College Major and the Economy: The Impact of Labor Market Conditions on Field of Study*

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Abstract

This paper explores the impact of economic conditions on the majors students graduate with. Since college major plays a role in channeling students into their future job market occupations, this relationship has the potential to, in turn, influence the skill set and wages of the next wave of the labor market. Using data from the American Community Survey (ACS), this paper will look at how students decide their majors across the business cycle. The empirical evidence indicates that students exhibit an increased probability of choosing a higher paying major when the unemployment rate at time of major decision increases, but the effect is small. Estimates suggest that students are 0.28% more likely to choose an occupation paying 10% more in a recession when the unemployment rate is very high but only 0.26% more likely to choose the higher paying major when the unemployment rate is very low. These effects vary by gender, with women being less sensitive to different pay by major at all levels of unemployment. The results are attributable to major switching by students as college completion is unaffected by the unemployment rate when deciding a major.

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I. Introduction

The major college students graduate with has a direct effect on the composition of the skilled labor force as the majority of recent graduates are channeled into an occupation related to their major. Changes in the distribution of majors college graduates matriculate in can therefore significantly impact the dynamics of the labor market well into the future. While there are many factors that may influence the majors students pursue, this paper will examine the possibility that the economy itself plays a role in the major distribution of college graduates and, in turn, the skill composition and wages of the future labor market.

Economic conditions have the potential to influence decision-making if students pursuing a degree believe that changes in the labor market they are interested in can impact their career trajectory over the course of their lifetime. Such changes may call for a re-evaluation of the preferred field of study as lifetime earnings profiles change. Recent literature in this area suggests that graduating in a recession results in long-term wage penalties over the course of a graduate's career (Oreopoulos et al. 2012, Kahn 2010, Kondo et al. 2010).

The result of these wage penalties is that labor market conditions may alter major decisions through two potential channels - switching majors, or selection into or out of college completion in response to the changing economic conditions. The first channel refers to students who go to college regardless of labor market conditions but choose a different major during a recession than during a boom. These students decide majors based on all relevant attributes of the field, recognizing that higher paid majors involve a compensating wage differential since they require more work than lower paid majors. These major specific traits, generally considered 'bads' by most students, result in higher pay. Students must decide how they are willing to trade off major bads for wages, and as they face the prospect of wage penalties due to a recession may become more willing to accept major bads in exchange for higher wages in the future.

Though there is a well-established literature on how students choose majors[1], little literature exists exploring this first channel on how students switch majors based on labor market conditions. Expected pay has been analyzed as an important factor in students' major decisions, but none of the existing studies explore the potential impact of economic conditions while in college. When a recession impacts wages, students are less able to 'afford' good working conditions in college and beyond. This compensating wage

[1] This paper contributes to the literature determining different factors that influence student decision-making regarding major field of study. For example, students choose majors based on the characteristics of a given field that they find desirable (Zafar 2009). These may include whether they believe the required course load will be enjoyable to them or not, the approval of parents, how many units are required for graduation, what level of analytical and math ability is involved, etc. Students also think about the jobs that will result from majoring in a certain field – how enjoyable they may be, what level of interaction with others they involve, how much prestige is associated with the job, and, of course, the pay (Montmarquette 2002). Alongside beliefs about their future earnings from their major and tastes for a certain major, students also emphasize their beliefs about their ability level as a factor in determining what they major in (Altonji et al. 2012, Wiswall and Zafar 2011).

differentials channel is the main contribution of this paper. Most of the studies examining how students choose majors also rely on administrative level data sets[2], which are not as representative as the American Community Survey (ACS) data used in this analysis.

The second channel involving selection refers to students who may or may not graduate from college depending on the state of the economy. These marginal students either decide to drop out of college (and therefore don't complete a major), or graduate in a major of their choosing. Those students who do graduate in a recession have been found to be more likely to end up in lower level occupations (Kahn 2010), consistent with marginal students choosing lower paying majors. Past literature suggests that college attendance increases when the unemployment rate at time of entrance does (Kahn 2010, Betts and McFarland 1995, Gustman and Steinmeier 1981). However less is known about college completion based on market conditions while in college.

The impact of this retention selection on majors is theoretically unclear. The decreased opportunity cost of taking time out of the labor force for education due to tougher labor markets could lead to stronger retention and increased college completion for students. However the effect of this on the majors students complete depends on which majors experience stronger retention – higher paid fields, lower paid, or a relatively even distribution. Much of the literature on selection deals with enrollment in college rather than completion, which this paper will focus on, and frequently ignores women as their decisions are more complicated. This means that while there is a good amount of literature on selection into college enrollment during recessions, it is not clear what the impact of labor market conditions is on the attainment of college degrees by men and women. This selection retention channel has the potential to alter major composition of college graduates as they either drop out of college from certain majors or remain to compete their degrees.

The two channels, which make up the overall effect of the labor market on college majors, are ambiguous as to what this effect actually is. This paper will use the ACS to analyze the potential influence of the economy/ labor market conditions on college student majors. It will show that as the state unemployment rate increases, there is a small but significant change in the majors students graduate with. College graduates gravitate toward majors that on average pay more when they are exposed to a tough labor market. Male students are 0.28% more likely to choose a major paying 10% more in a recession when the unemployment rate is very high but only 0.26% more likely to choose the higher paying major when the unemployment rate is very low. Women are less sensitive, choosing majors that pay 10% more with an increased likelihood of 0.060% when facing high unemployment but only 0.055% when facing low unemployment. The effect is attributable primarily to student major switching as college completion is unaffected by market conditions while in college for both men and women.

[2] Zafar 2009 utilizes a survey of Northwestern University students while Wiswall and Zafar 2011 take advantage of a survey administered to New York University students.

II. Theoretical Framework

Students choose their major based on a number of factors, many of which have been established in the literature (as cited). Among these are expected lifetime wages as a result of the degree and the characteristics of the major, everything from the course load to how it is perceived by their parents. So in choosing a major, students face the following utility maximization problem:

$$U_{ij} = U_i (w_j, t_j)$$

where each student *i*'s utility from a given major *j* is dependent on the lifetime earnings from that major (w_j) and on the major specific traits 'bad' (t_j), which encompasses all unpleasant characteristics and nonmonetary attributes of a given major. Students then face a tradeoff between wages and major traits, where they require extra promised compensation in exchange for increased effort, less prestige, and other such unpleasant characteristics that make up the bad[3].

At the same time, each major is characterized by w_j and t_j, its lifetime earnings and specific traits, where the earnings of a major increase as the level of its major specific traits ('bads') do. Different students have different preferences for major traits, and will tradeoff pay accordingly. Past work suggests that male and female students may make different decisions when facing this tradeoff. In the model this is reflected in the way they translate this tradeoff into preferences[4]. The literature suggests that female students rank pleasant working conditions, flexibility, and interacting with others as being more important than prestige and pay, which men rank higher[5]. On average extra pay has less impact for women than it does for men, making them less likely to be willing to take on more major specific bads in exchange for higher wages – especially if these bads involve traits like long hours and extensive travel (items that work against family flexibility).

The result is that matches are made between students and their ideal major as in Figure 1A. Notice that individual indifference curves tangent to majors in the traits-earnings space represent matches that occur in this compensating wage differentials framework. These matches determine the number of students in each corresponding major, where certain majors pay more but also require the student to accept more of the "bad." Higher paying majors such as engineering, for example, tend to involve longer study hours and require more classes to graduate than a lower paying major such as education.

In Figure 1A, students expressing preferences for lower paid majors such as Major A are matched with that major and therefore with the corresponding lifetime earnings. Similarly students who accept higher levels of the major bad are rewarded with higher levels of earnings such as with Major C. The relevance of economic conditions in

[3] See Footnote 1 for a listing of the literature covering characteristics students value when choosing majors.
[4] So in Figure 1A, the average female student will be more likely to express preferences in line with students of the indifference curve U_{2A}, while male students will be more likely to follow U_{2C}.
[5] See Bronson 2013, Wiswall and Zafar 2011, Zafar 2009, and Montmarquette 2002.

Figure 1A

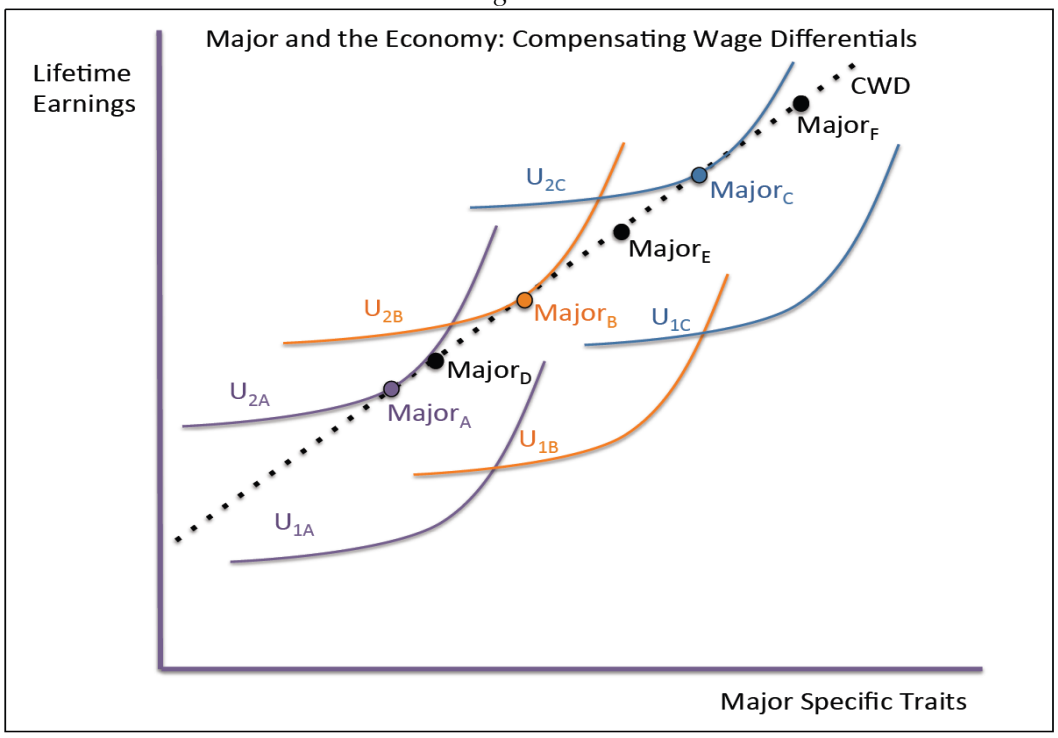
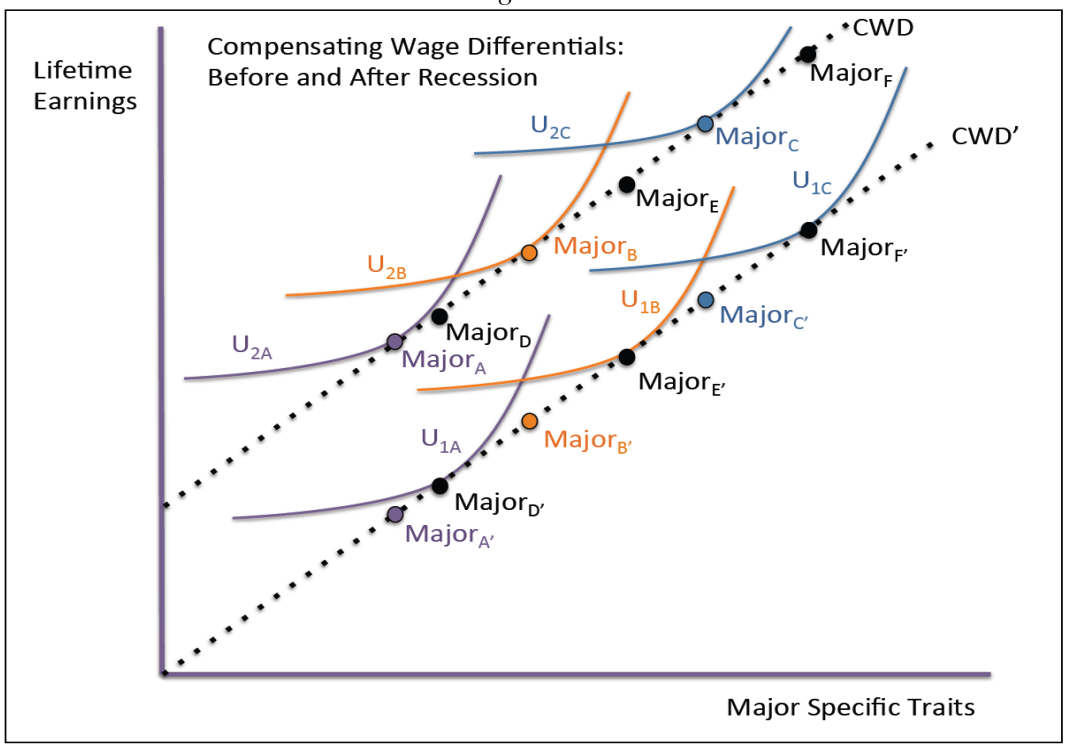


Figure 1B



this framework lies in the impact the economy during college has on the expected lifetime earnings of a major. As recessions occur and adversely impact lifetime wages, the different majors shift downward on this graph. Lifetime earnings are lower while the characteristics of a given major remain the same.

The result is a set of new tangency points that shift the CWD locus as in Figure 1B. In this way new matches are made and student's expected lifetime earnings change. The drop in wages leaves students less able to afford 'good' aspects of a major. In Figure 1B, students whose preferences before the recession dictated the choice of a lower paying major switched to a higher paying major with more negative traits as the economy worsened. Notice that those students who before preferred Major A have now switched to the higher paying Major D. Similarly for those at the relatively higher paying Major C, students have now switched to the even more lucrative Major F[6]. This switch holds for all students, so although the average male and female student may have different preferences they are affected similarly by the changing labor market.

III. Analysis & Methods

Following the above utility maximization problem, the probability that individual *i* chooses major *j* from among their set of choices M_i is:

$$P(y_i = j) = P_{ij} = P[\beta_w w_j + \beta_{w*ur} w*ur_{ij} + \varepsilon_{ij} \geq max_{k \in Mi,\, k \neq j}(\beta_w w_k + \beta_{w*ur} w*ur_{ik} + \varepsilon_{ik})]$$

Using the logistic distribution, this probability is expressed as:

$$P_{ij} = \frac{exp\,(\boldsymbol{\beta_w} w_j + \boldsymbol{\beta_{w*ur}} w*ur_{ij})}{\sum_{\boldsymbol{k \in Mi}} exp\,(\boldsymbol{\beta_w} w_k + \boldsymbol{\beta_{w*ur}} w*ur_{ik})}$$

where the independent variables are attributes of the *jth* alternative in the choice set M_i as perceived by the *ith* individual. In this case where the individual is deciding among a range of major choices, these attributes include the lifetime earnings of the major w_j and its interaction with the unemployment rate ur_i. Recall that conditional logit regressions differ from typical logits. The data here is grouped by individuals so the likelihood is determined for each group – hence, a conditional likelihood. For this reason the conditional logistic model is also known as a fixed effect logit model (in this analysis, individual fixed effects). The conditional logit explains the outcome *for each group* (the individual), so variables that do not vary within the group (ie., the unemployment rate while the individual is in college) will not have a place in the model on their own. The log-likelihood of the conditional fixed-effects logit model used for this analysis can be written as:

[6] Past work indicates that there are heterogeneous effects of a recession on wages, with higher paying majors suffering less of a wage penalty. This would result in a non-parallel shift as majors farther to the upper right quadrant of the graph face less of a drop in lifetime earnings (Oreopoulos et al. 2012). Notice that the overall predictions of the model would remain the same.

$$L = \sum_{i=1}^{N} \sum_{j \in Mi} d_{ij} \ln P(y_i = j)$$

where $$d_{ij} = \begin{cases} 1 & if\ individual\ i\ chooses\ alternative\ j \\ 0 & otherwise \end{cases}$$

To better interpret the coefficients obtained in the logit model, they can be converted into an elasticity that measures student responsiveness to pay across the business cycle:

$$\eta\,(w) = w_j \frac{\partial P_{ij}}{\partial w_j} = (\beta_w + \beta_{w*ur} * ur_i) * w_j * P_{ij}(1 - P_{ij})$$

Since the typical elasticity calculation does not make sense with the dependent probability being a number without units between 0 and 1, this elasticity of substitution between majors is a quasi-elasticity. It measures how the wage influences the probability of choosing a given major, and more specifically how a 1% increase in the wage changes the percentage point probability of choosing a given major. By recalculating the predicted probabilities at different unemployment rates, it can then be measured in different labor market conditions to visualize how student decisions change.

IV. Data and Summary Statistics

A. Data

The Census Bureau recently started collecting data on majors for college graduates. While the American Community Survey (ACS) has had information on educational attainment for many years, it has only gathered information on field of study for those who completed a college degree since 2009. Major data is collected for those respondents who report having completed their bachelor's, not for those in progress or who did not complete their degree. This study will take advantage of this newly available, highly representative data. It will also utilize data on general conditions in the labor market as captured by the state unemployment rate taken from the Bureau of Labor Statistics (BLS).

The ACS major data is ideal for this analysis in that it is nationally representative data. The sample used includes college graduates aged 21 from 1980-2010. These years provide a good amount of variation for the analysis as there are 3 'peaks'/booms and 3 'troughs'/busts (all of which were recessions as classified by the NBER). The majors students report vary widely, from Fine Arts to Business to Biology (see Table 3 for more detail)**.** There are a total of 38 main major categories in the data classified by the ACS, each of which are strongly represented in the sample with each major containing a significant number of observations. The lowest paid of these is Library Science with average pay for graduates in the sample at $14.29 an hour. The highest paid is

Engineering, with average pay of $36.22 an hour. Engineering is also one of the most popular majors in the sample (5.99% of graduates chose it), along with Psychology (5.44%), Business (21.77%), Social Sciences (7.86%), Medical Sciences (6.47%), Communications (5.11%), and Education (11.34%).

The use of students aged 21 is due to the fact that, despite the availability of major data, degree completion date is not provided in the ACS. Therefore linking students to labor market conditions at the time of their major decision requires the assumption that respondents completed their degrees at approximately age 22. This means they would be making final decisions about their major sometime prior to that point and after the expected completion of high school at age 18. The main assumption in this analysis is that the economy has influenced students' decisions by age 21[7], making them most susceptible to conditions around that time. Following the theoretical model, observing the ease (or hardship) with which their senior colleagues obtain jobs - and whatever other relevant environmental triggers influence their perceptions about the labor market - should either trigger students to switch majors or influence their decisions about obtaining a bachelor's degree at all. To depict the general conditions the student is exposed to while deciding on their major, rather than just a specific year's labor market, this analysis uses a three year moving average of the state unemployment rate at the expected time of the major decision[8].

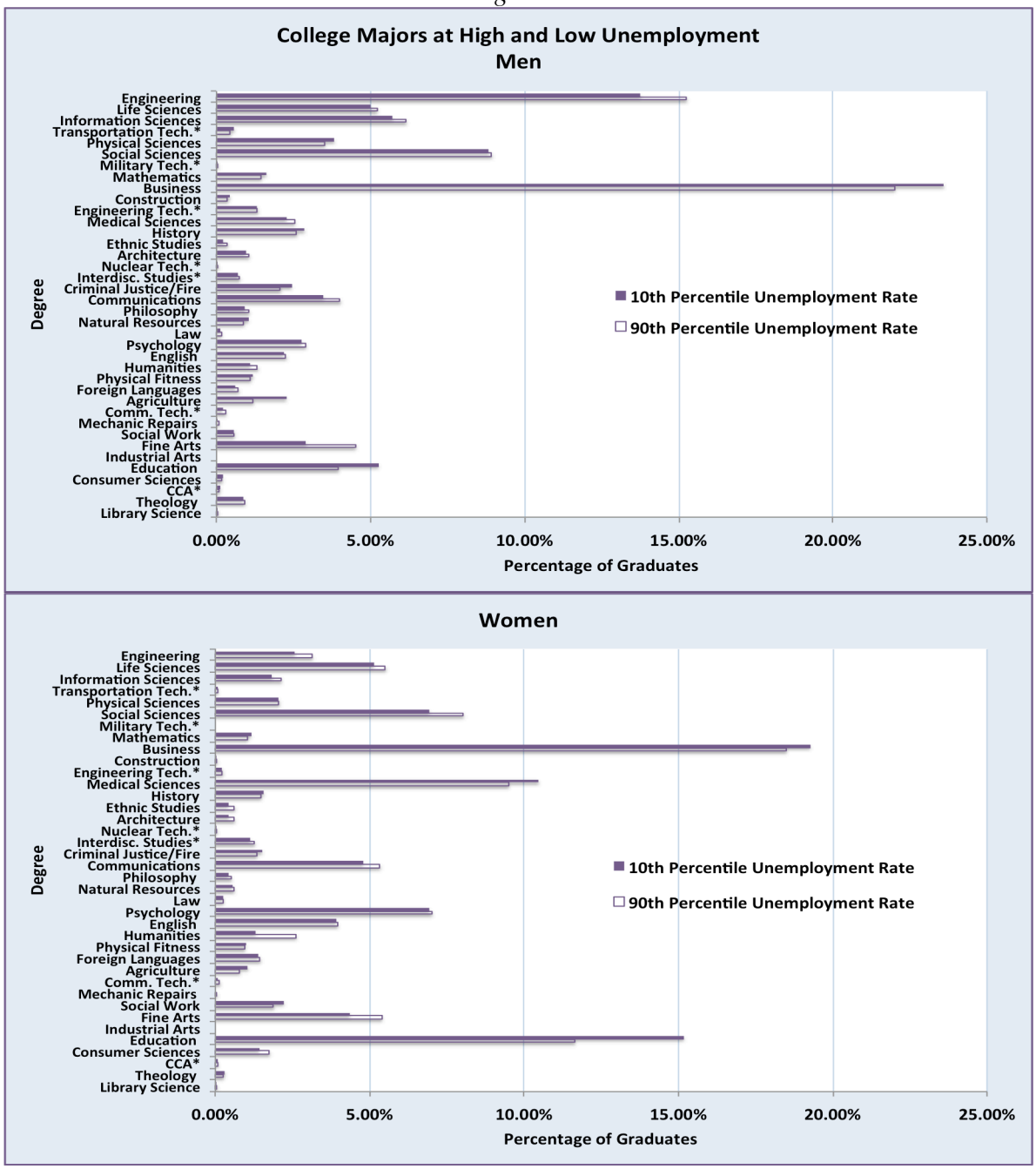
B. Major and the Business Cycle

There are changes in the majors students pursue as labor market conditions fluctuate. Figure 2 shows the distribution of majors across economic conditions. Notice that as students are exposed to high unemployment rates at age 21 the majors they graduate in are different from the students who were exposed to lower unemployment rates as they were making their major decisions[9]. The figure compares students who went to college and got jobs in states that fell into the ninetieth percentile and above in their unemployment rate for that year to those who were in states in the tenth percentile or below. According to the selection and compensating wage differentials channels in the model, the effect of the change in labor market conditions is ambiguous. It is possible to observe more students in higher paying majors, or lower paying majors, when the unemployment rate increases. In Figure 2, majors are ordered by average hourly pay with the highest paying major at the top to observe which, if either, of these trends holds.

The data seems to indicate that among some of the more popular majors (with higher proportions of graduates), students switch to more lucrative fields when facing high unemployment rates. However this trend doesn't always hold, and its magnitude varies for male and female graduates. For example, among both men and women, the highest paying field of engineering becomes more popular when facing higher

[7] Robustness checks will show that this age can be changed to 19 or 20 without significantly altering the results.
[8] The results are not significantly affected by altering this assumption slightly, robustness check to come.
[9] Recall that major decisions are assumed to be made by age 21, so Figure 2 plots the majors students graduated with after being exposed to high vs. low unemployment at that age.

Figure 2



Note: Data is taken from the 2010 American Community Surveys (ACS), with a sample including those aged 21 from 1980-2010 as in the analysis. The majors here are ordered by increasing average pay. The ninetieth percentile refers to states with unemployment rates above that percentile in a given year (on average for all years above 8.6%) and the tenth percentile includes rates below that percentile in a given year (on average for all years below 4.2%). A similar figure can be made for majors studied above and below the median unemployment rate of 5.9%.

* "Tech." abbreviates Technologies in the major names. CCA refers to the major Cosmetology and Culinary Arts. "Comm." abbreviates Communications, "Interdisc." Interdisciplinary.

unemployment. In better labor market conditions 13.76% of male and 2.58% of female college graduates finish a degree in engineering. However when unemployment rates are highest 15.24% of males and 3.13% of females graduate in the field, increases of approximately 10.7 and 21.3 percent respectively.

The same trend holds for social sciences, with increases of 1 percent for men and 15.7 percent for women. However in business, another popular field among college graduates, students actually chose the field less when encountering higher unemployment despite its position as a relatively high paying field. In a good labor market 23.6% of men and 19.26% of women graduate in business, but when in hard economic times only 21.99% of men and 18.48% of women make this decision. This represents a drop of 6.8 percent in the likelihood of male graduates to study business when times are hard, and a drop of 4.0 percent for females.

On the opposite side of the spectrum, students pursue relatively lower paying majors less in tougher labor markets. For example education, one of the lowest paying majors on the spectrum, graduates fewer students in harsher economies. Only 3.95% of men are in education when unemployment is high, and 11.63% of women, but this rises to 5.25% of men and 15.17% of women when unemployment is low. This translates to a drop of 24.8 percentage points during hard times for men and a drop of 23.3 percentage points for women.[10] Extremely similar trends emerge when plotting the differences in majors at levels of unemployment above and below the yearly median as well. The significance of these changes in the distribution of majors over time is that each of these majors yield different lifetime earnings on average (in Figure 2, higher earning majors are on the top of the scale). If the economy can help explain any part of these changes, it is then also responsible for influencing potential earnings of the college-educated workforce.

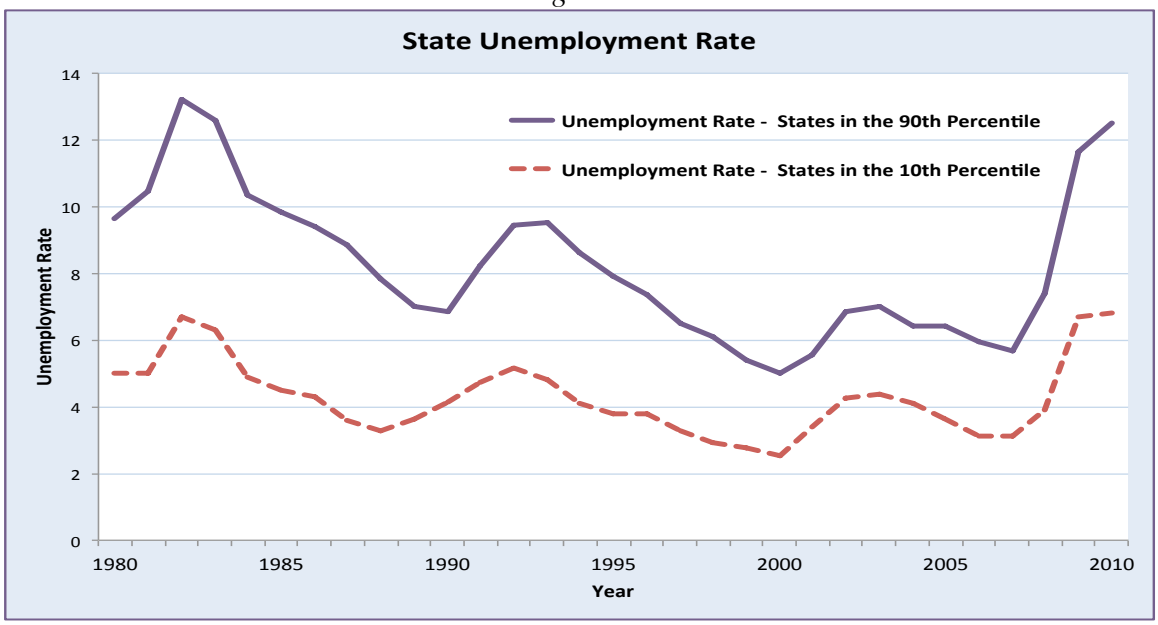
The correlation here between college major and labor market conditions leaves open the potential role for both the retention channel and compensating wage differentials. The analysis will pursue the overall combined impact of these two channels, since both are relevant to answering the question of how labor market conditions impact major decisions.

In this analysis general labor market conditions are captured by the state unemployment rate as reported by the BLS. State rates are more informative than federal ones as they capture more variation in labor market conditions that students are exposed to as they make decisions about their education. More variation beyond state is difficult to attain since precise locations for the students' graduation and working career are not available. This makes any unemployment rate more specific than state hard to accurately match to an individual in the data. Ideally these state unemployment rates capture the most concise picture of what students are using to form beliefs about their prospects in a more informative way than just federal rates, since state unemployment varies widely compared to the national level.

[10] All statistics are for the college graduate sample analyzed in this paper, aged 21 from 1980-2010.

In fact, the yearly state unemployment rates range from 2.3% (Connecticut and Virginia in 2000, Nebraska in 1990, and New Hampshire in 1987) to 17.4% (West Virginia in 1983) over the time period studied[11]. The 1980-2010 time frame provides a significant amount of variation for identification of the model since it includes both boom times and the Great Recession. Figure 3 illustrates the fluctuations in the economy during this time. In any given year there is a significant difference between states at the highest level of unemployment (in the ninetieth percentile or above for that year) and states at the lowest level (in the tenth percentile or below). As with Figure 2, a similar figure can be made for states above and below the median unemployment rate in any given year.

Figure 3



Note: Data is taken from the Bureau of Labor Statistics. The ninetieth percentile refers to states with unemployment rates above that percentile in a given year (on average for all years above 8.6%) and the tenth percentile includes rates below that percentile in a given year (on average for all years below 4.2%).

This analysis matches students with the appropriate state unemployment rate[12] while they were choosing their major. Those students who migrated at some point during their working career are dropped from the analysis. The data does not provide a listing of where students completed their bachelor's degrees, so it is difficult to match migrants with the unemployment rate that is likely to influence their decision-making. Students who had plans when in college to move states upon completion would in all likelihood

[11] The 3-year moving average as used in the analysis ranges from 2.4% to 15.5% accordingly.
[12] Alternatively, the unemployment rate for just those with a bachelor's degree could be used by aggregating the individual data in the ACS. Since this results in an unemployment rate that is highly correlated with the reported BLS state unemployment rates (correlation above 0.7), this analysis will employ the reported BLS numbers as the Bureau of Labor Statistics is responsible for reporting the correct statistics.

incorporate the destination state's unemployment rate into their decisions rather than the rate in their state of college attendance.

The data is also missing information about the precise year in which the student graduated. For this reason the model matches students with the best approximation of the relevant unemployment rate based on the "typical" college students' path of completion. Since students decide on their major at some point while attending school, but may change it at any point up until graduation, it is difficult (and probably inaccurate) to pinpoint a specific year during which the economy will impact this decision specifically. For this reason, the unemployment rate variable corresponds to a three year moving-average of the unemployment rate when the student is 21 years old. Using a three year average[13] better captures the general economic conditions the student is exposed to when making this decision.

C. Summary Statistics

For this sample of college graduates, students report 2010 average wages of approximately $55,935 as they are at the peak of their earnings profile with an average age of 37. There are of course differences for men and women here, with the males in the sample earning on average $31,839.63 more. These numbers compare all college

Table 1: Summary Statistics

	All	Men	Women
State Unemployment Rate	6.13% (1.92%)	6.16% (1.93%)	6.10% (1.92%)
2010 Wage	$55,935.02 ($62,539.22)	$73,602.96 ($75,820.01)	$41,763.33 ($44,564.94)
Age	37.19 (8.50)	37.63 (8.45)	36.84 (8.53)
Graduate Education	30.91%	30.04%	31.61%
White	87.95%	89.31%	86.86%
Married	62.73%	63.77%	61.91%
Employed Full Time	76.93%	87.63%	68.34%
Observations	302,164	134,492	167,672

Note: Data is taken from the 2010 ACS. Sample includes 302,164 college graduates aged 21 in 1980-2010. Standard deviation in parentheses, where applicable. Full time means at least thirty-five hours per week.

[13] Robustness checks will also evaluate without the moving average since the moving average smooths out a lot of variation. The moving average as defined here is the simple moving average. Alternatively the centered moving average could be used, which changes only the way the unemployment rates used are framed. For example, when using the moving average at age 21 this incorporates unemployment at 19, 20, and 21. The centered average would be the same, stated as the centered moving average at age 20.

graduates in the sample, including those who are not working and all types of occupations, levels of work intensity, ages, etc. Almost a third of the sample has a graduate education and that is quite evenly balanced for both men and women – 30.04% of men and 31.61% of women in the sample. The overwhelming majority of the students are white, married, and work full time (see Table 1). However 87.63% of the men work full time while only 68.34% of the women do. This includes 302,164 graduates reporting in the current ACS, who were deciding on their college majors over the three decades covered in this analysis.

V. College Major in the Data

A. Reliability of the Data

Major is self-reported in the ACS. Therefore measurement error in the variable is a potential concern as students may experience recall bias or for any number of reasons incorrectly state their major. Such error may be the basis for issues with identification so it is important to know how reliable this variable is in the data, especially since it is relatively new to the ACS and is a central focus of this study. Fortunately, comparison to the National Center for Education Statistics major data yields very similar distributions of majors during this time period, lending support to the reliability of the data[14]. Additionally, major distributions over time, race, and sex do not display erratic changes, consistent with the measure being reliably reported in the survey. Looking at the distributions of college major present in the sample over the five years of data available shows that they remain consistent over time. This lends credence to the reliability of the data as it would be unusual to observe erratic behavior or drastic changes in majors graduated in across such a short window of time. Major distribution by race and sex also stays relatively consistent over the five survey years.

More convincingly, comparison of the ACS data to other currently available data on major fields of study yields similar distributions of major by sex. The National Center for Education Statistics (NCES) B&B: 08/12 Baccalaureate and Beyond Longitudinal Study follows students after they complete their bachelor's degree in order to study their education and work experiences. The 2009 study interviewed graduates of 2007-08 and has just followed up with these graduates for another interview. It is the third such wave of the study. All studies use a "nationally representative sample of postsecondary students and institutions," according to the NCES website, just like the ACS data. It is the closest source for comparison to the ACS data as they are both nationally representative datasets and cover approximately the same cohort of college graduates. However the NCES is not being utilized here since it does not include nearly as many years of students.

[14] Comparison of the two data sets yields similar distributions for recent college graduates as measured by the Duncan Dissimilarity Index. Survey used is the NCES' B&B: 08/12 Baccalaureate and Beyond. The Duncan enumerates major distributions by assigning a number between 0 and 1 indicating what percentage of women (or men) would need to switch their major in order for the relative distribution of majors for both men and women to be the same. A zero value implies parity between male and female graduates, while one implies complete separation.

When the ACS data is categorized into roughly the same ten major groups as the NCES, the major distribution by sex is approximately the same across both sources. The Duncan Index quantifying this distribution by sex is 0.34 for the NCES data, while for the ACS data it is 0.35. Each of the major categories are also quite similar in their breakdown in the sample, as shown in Table 2. These figures aggregate the ACS data into approximately the same classifications as the B&B study for recent graduates up to age 25 (for comparison, since the B&B only includes recent graduates). Since the aggregation is an attempt at imitating the B&B classifications as closely as possible, the distribution of majors is similar but not identical. For example, Business graduated 23.1% of students according to the B&B, and 20.0% according to the ACS.

Table 2: Comparison of ACS and NCES Data

Major	Percent of Graduates B&B	Percent of Graduates ACS
Computer and information sciences	2.9%	2.4%
Engineering and engineering technology	6.2%	7.0%
Bio/physical science/science tech/math/agriculture	7.3%	14.4%
General Studies and other	2.9%	1.1%
Social sciences	15.0%	15.0%
Humanities	11.8%	15.3%
Health care fields	7.5%	6.2%
Business	23.1%	20.0%
Education	8.3%	8.9%
Other applied	14.9%	10.0%

Note: Majors in the 2010 ACS are aggregated here to approximate the B&B:08/12 classification of major. Figures presented represent the percentage of recent college graduates who graduated in each major.

B. Calculation of Major Premiums

To evaluate student decision making over the business cycle when faced with a pool of potential college majors, this analysis looks at how different levels of pay by major impact the likelihood of graduating in a given field as the unemployment rate fluctuates[15]. In short, it analyzes whether students are more likely to choose higher or lower paying fields when faced with increased levels of unemployment. Average pay by major fails to account for a number of factors including self-selection into a given major, perhaps by innate ability of the individual. It also omits the fact that in the labor force graduates with some majors may have different characteristics than others, such as more experience on average. For these reasons the major pay variable does not just measure average pay. A simple measure of average pay groups together all graduates in a given major, of all ages

[15] Recall that the theoretical model emphasizes the link from unemployment to major decisions through pay as students make different wage-traits tradeoffs when faced with higher unemployment.

and experience levels, and so may be misleading when ranking the choice of majors by pay from a graduate's perspective[16].

In the theoretical framework, majors differ by their specific traits and wages. In fact wage profiles by major vary widely, with (for example) male graduates in engineering earning on average more than $40,000 extra in wages than their counterparts in education. This is approximately equal to the difference in earnings between the average high school and college graduates. To construct an accurate ranking of majors, the major premium variable is derived by determining the wage premium or penalty associated with a given major relative to others, after controlling for relevant variables such as potential experience, intensity of work, and demographic traits. Since major information is only available as of 2009 in the data, all pay information by major is from that point on. However it will be covariate adjusted, including the age-wage profile, for use in the analysis. Because of this, however, wage profiles are being accounted for using currently reported pay for all age/experience levels. This assumes that today's business majors will be compensated in a similar pattern/at the same relative level compared to other majors as yesterday's graduates, at least in the minds of current students forming decisions about their major.

A basic fixed effects regression of the following form determines the covariate adjusted wage premiums:

$$wage_{jst} = \beta_1 * age_{jt} + \beta_2 * age^2_{jt} + \beta_3 * married_{jt} + \beta_4 * race_{js} + \alpha_j + \mu_s + \gamma_t + \varepsilon_{jst}$$

where the hourly income for a given major *j* in state *s* at time *t* is explained by its age wage profile/potential experience, the race (an indicator for minority) and marital status composition of the major[17]. State and time fixed effects are included. More importantly, the coefficients on the major fixed effects (α_m) represent the wage premium (or penalty) associated with a given major after controlling for the fact that some majors consist of more experienced people and therefore higher pay, etc. The coefficients on each of these major indicators make up the major premium variable.

Included in these premium calculations are all graduates reporting a given major, whether they are currently working or not. Relative employability of a given major is an important consideration for students considering a field when facing tough labor markets. Including students with zero wage allows for the incorporation of information about relative major employability as well as pay[18]. Similarly some majors, such as Biology

[16] This is assuming that students consider factors such as experience and don't just evaluate a major's pay potential using the average. Robustness checks using the 'naïve' average pay will show similar general results.

[17] Hourly wage is computed by taking the annual wage reported in the ACS, divided by hours worked (hours worked per week times weeks worked per year). Hours worked per week range from 0-99 and weeks worked per year are in bins of: 0, 1-13, 14-26, 27-39, 40-47, 48-49, and 50-52 weeks, each used in this calculation as their respective midpoints.

[18] To test the importance of employability in major decisions, robustness checks will re-evaluate the major premium excluding graduates who don't report wages. Those premiums will be calculated using the same regression as these premiums, excluding non-workers from the sample.

and Life Sciences, Physical Sciences, History, and Psychology (to name a few) end up with a larger proportion of their graduates with graduate degrees than other majors (see Table 3). The increased education leads to higher pay, and makes the likelihood of attending graduate school a possible consideration for students thinking about their major and its long term potential. For this reason graduate education is an important endogenous variable that acts as a mechanism through which students make major decisions and is therefore not added as a control in this regression[19].

The major premiums are evaluated using the 2009-13 ACS to determine the most accurate ranking of major pay possible. The calculation includes college graduates of working age from 21 to 65. Since male and female earnings are different on average (see Table 1), there is reason to believe their major premiums will be different as well. For this reason the premiums are calculated separately for male and female graduates, hence there is no control for gender in the equation. In fact notice in Table 3 that the premiums for male and female graduates are not only significantly different, but the resulting relative ranking of majors by these pay premiums is different as well. Majors such as Consumer Sciences, Fine Arts, Mechanic Repairs, and Humanities for example have premiums that are positive for men and negative for women (relative to the comparison Library Science major), placing them at completely different relative rankings for the genders. It would be inaccurate, then, to utilize the combine major premium in analysis[20]. For this reason the logit coefficients and the corresponding elasticities will be obtained in analysis for men and women separately.

The different major premiums are listed in Table 3. The premiums are calculated compared to the major "Library Science," a relatively low paying major in the sample. This means that more lucrative majors, such as Engineering, boast premiums as high as $16.96 per hour above graduates in the Library Sciences for male graduates, while Humanities yield only $5.59. There are differences by sex as the premiums when calculated for women are in general lower than the male major premiums. For example, the premiums for engineering and Humanities are $10.18 and -$0.36, respectively, for female graduates. When the premiums are calculated for both men and women together (using the above fixed effects regression with the addition of an indicator for gender) the premiums lose variation, with engineering majors overall earning $12.64 more than the base and Liberal Arts & Humanities earning $1.06. Following this result, the analysis will evaluate men and women separately and will therefore use the male and female major premiums separately. However to check robustness, and to acknowledge the fact that college students may not utilize separate premiums when evaluating payoffs to a major, the combined major premium will be used as well.

Since no major information is collected before 2009, pay for older, more experienced graduates is taken from current pay information. In other words, students

[19] However the main results do not change significantly when graduate education is added as a control. In the sample 33.67% of students hold a graduate degree.

[20] Evaluating major premiums together (including a gender control) results in slightly different premiums and ranking of majors. However in robustness checks evaluating men and women's premiums together rather than separately does yield similar results.

Table 3: Covariate Adjusted Major Premiums

Major	Percent of Sample	Percent with Graduate Degree	Average Hourly Wage	Male Major Premium	Female Major Premium	Combined Major Premium
Library Science	0.02%	76.92%	$14.29	$0.00	$0.00	$0.00
Theology	0.54%	32.99%	$16.21	-$6.04	-$5.24	-$8.29
CCA[1]	0.08%	11.24%	$16.94	-$1.84	-$5.60	-$5.62
Consumer Sciences	0.91%	23.81%	$17.58	$4.62	-$0.89	$0.38
Education	11.34%	41.36%	$18.41	$2.25	$0.73	-$0.80
Industrial Arts	0.01%	14.11%	$19.90	-$0.30	-$8.62	-$4.90
Fine Arts	4.39%	21.31%	$20.18	$1.36	-$1.69	-$1.43
Social Work	1.41%	39.34%	$20.52	$3.10	-$0.03	$1.15
Mechanic Repairs	0.03%	13.64%	$21.32	$0.34	-$2.94	-$4.16
Comm. Tech.[1]	0.17%	11.09%	$21.38	$3.73	$0.04	-$0.62
Agriculture	1.26%	21.45%	$21.49	$0.19	$0.52	$1.66
Foreign Languages	0.92%	40.98%	$21.89	$7.49	$1.19	$2.57
Physical Fitness	1.17%	24.38%	$22.28	$3.99	$2.26	$1.50
Humanities	1.42%	25.13%	$22.58	$5.59	-$0.36	$1.06
English	3.27%	39.48%	$23.60	$8.17	$1.47	$3.16
Psychology	5.44%	42.13%	$24.04	$4.02	$1.42	$3.20
Law	0.20%	26.55%	$24.15	$6.28	$2.22	$3.27
Natural Resources	0.76%	23.45%	$24.52	$4.23	$1.26	$1.02
Philosophy	0.72%	45.43%	$24.53	$4.16	$1.63	$0.65
Communications	5.11%	18.26%	$24.78	$6.34	$2.32	$3.14
Criminal Justice/Fire	2.06%	17.86%	$25.05	$4.02	$2.45	$1.68
Interdisc. Studies[1]	0.78%	32.39%	$25.36	$9.68	$2.07	$4.27
Nuclear Tech.[1]	0.03%	16.67%	$26.31	$8.22	$5.29	$5.51
Architecture	0.67%	28.59%	$26.96	$5.39	$0.85	$1.58
Ethnic Studies	0.37%	43.15%	$27.05	$12.55	$2.66	$5.87
History	2.20%	41.42%	$27.14	$8.41	$3.46	$4.34
Medical Sciences	6.47%	31.27%	$29.08	$17.46	$9.48	$11.11
Engineering Tech.[1]	0.70%	14.84%	$29.31	$7.31	$3.53	$3.39
Construction	0.20%	7.03%	$29.47	$8.32	$2.24	$3.63
Business	21.77%	19.33%	$29.82	$11.47	$4.16	$6.49
Mathematics	1.19%	41.94%	$30.78	$15.98	$6.86	$10.00
Military Tech.[1]	0.01%	10.00%	$30.80	$5.25	$11.56	$1.75
Social Sciences	7.86%	38.07%	$30.90	$13.95	$3.99	$7.72
Physical Sciences	2.56%	44.30%	$32.84	$16.78	$7.25	$11.27
Transportation Tech.[1]	0.30%	15.83%	$32.87	$11.76	$5.03	$7.48
Information Sciences	2.87%	19.33%	$34.64	$13.96	$6.45	$8.71
Life Sciences	4.81%	51.28%	$35.08	$20.00	$8.87	$13.20
Engineering	5.99%	33.38%	$36.22	$16.96	$10.18	$12.64

Note: Data taken from the 2009-13 American Community Surveys (ACS). Notice that all majors are being compared to Library Science as the omitted category in this design.

[1] "Tech." abbreviates Technologies in the major names. CCA refers to the major Cosmetology and Culinary Arts. "Comm." abbreviates Communications, "Interdisc." Interdisciplinary.

who graduated in Education Administration and Teaching in 1985 at the age of 22 (for example), making them 47 in the 2010 survey, are responsible for the pay associated with that major and experience level in the calculation of the premiums. Since this analysis spans a number of years, it is important that the relative ranking of major premiums, if not the absolute level of the premiums themselves, stays approximately the same across the time period studied. Using the years of data that are available, this does seem to be the case[21]. Incorporating as many years of data as possible into the calculation makes this assumption and the reliability of the major premiums calculated stronger since it allows for changes across time in pay reported during different surveys. The result is the most accurate premiums possible given the lack of major data alongside income prior to 2009.

Table 3 presents the major premiums by gender and combined for both men and women alongside information on what portion of the sample each major comprises. For comparison sake (and to provide a base to compare the premiums to) average wages are also presented. Notice how the ranking of majors by average wage (as they are ordered in Table 3) does not necessarily line up with the ranking of majors by their pay premium since the premium measure controls for a number of important factors that average pay does not.

VI. Results and Channels

A. Main Results

The results suggest that students are relatively inelastic to different major premiums as the unemployment rate fluctuates. Students are more likely to choose a higher paying major as conditions worsen, but this effect is small. The overall impact is that on average a major paying 10% more increases the likelihood of choosing the field by only 0.27%

Table 4: Regression Results by Sex

	(1) Men	(2) Women
Major Premium	0.0904*** (0.0015)	0.0580*** (0.0017)
Unemployment Rate* Major Premium	0.0018*** (0.0002)	0.0013*** (0.0003)
Observations	134,492	167,672
Elasticity	0.027	0.0057

Note: Major premium measured hourly. Robust standard errors, clustered by individual, in parentheses. Significance at the 1% level is depicted by ***, at the 5% by **, and at the 10% by*. Data is taken from the 2010 ACS. Unemployment rate data is from the BLS and is used here as the state 3 year moving average.

[21] Calculating the premiums for each year of the survey data does indeed yield similar major pay premiums for each year available.

for male graduates - an elasticity of 0.027. For female graduates the likelihood increases by even less, just 0.057%, an elasticity of 0.0057 (see Table 4). The relatively lower elasticity for female graduates concurs with past literature suggesting that women place less importance on higher pay. In this specific case, women emphasize pay less when choosing majors compared to their male colleagues[22].

In the model, the coefficient on the major pay premium variable represents student response to higher paying majors, and the coefficient on the interaction of market conditions and the premium represents any extra response when the unemployment rate changes[23]. So a positive coefficient on the major premium indicates that students prefer higher paying majors, and a positive coefficient on the interaction term indicates that they prefer higher paying majors even more as the unemployment rate increases. This second coefficient is positive for both men and women, indicating that a higher unemployment rate when deciding on your major does increase the likelihood of choosing a major that pays more. Since logit coefficients are not directly interpretable on their own, they are presented here for understanding, as they are used to calculate the elasticity, and to observe their signs[24]. The elasticity is the most important number for interpretation of this model.

It is simplest to interpret elasticities across different potential unemployment rates. Each of the major elasticity of substitution values calculated in Table 4 represents the elasticity when unemployment is at average levels. To better answer the question of how students respond to labor market conditions when choosing their major, it is also useful to see the potential range of elasticity values students may exhibit at different unemployment levels. Table 5 shows these values for potential unemployment rates of zero through fifteen[25]. The increase in the elasticity as the unemployment rate rises suggests that men are 0.28% more likely to choose a major paying 10% more in a recession when the unemployment rate is very high (fifteen percent) but only 0.26% more likely when the unemployment rate is very low (one percent). The difference is subtle.

Women will also choose higher paying majors when facing high unemployment. They are 0.060% more likely to choose the higher paying major when unemployment is high, but only 0.055% more likely when unemployment is low. In general women are

[22] The effect is robust to changing the time frame studied, for example from 1990-2010 or even 2000-2010. The 2010 ACS is used here since the computational requirements of conditional logits make difficult the use of multiple surveys at once. Robustness checks have shown that similar results are achieved using other available ACS data.

[23] Recall from the methods section that conditional logits are fixed effects models, in this case individual fixed effects, and so only include variables that define characteristics of the choice being made – in other words, variables that define aspects of a given major and therefore vary within individual groups. As a result unemployment rate during college, which doesn't vary by individual/across majors, is not in the regression except as an interaction.

[24] Alternatively marginal effects are useful for interpretation. However since the elasticity is the most relevant number for interpretation in this model, actual coefficients are presented to understand the calculation of this number better.

[25] The elasticities here are being calculated by holding unemployment constant at each rate 0-15%.

less sensitive to pay premiums but exhibit the same pattern of changing majors when facing higher unemployment. This is in line with average female students preferences regarding pleasant major traits rather than pay[26].

Table 5: Elasticity of Substitution Across the Business Cycle

Unemployment Rate	(1) Men	(2) Women
0	0.0276	0.00258
1	0.0278	0.00259
2	0.0279	0.00261
3	0.0281	0.00262
4	0.0282	0.00264
5	0.0284	0.00265
6	0.0285	0.00267
7	0.0287	0.00268
8	0.0289	0.00270
9	0.0290	0.00272
10	0.0292	0.00273
11	0.0293	0.00275
12	0.0295	0.00276
13	0.0296	0.00278
14	0.0298	0.00279
15	0.0299	0.00281
Average	0.0286	0.00267

In Figure 2, there was movement in and out of majors when students faced relatively high or low unemployment. For example, a number of women left the business major when facing high unemployment rates, while others joined engineering. A similar trend held for men. Whether this happens through selection or switching as students re-optimize their pay versus major traits tradeoff (recall the theoretical compensating wage differentials framework), the countervailing forces potentially balance each other out. This may result in the seemingly small effects observed here despite hypothetically large underlying changes. In fact these results may be a lower bound as many students do not follow the traditional college career path. According to the National Center for Education Statistics[27], as many as 12% of public 4-year institutions are students aged 25 and over. This number is drastically higher – 71% - at for-profit universities. For these students, analyzing the economy around the typical college student's major decision period would result in no effect, and hence result in downward attenuation bias. Since they graduate later in life, labor market conditions at the time they were approximately 21 may have minimal or no impact on their major decisions.

The literature also suggests that beliefs about returns to schooling probably matter more for its accumulation rather than actual returns – whether these beliefs are correct or

[26] See Bronson 2013, Wiswall and Zafar 2011, Zafar 2009, and Montmarquette 2002.
[27] Taken from the NCES Integrated Postsecondary Education Data System (IPEDS), enrollment component.

not (Jensen 2010, Nguyen 2008, Kaufmann 2008, Manski 1993, Betts 1996). Students are often wrong in their assumed beliefs about potential expected earnings and other major specific outcomes (Wiswall and Zafar 2011). It is therefore entirely possible that the effects of the economy measured here are small due to people's reliance on potentially faulty beliefs about the prospects a given major holds rather than actual analysis of how it is impacted by the economy[28]. These beliefs could range from general consensus on how lucrative a major is to how 'employable' a given major is seen as by students.

Additionally, if a marginal student is just indifferent between earning in the labor market and attaining higher education, the decreased opportunity cost of college due to a recession will lead to a preference for education. These students will not be those with relatively high earnings potential, as those high earners would choose to remain in college regardless of the circumstances, but rather those in relatively lower paying fields. As the unemployment rate rises this will result in an increasing number of students in the lower paying majors, making it appear as though tough economies push students toward lower paying majors rather than higher paying ones. This potential retention could therefore also help to explain why reaction to labor market conditions is small in the analysis, as the response in college graduation rates may be pushing the results downward. However this will only be true if retention is a relevant factor in major decisions for men and women in the sample.

B. Retention Channel

Both male and female college major decisions across the business cycle involve an element of potential selection since individuals may also make decisions about whether to continue their college degree based on economic conditions. If attainment of higher education is influenced by the economy, then estimates of how the economy affects major decisions include this potential channel through which graduates' fields of study are changed. In fact previous work suggests that this may indeed be the case – that as the economy worsens, students turn to higher education as a means of increasing human capital in their field or gaining training in a new one (Kahn 2010, Betts and McFarland 1995, Gustman and Steinmeier 1981). Betts and McFarland (1995) found that a one percent increase in unemployment led to a four percent increase in full time college enrollment in the 80s, while Gustman and Steinmeier (1981) also found that higher unemployment stimulates less choice for work versus school enrollment. Analysis of the effect of graduating under bad economic conditions, besides finding long-term wage penalties, also notes that cohorts who graduate in worse economies have higher levels of educational attainment especially as students pursue graduate education (Kahn 2010).

To determine whether retention is a potential channel through which major decisions are being made when students are exposed to varying economic conditions, tests following the literature on college attendance selection can be performed to determine whether a recession really does increase college completion in the data. A key

[28] Robustness checks will attempt to understand some aspects of student thinking by, for example, using a naïve average pay by major measure rather than covariate adjusted major premiums.

point is that previous papers looked at college attendance rather than completion (Gustman and Steinmeier noted that better conditions reduce probability of *enrollment*, while Betts and McFarland noticed effects on community college enrollment) or involve only selection into education beyond a bachelor's degree (Kahn 2010). The sample used in this paper is those students who *completed* (not just enrolled in) a certain major. The possibility that many of the marginal students who attend school during a recession may drop out before completion, perhaps since they may not have gone to college under other circumstances, could mean that selection plays a different role in this sample.

To test for the presence of retention selection, it is necessary to see whether labor market conditions have a direct impact on the likelihood of completion of a bachelor's degree given that you have a high school education for both men and women:

$$bach_{ist} = \beta_1 * ur_{st} + \beta_2 * age_{it} + \beta_3 * age^2_{it} + \beta_4 * race_{is} + \mu_s + \gamma_t + \varepsilon_{ist}$$

where the outcome variable *bach* indicates whether the individual completed a bachelor's degree or not, given that they started college. A significant value for β_1 (using logit) indicates that there is some selection into completion of a degree based on economic conditions – the same conditions used in regression, a three year moving average of the unemployment rate while deciding on your major at age 21. Just as in the fixed effects calculations of the major premiums, there is no gender control here since the retention selection test will be run for men and women separately.

Table 6: Retention Channel

Dependent Variable: Bachelor's Degree	(1) Men	(2) Women
Unemployment Rate	0.0004	0.0004
	(0.0013)	(0.0012)
Age	0.9318***	0.9964***
	(0.0715)	(0.0442)
Age^2	-0.0126***	-0.0136***
	(0.0010)	(0.0006)
White	0.0508***	0.0577***
	(0.0030)	(0.0033)
State and Year FE	Yes	Yes
Observations	305,621	368,824

Note: Marginal effects shown. Robust standard errors, clustered by state and year, in parentheses. Significance at the 1% level is depicted by ***, at the 5% by **, and at the 10% by*. Data is taken from the 2010 ACS. Unemployment rate data is from the BLS and is used here as the state 3 year moving average.

Using these selection checks, it appears that retention in college is unaffected by the unemployment rate (see Table 6). These results are robust to the possibility that this selection is driven by timing. Students may, for example, be 21 in 2008 but take longer than the typical schedule to obtain their degrees so that in the 2010 Census they have yet

to obtain their bachelor's. It is possible that they will not, but they also may not show in the data as having a degree simply because they have not yet completed rather than due to labor market conditions. However robustness checks of the selection test using only years up until 2005, as well as up until 2000, (to include only individuals who, if they are going to graduate, already have) result in similar conclusions. Student retention is unaffected by the unemployment rate. This indicates that the main results found are reflective of a pure major switching compensating wage differentials channel.

This is a different selection test than the previously cited past literature, which in many cases suggests that students select into college when facing bad labor market conditions**.** Those studies test selection based on the unemployment at age 18, after high school, and this is a test of the effect of unemployment while in college deciding on a major. Those studies also focus on enrollment, while these results capture completion of a degree. While enrollment may increase as marginal students (who might not have gone to school when its opportunity costs were higher) now attend college, this does not mean that they will complete the degree. The effect of the unemployment rate *at age 21 on completion of a bachelor's degree* is therefore insignificant for men and women in this data.

VII. Alternative Specifications and Robustness Checks

A. Major Premiums

The results are robust to a number of specifications, including alternate versions of each of the three main parts of this analysis: computation of the major specific wage premium, the unemployment rate used, and timing of student major decisions. For example, evaluating the model with combined rather than gender specific major premiums as well as the combined (male and female) sample leads to similar results, where students are more likely to choose higher paying majors when unemployment is elevated. Table 7 shows that if covariate adjusted major premiums are calculated for men and women together, with a gender indicator included in the regression, the results for men and women are similar to the results obtained when evaluating men and women separately. The main difference is that male and female graduates' range of elasticities converge due to the combined analysis. Recall that the elasticity at average unemployment levels was 0.027 for men and 0.0057 for women in the main specification. Here those elasticity values are 0.020 and 0.010, respectively. Table 7 also shows what happens when the results are obtained for men and women as a combined sample, both using joint premiums and gender specific ones. This yields similar results, with even more convergence and an average elasticity of 0.014.

Exploiting combined premiums accounts for the fact that it is entirely possible that students do not form beliefs about the payoffs to a certain major using specific premiums but rather more general ones. For this reason Table 7 also shows the results using not just the combined premiums, but the male premiums as the default payoffs in decision making. Notice that this gives a similar result in female student decision-

making, although women who use male payoffs in their decision making become slightly more sensitive to major pay with an elasticity of 0.014 at average unemployment levels.

Table 7: Results with Combined Sample and Major Premiums

	Men & Women		**Men**	**Women**	
	(1) Combined Premiums	(2) Gender Specific Premiums	(3) Combined Premiums	(4) Combined Premiums	(5) Male Premiums
Major Premium	0.0005*** (0.0012)	0.0770*** (0.0012)	0.1152*** (0.0019)	0.0754*** (0.0016)	0.0572*** (0.0014)
Unemployment Rate* Major Premium	0.0019*** (0.0002)	0.0018*** (0.0002)	0.0024*** (0.0003)	0.0009** (0.0003)	0.0007** (0.0002)
Observations	302,164	302,164	134,492	167,672	167,672
Elasticity	0.014	0.015	0.020	0.010	0.014

Note: Major premium measured hourly. Robust standard errors, clustered by individual, in parentheses. Significance at the 1% level is depicted by ***, at the 5% by **, and at the 10% by*. Data is taken from the 2010 ACS. Unemployment rate data is from the BLS and is used here as the state 3 year moving average.

It is also possible that students don't covariate adjust when analyzing relative pay by major as in this model. Table 8 shows what happens when students use a naïve measure of relative major pay – a simple average hourly pay by major metric. Notice that similar results are obtained as in the main specification but students exhibit heightened sensitivity to measures of average pay compared to the covariate-adjusted premium. Men now have an elasticity of 0.085 at average levels of unemployment, while women's elasticity is also noticeably higher at 0.016. These are increases of 215 and 186 percent, respectively, as compared to the preferred specification in Table 4[29]. The drastic increases in major elasticity of substitution suggest that students utilize average pay by major in their decision making rather than covariate adjusting their analysis.

If students don't covariate adjust, they may also fail to account for the entire life cycle of major pay. This equates to a short-term outlook of the relative payoffs a major entails. For this reason Table 8 also shows how student decisions change when major premiums are calculated using just recent graduates (aged 22-30)[30]. The results are consistent with the preferred specification, but also seem to indicate that male graduates are less responsive to short term pay outcomes while female graduates are more responsive to them in their decision-making. The difference is not as large as the change

[29] Average pay by major here is calculated for men and women together to reflect lack of covariate adjustment. Applying average pay by major by gender also yields similar results.
[30] Similar results are obtained using graduates aged 22-35, or even 22-40.

when evaluating average pay by major. Male elasticity decreases by 51.9 percent while female increases by 181 percent.

Table 8: Results with Alternate Major Premiums

	Men		**Women**	
	(1) Average Pay	(2) Short Term Premium	(3) Average Pay	(4) Short Term Premium
Major Premium	0.1044***	0.1603***	0.0196***	0.1071***
	(0.0019)	(0.0031)	(0.0016)	(0.0022)
Unemployment Rate* Major Premium	0.0022***	0.0050***	0.0008***	0.0046***
	(0.0003)	(0.0005)	(0.0003)	(0.0004)
Observations	134,492	134,492	167,672	167,672
Elasticity	0.085	0.013	0.016	0.018

Note: Major premium measured hourly. Robust standard errors, clustered by individual, in parentheses. Significance at the 1% level is depicted by ***, at the 5% by **, and at the 10% by*. Data is taken from the 2010 ACS. Unemployment rate data is from the BLS and is used here as the state 3 year moving average.

There are also endogenous variables that students may or may not consider when analyzing pay by major, namely the employability of a given major and its likelihood of leading to graduate school. Both of these are relevant to the lifetime earnings expected by students of a given major and should therefore be relevant mechanisms through which market conditions impact major decisions. However considering employability or graduate school adds an additional layer to major decisions that involves long term planning by students. For this reason Table 9 examines how the results change when students do not incorporate these elements into their decisions. When students who are not working are excluded from the major premium calculation (columns 1 and 3), reflecting premiums given that students are working and therefore excluding information about relative employability of a major, the results are again similar but both men and women are slightly less responsive to these premiums. The elasticity at average unemployment decreases by 7.4 percent for men and 38.6 percent for women, indicating that students are more likely to incorporate employability by major into their decision.

Student major decisions may also be impacted by decisions about graduate school completion. Since the likelihood of holding a graduate degree varies by major (see Table 3), decisions about which major to choose when facing different labor market conditions may involve long term outlooks about pursuing graduate school (and ideally higher pay). In Table 9 (columns 2 and 4) when premiums are calculated while controlling for graduate school attainment, student response actually increases slightly. This indicates that students respond more to major premiums on average when they do not incorporate potential returns to graduate school. This time the calculated elasticity at

average unemployment increases by 66.7 percent for men and 61.4 percent for women. In all of these alternate premium specifications, the general results remain robust – students are relatively inelastic to majors that pay differently but this sensitivity does increase as the labor market worsens.

Table 9: Results without Endogenous Variables

	Men		**Women**	
	(1) Employability	(2) Graduate School	(3) Employability	(4) Graduate School
Major Premium	0.0853*** (0.0015)	0.1075 *** (0.0020)	0.0440 *** (0.0015)	0.0502 *** (0.0020)
Unemployment Rate* Major Premium	0.0018 *** (0.0002)	0.0025 *** (0.0003)	0.0009 ** (0.0002)	0.0027 *** (0.0003)
Observations	134,492	134,492	167,672	167,672
Elasticity	0.025	0.045	0.0035	0.0092

Note: Major premium measured hourly. Robust standard errors, clustered by individual, in parentheses. Significance at the 1% level is depicted by ***, at the 5% by **, and at the 10% by*. Data is taken from the 2010 ACS. Unemployment rate data is from the BLS and is used here as the state 3 year moving average.

B. Unemployment Rate

The results are also robust to different specifications of the unemployment rate used. For example, Table 10 shows how using only the year specific state unemployment rate[31] rather than the three year moving average results in similar measures for both men and women. In fact the elasticities here are identical to the elasticities at average unemployment for the preferred specification. Additionally, since it is possible that students don't assess their prospects based on a specific measure like the state unemployment rate, columns two and five evaluate the impact of making major decisions during a year classified by the NBER as a recession year[32]. Using an indicator for whether or not a given year's labor market was classified by recession conditions, the results indicate that both men and women respond similarly to general recessions as they do to specific state unemployment rates. In fact the elasticities are once again identical to the preferred specification. Students seem to classify labor market conditions generally rather than responding primarily to a specific indicator.

[31] The state unemployment rate at age 21. Upcoming robustness checks will evaluate the strength of the results at different age matches.

[32] These years include: 1980-82, 1990, 2001, and 2008-09. Each of these had at least six months of the year classified as a recession by the NBER.

Table 10: Results with Different Unemployment Rates

	Men		**Women**	
	(1) No Moving Average	(2) Recession Indicator	(3) No Moving Average	(4) Recession Indicator
Major Premium	0.0914***	0.0999***	0.0610***	0.0652***
	(0.0014)	(0.0005)	(0.0016)	(0.0005)
Unemployment Rate* Major Premium	0.0016***	0.0058***	0.0008**	0.0030***
	(0.0002)	(0.0010)	(0.0002)	(0.0011)
Observations	134,492	134,492	167,672	167,672
Elasticity	0.027	0.027	0.0057	0.0057

Note: Major premium measured hourly. Robust standard errors, clustered by individual, in parentheses. Significance at the 1% level is depicted by ***, at the 5% by **, and at the 10% by*. Data is taken from the 2010 ACS. Unemployment rate data is from the BLS and is used here as the state 3 year moving average.

C. Timing

Finally, the results are robust to variations on timing of major decisions. The preferred specification assumes major decisions are most influenced by labor market conditions when the student is in college and uses a moving average of the unemployment rate at age 21. However changing this assumption slightly does not alter the results. Table 11 shows how students respond in a similar manner to three year moving averages of the unemployment rate at ages 19 and 20. This suggests that major decisions may be the accumulation of a number of years of exposure to general conditions rather than the result of a specific time period. In fact since the nature of the data makes it difficult to precisely pinpoint the age at which a student graduated there may be effects at a number of different ages since some students finish their schooling later than others.

The results do seem to indicate that general labor market conditions around the time of their major decision matter more for the decision than some strict turning point year. Not only does it not matter which measure of the unemployment rate is used (3-year versus single year), but also evaluating different timing of impact still results in a similar measure of how student decision-making is impacted by the business cycle. The general state of the economy as the student is thinking about college matters, perhaps suggesting that the economy impacts decision making through a general 'feeling' about the state of the economy around the time the student is considering attaining a degree. This is also supported by the previously identified robustness of utilizing a specific yearly unemployment rate versus a moving average. Even the robustness of utilizing average major pay instead of premiums indicates that students conduct more generalized analysis rather than specific.

Table 11: Results at Different Age of Major Choice

	Men		Women	
	(2) At Age 19	(3) At Age 20	(5) At Age 19	(6) At Age 20
Major Premium	0.0899*** (0.0016)	0.0906*** (0.0016)	0.0557*** (0.0017)	0.0563*** (0.0017)
Unemployment Rate* Major Premium	0.0018*** (0.0002)	0.0017*** (0.0002)	0.0017*** (0.0003)	0.0016*** (0.0003)
Observations	134,492	134,492	167,672	167,672
Elasticity	0.027	0.027	0.0057	0.0057

Note: Major premium in thousands of dollars. Robust standard errors, clustered by individual, in parentheses. Significance at the 1% level is depicted by ***, at the 5% by **, and at the 10% by*. Data is taken from the 2010 ACS. Unemployment rate data is from the BLS and is used here as the state 3 year moving average.

VIII. Conclusions

Using the new ACS data collected on college majors, this paper finds that students choose higher paying majors when the unemployment rate increases. However this effect is small. Estimating an elasticity of substitution between majors suggests that students are 0.28% more likely to choose a major paying 10% more in a recession when the unemployment rate is very high but only 0.26% more likely when the unemployment rate is very low. This effect varies by gender, with women less sensitive to measures of pay. Female graduates are only 0.060% more likely to choose a major paying 10% more in a recession when the unemployment rate is very high but only 0.055% more likely when the unemployment rate is very low.

The results use a measure of pay by major that is covariate adjusted for relevant factors that influence lifetime earnings of a college graduate in a given field, such as age profiles. Though small, these effects are robust to different specifications of the major pay metric, unemployment rate used, and timing of major decisions.

These conditional logit estimates may be a lower bound estimate of how the economy impacts major decisions as the data does not provide information on college graduation date or age. The significant number of students who finished their degrees later in life are not affected by the economy in the same way, or during the same time, as their traditional counterparts. The impact of the economy on their major decisions during the typical college attendance period should therefore be zero, biasing the results downward.

Additionally many students move to higher paying majors such as engineering when facing a recession, but majors such as business (also relatively high paying) appear to be more popular when in a good economy. The opposing effects may counteract each other in the analysis. The literature also suggests that student beliefs about returns to schooling matter more for their decision-making than actual returns do. Since past literature has also found that student beliefs are often incorrect, the effects of labor market conditions on major found here may be small due to student use of faulty beliefs about the relative lifetime earnings a major rewards.

In general students appear to be most sensitive to measures of average pay, rather than a covariate adjusted major premium, and respond more to relative rankings of major that incorporate information about relative employability of a major than to those that do not. This indicates a tendency to evaluate prospects using general measures rather than more specific ones, something that is furthered by the observation that students evaluate major decisions using general labor market conditions for a number of years just prior to and during college.

Changes in major composition as a result of the business cycle come about through enrolled students switching majors and through students selecting in or out of college completion based on the unemployment rate. In this analysis both men and women are unaffected by the business cycle in their decisions about whether to attain a bachelor's degree. The effects found here are therefore primarily attributable to student major switching as they reevaluate their willingness to accept major bads in exchange for increased lifetime earnings. Therefore through a compensating wage differential channel, students are responsive to different pay by major and the level of this sensitivity increases across the business cycle.

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