area. Furthermore, if a high-income major (such as business, engineering, science, or mathematics) is combined with a lower-income major (such as art, social science, or education), there will be a 7 %~50% income premium, but the difference is not obvious compared with just a high-income major [11]. Using the latest NSCG 2010 data, Rossi and Hatch have similar findings. The results show that, compared to single liberal arts major, having a dual major in business or STEM fields can significantly increase income levels. However, compared with a single business major or STEM major, having a dual major in liberal arts will have a negative impact on income. The combination of the two STEM fields and business majors will make graduates earn more than any major in these two fields. Hemet added the dummy variable of whether there are dual majors in the income model to interact with the graduate's first major. The results show that the first major is a graduate of physical sciences, biology/life sciences, computer science, or mathematics. Double majors get a higher income premium. In addition to the income premium, the researchers also examined the impact of dual majors on the quality of employment matching and job satisfaction but did not find a significant difference between dual major graduates and single major graduates.

3. Data and methods

The data used in this article comes from an ACS survey. ACS is currently the most important source of data being implemented in the United States that can reflect changes in the national demographic structure, labour market, and real estate market. Since 2005, about 3 million respondents have participated in the ACS survey each year, accounting for about 1% of the total population of the United States. Since 2009, ACS has added relevant information about the undergraduate major of the respondent and asked about the specific major of the undergraduate degree that the respondent has obtained. Among them, the first two undergraduate majors reported by the interviewees were coded into 173 standard professional fields. It should be noted that this issue does not distinguish between dual majors and dual degrees. Therefore, this article uses dual majors to broadly refer to graduates who have obtained academic certification in two different professional fields, regardless of whether they have obtained two degrees. Although this limitation may bias the estimation of the actual effect of the two majors in this article, the deviation is not large.

In 2009, a total of 18.69 million respondents completed the ACS survey. This article further restricts the sample to people who meet the following criteria: (1) born in the United States; (2) between 25 and 59 years old; (3) the highest degree is a bachelor degree; (4) not enrolled in school at the time of the interview; (5) Being in employment at the time of the interview. The sample number of college graduates meeting the above criteria is 1,162,284. This sample will be used to analyze the relationship between dual majors and unemployment probability. It is necessary to exclude respondents who were born in foreign countries from the sample because foreign education experience has a lower income premium in the US labor market [12]. Although the relationship between dual majors and undergraduate education experience is also a question worthy of research, this article does not include respondents who have obtained a postgraduate degree, because the potential income bonus

effect of dual majors may be affected seriously diluted. When income is used as the dependent variable, this article further restricts the sample to those who are currently employed and have reported legal wage income-a total of 1,063,648 college graduates (hereinafter referred to as the income sample). It can be seen that ACS provides a large sample size that is unmatched by other graduate surveys. Using the same limitation standards, the sample size of ACS is about 50 times that of NSCG.

Table 1. Descriptive statistics of the main variables

Variable	Average value	Standard deviation
Unemployment status (1=unemployment; 0=other)	0.041	
Salary income (USD)	70321	64740
Working hours per week	42.196	10.487
Double major (1=double major; 0=single major)	0.098	
Female (1=female; 0=male)	0.495	
Age	41.015	10.057
White person	0.833	
Black person	0.077	
Hispanic	0.051	
Indians and Alaska Natives	0.004	
Asians and Pacific Islanders	0.021	
Other races	0.014	
Sample size	1063618	

Note: The sample size of data used to describe unemployment is 1,162,284, and the sample size of data used to describe other numbers is 1,063,648.

[Table 1] presents descriptive statistics based on the main variables of the income sample. It should be noted that this article uses weighting to make the sample representative of college graduates across the country. Wage income and unemployment are the two dependent variables of this article. Unemployment is a binary variable, which means that a person has a willingness to find employment in the job market but does not have a job. In 2009, the unemployment rate of college graduates was about 4.1%, which was higher than the 2%~2.5% before the economic crisis in 2008. Calculated in constant US dollars in 2014, the average income of working college graduates is approximately US$70,000, and the average weekly working time is 42 hours. In the income sample, about 9.8% of college graduates reported that they have dual majors.

This article uses a multiple linear regression model to estimate the impact of dual majors on graduates' income. As shown in model (1), the dependent variable y is the logarithm of salary income, and D represents whether to obtain a double major. Control variables include the logarithm of hours worked per week (H), the demographic variable X (gender, age, square of age, race/ethnicity), and the ACS survey year (Year) dummy variable. More importantly, 173 professional dummy variables (Majorj) are added to the model to provide a benchmark for comparison between the two majors.

$$(Y_i) = \alpha_0 + \alpha_1 D_i + \alpha_2 \, ln(H_i) + \alpha_3 X_i + Ma_j + Y_{ear_i} + Y_{ear_i} + u_i \; (1)$$

Existing research on the income premium of dual majors usually compares dual majors with single majors. When no major category control is added to the model, all double major students and single major students are compared. This method is likely to overestimate the salary premium of dual majors because many high-income majors (such as economics and business administration) are popular choices for students when choosing a second major. Compared with the professional structure of a single major, double majors, there are more graduates of high-income majors in the student group, and the observed income premium

brought by dual majors may only be derived from the composition of the group, rather than the impact of dual majors' learning experience. In other words, some form of professional dummy variables must be controlled in the model to provide a benchmark for comparison between dual majors and single majors.

Some studies add whether to obtain the interaction terms of dual majors and first majors in the model to estimate the heterogeneity of dual majors' premium among students of different first majors. The assumption behind this approach is that the first major reported by the student is its initial major, which has a major impact on their income. Therefore, the researchers are concerned about whether the second major will have a bonus effect on income. However, the questionnaire usually asks respondents to list all their undergraduate majors. The order in which students report majors may not be based on the chronological order of their chosen majors. They may also be randomly selected to fill in the order, or selected according to their perceived major importance. Fill in the order. Therefore, focusing only on the income bonus of the dual majors relative to the first major reported may not have economic meaning, which is ignored in the existing literature on the economic returns of the dual majors.

Therefore, this article constructs different forms of professional dummy variables (Majorj) to examine the income premium of dual majors under different benchmarks. First of all, according to the existing literature, the dummy variable of the first major is added to the income model, and it is estimated that compared with a single major student with the same major, the income premium of having one more major is estimated; secondly, the second major is added to the income model. Professional dummy variables are estimated to have one more professional income premium compared to a single major student with the same major.

This article proposes a more meaningful way to define a reference group: What is the salary premium for a dual major relative to a high-income major or a low-income major? First, this paper uses a sample of graduates of a single major to estimate the income model: the dependent variable is the logarithm of income. The independent variables include the logarithm of the number of hours worked per week, gender, age, square of age, ACS survey year, race/ethnicity, and a total of 173 college majors. This article retains the regression coefficients of all 173 professions and defines them as professional profitability. The higher the profitability of a profession, the higher the average income of graduates of that profession. For example, the regression coefficient of the business management major is 0.141, indicating that the average income of business management graduates is 15.1% higher than that of the history major (reference group); on the contrary, the coefficient of the social work major is -0.106, indicating that it is relative to the history major (Reference group), the average income of social work graduates is 10.1% lower. Therefore, the profitability of business management majors is higher than that of social work majors. Secondly, the two majors of dual majors are sorted according to their profitability. The major with higher profitability is defined as a high-income major, and the major with lower profitability is defined as a low-income major. If a graduate holds both business management and social work majors, his high-income major is business management, and his low-income major is social work. Finally, this article adds high (low) income majors to the model in the form of dummy variables to compare the income gap between double major graduates and single major graduates of high (low) income majors. Since the impact of the first major on income may be more important than the second major, this article further distinguishes two situations where the high-income major is the first major reported by the respondent and the high-income major is the second major reported by the respondent.

4. Data analysis and results

4.1. The effect of double majors compared to the first major and the second major

Table 2. Estimated income premium for dual majors (all university graduates)

Age group (sample size)	1	2	3	4	5	6
	First major	Second major	High-income major is the first major		High-income major is the second major	
			High-income major	Low-income major	High-income major	Low-income major
Mix	0.0121***	0.0069*	-0.0471***	0.0760***	-0.0559***	0.0667***
(1063648.00)	(4.41)	(2.46)	(-12.33)	(19.53)	(-14.74)	(17.74)
25~29	0.0313***	0.0254***	-0.0229**	0.1030***	-0.0463***	0.0822***
(161675.00)	(5.35)	(4.25)	(-2.80)	(12.24)	(-5.92)	(10.44)
30~34	0.0242***	0.0208**	-0.0291***	0.0972***	-0.0540***	0.0777***
(151090.00)	(3.80)	(3.22)	(-3.32)	(10.81)	(-6.19)	(8.92)
35~39	0.01	0.00	-0.0471***	0.0891***	-0.0768***	0.0573***
(141475.00)	(0.86)	(0.52)	(-4.70)	(8.64)	(-7.78)	(5.82)
40~44	0.01	0.01	-0.0507***	0.0754***	-0.0549***	0.0745***
(153681.00)	(1.79)	(1.13)	(-4.68)	(6.86)	(-5.42)	(7.35)
45~49	0.01	0.00	-0.0653***	0.0709***	-0.0547***	0.0767***
(157224.00)	(1.07)	(0.60)	(-5.95)	(6.32)	(-5.06)	(7.09)
50~54	(0.00)	(0.01)	-0.0628***	0.0727***	-0.0823***	0.0566***
(159173.00)	(-0.07)	(-0.92)	(-5.72)	(6.55)	(-6.57)	(4.62)
55~59	(0.01)	-0.0234**	-0.0813***	0.0453***	-0.0856***	0.0545***
(139330.00)	(-1.22)	(-2.77)	(-6.71)	(3.73)	(-7.63)	(4.90)

Note: The semi-logarithmic linear model is used here. The model controls the number of working hours per week (logarithm), gender, age, a square of age, dummy variables for ACS survey year, dummy variables for a race, and dummy variables for a total of 173 university majors. The t value is in parentheses. $* p < 0.05$, $** p < 0.01$, $*** 0.001$.

The first and second columns of [Table 2] respectively show the income premium of the double major compared with the first major and the second major. In the mixed sample (25 to 59 years old), having one more major would generate a 1.2% income premium. This estimate is slightly smaller than the 2.3% revenue premium derived by Rossi and Hatch. Taking the second major single major students as the reference group, having one more major can bring a 0.7% income premium. It shows that regardless of whether the first major or the second major is the reference group, the double major will only generate a small income premium. The income premium compared to the first major (2.3%) is higher than the income premium compared to the second major (0.7%), which seems to imply that respondents tend to report high-income majors as the second major. If the interviewee does choose the reporting order according to the professional income ability when reporting the major, this article will not need to create a new comparative reference group according to the income ability. Therefore, this article further compares the profitability gap between the first major and the second major reported by the dual major students to test whether the respondent determines the order of majors according to a specific pattern. As shown in [Figure 1], the mean value of the profitability gap distribution between the two majors is 0.0042, the standard deviation is 0.1624, and the skewness is 0.0067 (p=0.36), indicating that although individuals are more inclined to report high-income majors as the second major. But this is not a statistically significant trend. In addition, this article also uses the profitability of two majors to predict the income of dual majors and finds that the influence coefficient of the first major (0.703) is statistically significantly higher than that of the second major (0.618), indicating that in the double majors Among the determinants of graduate income, the first major is more important

than the second major. In other words, when looking at the income premium of dual majors, it is necessary to consider the order of majors.

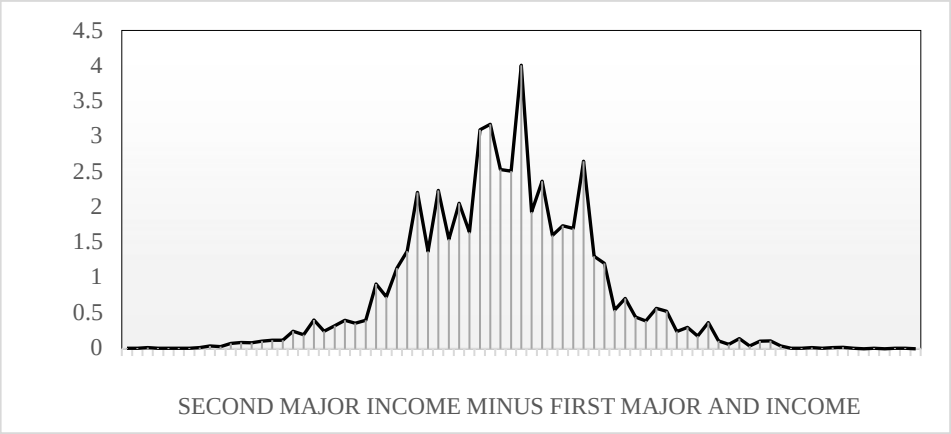

Figure 1. The income gap between the first major and the second major

4.2. The effect of dual majors in comparison with high-income majors and low-income majors

Columns 3 to 6 of [Table 2] show the income premium of dual majors compared with high-income majors and low-income majors. When the high-income major is the first major, the average income of two majors is 4.6% lower than that of only one high-income major (the coefficient in the third column is -0.0471), and 7.9% higher than that of only one low-income major (in the fourth the coefficient in the column is 0.0760). Conversely, when the high-income major is reported as the second major, the average income of the double major is 5.4% lower than that of only one high-income major (the coefficient in column 5 is -0.0559) and is 6.9% higher than that of only one low-income major % (The coefficient in column 6 is 0.0667). On average, the income of two majors is significantly lower than that of only one high-income major by about 5% but is significantly higher than that of only one low-income major by 7% to 8%, regardless of the order of the two majors. Comparing the third and fifth columns, the fourth and sixth columns, we can find that dual-professional students with high-income majors as the first major earn slightly higher incomes. After testing, this difference is statistically significant.

4.3. Differences in the income premium of dual majors among different age groups

The remainder of [Table 2] presents the wage premium levels of dual majors in different age groups. This paper divides the mixed sample into different groups according to the 5-year age interval and conducts regression analysis for each group separately. Since the profitability ranking of professional fields may vary among different age groups, this article re-estimates the profitability of each professional within each age group when determining low-income and high-income majors. The results show that for older groups, the effect of dual majors is weaker. For example, after controlling for the first major, the average effect of double majors was 1.2%, but this effect only reached a statistically significant level in the 25-29 year old and 30-34 year old groups, and the effect values were respectively They are 3.2% (coefficient of 0.0313) and 2.5% (coefficient of 0.0242). For other age groups, this effect is much smaller and not significant. If the second major is used as a benchmark, the above model remains

unchanged. Having dual majors will bring an income premium of 2.6% (coefficient of 0.0254) for the 25- 29year old group, and 2.1% (coefficient of 0.0208) income premium for the 30-34year old group, but this effect is in other areas Become very small in the age group and not significant.

When using high-income majors or low-income majors as benchmarks, a similar pattern will appear. In the mixed sample, for those who report high-income majors as the first major, the average income loss for double majors is 4.6% based on the high-income majors. The results in the third column show that in the 25-29year old group, this income loss was 2.3% (coefficient of -0.0229), and then climbed to 7.8% of the 55 to 59year old group (coefficient of -0.0813). Based on low-income majors, as shown in column 4, the income premium is 10.8% for the 25- 29year old group (coefficient is 0.103), and then gradually but not uniformly reduced to the 55- 59year old group 4.6% (coefficient of 0.0453). This result is similar to the analysis result of reporting high-income majors as the second major.

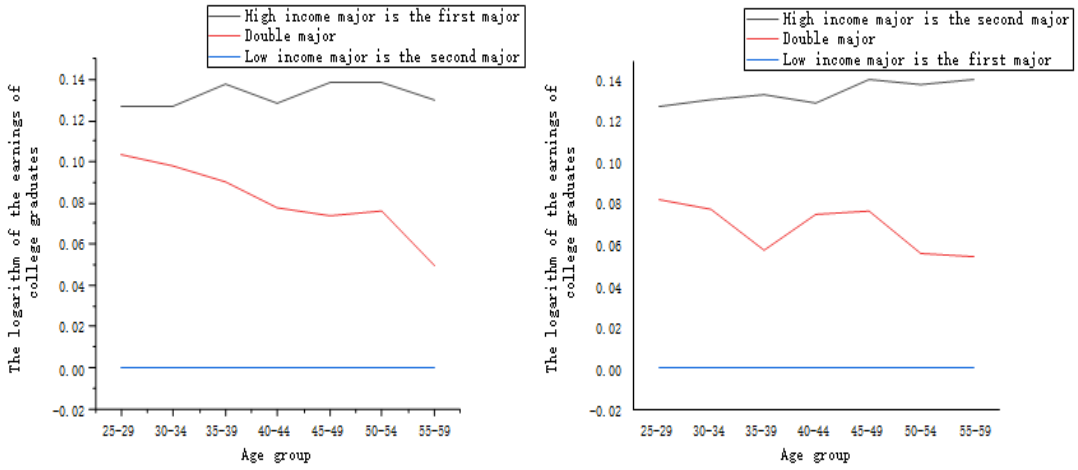

Figure 2. Estimated income of high-income majors, low-income majors, and dual majors

[Figure 2] presents the analysis results of reporting high-income majors as the first major and the second major. This article analyzes the income gap between high-income majors and low-income majors (standardized to 0) for each age group. The gap between the two groups is very stable, between the point-to-point value of about 0.13 to 0.14. In all age groups, the expected income of double major graduates falls between the low-income majors and the high-income majors, regardless of the order of majors they report. With age, the expected income will gradually approach low-income majors.

4.4. Differences in the income premium of dual majors between different genders

To test whether the effects of dual majors differ from gender to gender, this article estimates separately for men and women. For male college students, as shown in [Table 3], regardless of whether the first major or the second major is the baseline, the double majors have an income premium of about 0.8%. These estimates are not statistically significant or have just reached the signature requirement. If compared with graduates of a single high-income major, a dual professional male who reports a high-income major as the first major will have a 4.2% lower income (coefficient of -0.0427). However, if compared with those

graduates from a single low-income major, the double-professional men who report a high-income major as their first major earn about 9.1% higher (coefficient of 0.0869). For those who report high-income majors as second majors, the income of dual majors will be slightly lower, 6.5% lower than that of high-income majors (coefficient of -0.0670), but 5.8% higher than those of low-income majors (coefficient of 0.0566)). In fact, by comparing high-income majors as the first major and the second major, it can be found that the income of the former is significantly higher than that of the latter.

Table 3. Double professional income premium (male graduates)

Age group (sample size)	1	2	3	4	5	6
	First major	Second major	High- income major is the first major		High- income major is the second major	
			High- income major	Low-incomemajor	High-incomemajor	Low-incomemajor
Mix (530488.00)	0.0081* (1.99)	0.01 (1.94)	-0.0427*** (-7.69)	0.0869*** (15.35)	-0.0670*** (-11.48)	0.0566*** (9.86)
25~29 (74604.00)	0.0198* (2.18)	0.0270** (2.90)	(0.02) (-1.95)	0.1140*** (9.05)	-0.0612*** (-4.76)	0.0644*** (5.00)
30~34 (74100.00)	0.0296** (3.18)	0.0370*** (3.87)	(0.01) (-1.08)	0.123*** (9.18)	-0.0513*** (-4.02)	0.0763*** (5.96)
35~39 (72064.00)	0.00 0.00	0.00 (0.19)	-0.0470*** (-3.31)	0.0968*** (6.58)	-0.0895*** (-5.98)	0.0464** (3.13)
40~44 (78345.00)	0.02 (1.58)	0.02 (1.58)	-0.0301* (-2.11)	0.1010*** (7.01)	-0.0648*** (-4.31)	0.0624*** (4.15)
45~49 (79404.00)	0.01 (0.95)	0.01 (1.00)	-0.0507** (-3.13)	0.0905*** (5.55)	-0.0647*** (-4.01)	0.0723*** (4.51)
50~54 (79866.00)	(0.00) (-0.27)	(0.01) (-0.74)	-0.0643*** (-4.10)	0.0835*** (5.24)	-0.0986*** (-4.69)	0.0524** (2.61)
55~59 (72105.00)	(0.02) (-1.51)	-0.0282* (-2.30)	-0.0660*** (-3.76)	0.0725*** (4.12)	-0.1220*** (-7.67)	0.03 (1.79)

Note: The semi-logarithmic linear model is used here. The model controls the number of working hours per week (logarithm), gender, age, a square of age, dummy variables for ACS survey year, dummy variables for a race, and dummy variables for a total of 173 university majors. The t value is in parentheses. $* p < 0.05$， $** p < 0.01$， $*** 0.001$

In the overall sample, the impact of dual majors for men will also decrease with age. Although for 25-29 years old and 30-34 years old, this effect is around 2% to 4% regardless of whether the first major or the second major is controlled, in other age groups, this effect is not significant anymore. In all age groups, when a high-income major and a low-income major are combined, the expected income is lower than the high-income major but higher than the low-income major. However, for the 25-34-year-old group of young people aged 25 to 34 who regard high-income majors as their first majors, there is no significant income loss in double majors compared with high-income majors. In addition, comparing the estimated values between the third and fifth columns, and the fourth and sixth columns, it can be seen that these differences have reached a statistically significant level, except for the 45 to 54-year-old group.

The results in [Table 4] reveal two notable differences regarding women. First, when the first major is controlled, the effect of the double major is higher than that after the second major is controlled. This shows that women are more likely to report high-income majors as their second major. The ranking analysis also shows that 52.8% of women will report high-income majors as their second major, while only 51.6% of men will do so. Second, there is no significant income gap between women who report high-income majors as their primary and

secondary majors. Combining the results in [Table 2] and [Table 3], it can be seen that the income premium for reporting high-income majors as the first major mainly appears on men.

Table 4. Estimated income premium for dual majors (female graduates)

Age group (sample size)	1	2	3	4	5	6
	First major	Second major	High- income major is the first major		High- income major is the second major	
			High- income major	Low- income major	High- income major	Low- income major
Mix (533160.00)	0.0156*** (4.23)	0.01 (1.48)	-0.0489*** (-9.29)	0.0698*** (13.13)	-0.0508*** (-10.33)	0.0727*** (14.82)
25~29 (87071.00)	0.0397*** (5.22)	0.0241** (3.12)	-0.0300** (-2.76)	0.0939*** (8.38)	-0.0393*** (-3.97)	0.1030*** (10.40)
30~34 (76990.00)	0.0205* (2.36)	0.01 (1.10)	-0.0529*** (-4.38)	0.0799*** (6.48)	-0.0531*** (-4.52)	0.0883*** (7.53)
35~39 (69411.00)	0.02 (1.60)	0.01 (1.04)	-0.0438** (-3.21)	0.0933*** (6.72)	-0.0709*** (-5.30)	0.0737*** (5.47)
40~44 (75336.00)	0.01 (1.26)	0.00 (0.35)	-0.0666*** (-4.28)	0.0647*** (4.06)	-0.0512*** (-3.61)	0.0888*** (6.22)
45~49 (77820.00)	0.01 (0.51)	(0.00) (-0.04)	-0.0720*** (-5.06)	0.0647*** (4.41)	-0.0619*** (-4.15)	0.0807*** (5.26)
50~54 (79307.00)	0.00 (0.16)	(0.00) (-0.44)	-0.0740*** (-5.10)	0.0613*** (4.17)	-0.0652*** (-4.53)	0.0715*** (4.97)
55~59 (67225.00)	0.00 (0.02)	(0.02) (-1.46)	-0.0825*** (-5.11)	0.0387* (2.38)	-0.0656*** (-4.11)	0.0733*** (4.57)

Note: The semi-logarithmic linear model is used here. The model controls the number of working hours per week (logarithm), gender, age, a square of age, dummy variables for ACS survey year, dummy variables for a race, and dummy variables for a total of 173 university majors. The t value is in parentheses. $* p < 0.05$, $** p < 0.01$, $*** 0.001$

4.5. The impact of the combination of two majors on the income premium

Through the above analysis, it is found that, on average, the income of dual majors is between a single high-income major and a single low-income major. When the high-income major is the first major, the income of dual majors is closer to that of a single high-income major. A natural question is: Is the combination of two majors important? In other words, to what extent can this "average effect" be applied to the combination of different majors? Previous researchers have based on a broad field of study Tested professional combination methods, such as business, science/mathematics, engineering, social sciences, humanities, and arts, etc. This kind of analysis based on the subject area group has the advantages of clear definition and intuition. However, within these broad subject areas, income premiums still vary greatly. In the following analysis, this article adopts a different approach-creating a professional portfolio based on professional profitability. Although this method risks being too simplistic, it provides a unique measure of professional heterogeneity.

This article uses the profitability rankings of these 173 majors to create three groups of roughly the same size①: those with a professional ranking of 1 to 62 are classified as high-income groups, and those with a professional ranking of 63-110 are middle-income groups. The low-income group ranks 111-173 in majors. The three groups contain 33.03%, 33.63%, and 33.34% of majors respectively. Unsurprisingly, the high-income group includes many majors in business, mathematics/science, engineering, and economics, the middle-income group includes social sciences and communication sciences, and the low-income group

includes education, humanities, arts, and languages. Based on these groupings, this article created a total of 9 dual-professional combinations: high-high, high-medium, high-low, medium-high, medium-medium, medium-low, low-high, low-medium, and low- Low. The appendix lists the most common double professional combinations in each group.

[Table 5] shows the distribution of these combinations, and "total" shows the marginal distribution of the first specialty and the second specialty. Among the graduates of all single majors, the proportion of each group (high, medium, and low) is about one-third. The marginal distribution of the first major and the second major clearly shows that the proportion of low-income majors in the two majors is too large - 36% in the first major and the second major. The numbers in parentheses are calculated by multiplying the two corresponding marginal distributions. In other words, they represent the expected proportion that the first major and the second major are randomly combined. By comparing the actual proportion of each double major combination with the expected proportion under the random combination, it is found that graduates prefer the combination of "high-high" and "low-low", and less choose the combination of "high-low" or "low-high". For example, among all double specialty combinations, the "high-high" combination accounts for 14.17%, which is 5% higher than the expected proportion under random combination? According to the chi-square test one by one, the four grids have the largest component in all chi-square tests. The imbalance in the combination of two majors may reflect the differences in skills required by different professional learning fields.

Table 5. Double majors composed of the first major and the second major (%)

Double major		Second major			
		High	Middle	Low	Total
First major	High	14.17 (9.08)	9.67 (9.11)	4.66 (10.31)	28.50
	Middle	12.76 (11.17)	10.52 (11.21)	11.80 (12.70)	35.08
	Low	4.93 (11.60)	11.77 11.64	19.73 (13.18)	36.42
	Total	31.85	31.96	36.19	100.00

Note: The marginal distributions of the first and second majors are shown in the "total" rows and columns. The numbers in parentheses are calculated by multiplying two corresponding marginal distributions, which is the assumed proportion when the first and second majors are randomly combined.

Table 6. Income comparison between a single major and dual majors (in 2014 constant U.S. dollars)

Double major		Second major		
		High（85503）	Middle（71901）	Low（53285）
First major	High（85503）	99053	82691	74912
	Middle（71901）	78965	67850	60894
	Low（53285）	67235	59189	50717

For each combination of dual majors in [Table 5], this article compares the difference between them and the expected income of each major that constitutes the combination. [Table 6] provides income data used to compare single major and dual majors. On average, if a college graduate has a single high-income, middle-income, and low-income major, the income is 85503 US dollars, 71901 US dollars, and 53285 US dollars. This article also calculates the average income of each dual-professional combination. For example, on

average, graduates of the "high-middle" dual major combination can earn US$82,691, while the "middle-high" dual major combination can only earn US$78,965. The results in [Table 7] show three general patterns, which are consistent with the regression analysis results in the previous table. First of all, generally speaking, dual majors earn more than a single low-income major, but less than a single high-income major. For example, on average, the income of a "high-medium" or "medium-high" combination is higher than those of a single middle-income major ($71,901) but lower than a single high-income major ($85,503). In addition, the first major reported by the interviewees has greater influence than the second major. For example, the "high-medium", "high-low" and "medium-low" combinations have higher average incomes when compared with the "medium-high", "low-high" and "low-medium" combinations, respectively. Furthermore, graduates with dual majors generally earn less than a single high-income major, except "high-high" dual majors. Compared with the income of dual majors in the combination of "medium-medium" and "medium-low", graduates of a single middle-income major earn more.

Table 7. Regression results of income differences between a single major and dual major with different combinations

	Mix	Male	Female
High-high	0.432***	0.446***	0.416***
	(58.14)	(46.11)	(36.41)
High	0.372***	0.379***	0.370***
	(169.33)	(114.11)	(125.12)
High-medium	0.299***	0.304***	0.298***
	(38.52)	(29.08)	(25.69)
Middle-high	0.280***	0.261***	0.297***
	(38.60)	(24.49)	(30.47)
High-low	0.256***	0.286***	0.233***
	(21.77)	(17.24)	(14.20)
Low-high	0.228***	0.191***	0.255***
	(20.20)	(10.58)	(17.81)
Middle	0.181***	0.189***	0.170***
	(81.95)	(56.06)	(57.99)
Middle-middle	0.169***	0.166***	0.167***
	(21.63)	(14.19)	(15.98)
Middle-low	0.0824***	0.0819***	0.0775***
	(10.45)	(6.33)	(7.91)
Low-Middle	0.0568***	0.0482***	0.0590***
	(7.49)	(4.05)	(6.05)
Low(referencegroup)			
Low-low	-0.0324***	-0.0581***	-0.0189*
	(-5.37)	(-5.65)	(-2.54)
Sample size	1063648.00	530488.00	533160.00

Note: The semi-logarithmic linear model is used here. The model controls the number of working hours per week (logarithm), gender, age, a square of age, dummy variables for ACS survey year, dummy variables for a race, and dummy variables for a total of 173 university majors. The t value is in parentheses. $* p < 0.05$, $** p < 0.01$, $*** 0.001$

These observations predict the results of regression analysis. In the regression analysis, this article controls a series of demographic variables. Table 7 only lists the income premium estimates for professional portfolios, and the results show a clear pattern of income premiums for three single majors and nine dual-professional combinations. It should be noted that although in these regression analyses, the significance test is related to the reference type (that is, a single low-income major), for any two adjacent groups (such as "high-high" and "high",

The t-test of the income gap between "high" and "high-medium" shows that in the mixed model, most income gaps are statistically significant.

First of all, the income premium between a single major and dual major conforms to the "money first" ranking of strengths and weaknesses. In other words, college graduates with high-income majors, regardless of whether they are single majors or double majors, have an average income higher than those of middle-income majors, and the latter's average income is higher than that of low-income majors. Secondly, for the combination of the same major, the order is important. When the first major is a higher-income major, the average income is higher. But this difference is not big. For example, in the mixed model, the gap between the "high-medium" and "medium-high" combinations is 0.019 points logarithmic value (0.299~0.280), and the difference between the "high-low" and "low-high" combinations It is 0.028 points logarithmic value (0.256~0.228), and the value between "medium-low" and "low-medium" is 0.026 points logarithmic (0.0824~0.0568). These gaps are larger among boys than among girls. Third, on average, the income of a single major is higher than adding a double major with similar or lower profitability. For example, a person with a single middle-income major has a higher income than someone with a "medium-medium" professional combination or a "medium-low" combination. Even a person with a single low-income major has a higher income than a person with a "low-low" major combination. The only exception is the "high-high" combination. The double-professional income of the "high-high" combination is higher than that of a single high level professional.

5. Conclusion

This article uses the latest university major data from the ACS survey to estimate the impact of dual majors on graduate income. It turns out that it is important to have a clear benchmark when measuring the economic benefits of dual majors. Compared with the first major or second major reported by graduates, having a double major has only a small (about 1%) income premium. There is also some evidence that having dual majors may benefit young people more. When dividing the two majors in the dual majors into high-income and low-income majors, this article finds that the income of the dual majors lies between the single high-income major and the single low-income major. Compared with a single high-income major, the double major has an income loss of about 5%. Compared with a single low-income major, the double major has an income premium of about 7%. Further analysis found that the first major reported by the interviewees has a greater impact on income. When the high-income major is the first major, the income level of the double major is higher. Finally, the analysis of the combination of dual majors shows that in most cases, when compared with a single high-income major, dual majors have lower incomes. However, when the dual major is composed of two highly profitable majors, the economic benefits are the highest.

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