

Thesis

Is a New, Innovative Form of Financial Aid Already Threatened?

Abstract:

Purdue University, through their “Back a Boiler” program, is the only major research institution in the United States to offer an Income Share Agreement (ISA) as a form of college financial aid. With an ISA, students receive a specified amount of money to pay for college in return for a percentage of their future income over a certain number of years indicated in the agreement. One concern about the ISA is that it suffers from adverse selection, where students who expect low incomes after graduation predominantly choose the ISA. An initial empirical analysis of Purdue’s program does not find evidence of adverse selection between students of different academic ability or backgrounds in a given major. This is a hopeful sign for the ISA. However, it is possible that the lack of adverse selection was a product of people’s ignorance about how the ISA program works and who benefits most from its conditions. Using experimental data from 31 college participants at the College of the Holy Cross, I measure the impact of additional knowledge of ISAs on the participation rate for ISAs over a traditional loan. I find that greater knowledge of the workings of the ISA does not lead to greater adverse selection and, in fact, might lessen it.

Karter Seitz '22

Advisor: Professor Svec

March 28, 2022

Introduction and Background

As high school students begin their search for the school they will call home for the next four years, some know they want a small liberal arts school, others know they want to live in a big city, and then some college degree seeking individuals cannot look beyond the price tag and potential financial aid before looking at the finer details of a school. In a market with \$1.7 trillion dollars of outstanding debt, student loans and the affordability of college are at the forefront of public policy.¹ Between 1993 and 1999, the percentage of bachelor's degree recipients in the United States borrowing money to fund their education rose 16 percentage points to 65 percent.² Currently, through the federal government, eligible students are offered Direct Unsubsidized, Subsidized, and Parent PLUS loans—all of which contain different repayment timelines and interest rates. As shown in Baum, Elliot, and Ma (2014), the rising costs of college tuition have also caused an increase in the number of students receiving financial aid through either grants, which do not need to be repaid, or loans, which do need to be repaid. However, according to Delavande and Zafar (2014), even with an increase in financial aid, 37% of students are financially constrained in their choice of a university.

There are two issues with college affordability: it constrains the selection of a college, and it can be hard to repay student loans. With only 77 percent of current student debt being in good standing, many individuals are proposing solutions to mitigate the negative consequences of college debt.³ Leading up to the 2020 elections, multiple candidates proposed eliminating all current student debt to stimulate the economy and eliminate the constraint placed on individuals

¹ U.S. Department of Education Federal Student Loan Profile (2020)

² Zhang (2013)

³ U.S. Department of Education (2020)

with heavy student loan debt; others proposed plans to tackle the lack of accessibility to higher education for those financially constrained by making tuition at public institutions free.

In 2016, another alternative model to fix the higher education debt crisis was proposed by Presidential candidate Jeb Bush, who suggested that the existing federal student loan programs be replaced with a model that offered eligible students money for their education in exchange for the government receiving a percentage of their future income.⁴ This idea of entering into a human capital contract and giving up a portion of future earnings is known as an income share agreement (ISA) and is being implemented at select higher education institutions—most notably, Purdue University’s Back a Boiler program.⁵ Under an ISA, individuals receive money upfront to pay for their tuition costs and their repayments are tied to their earnings after graduation. The big selling point of the ISA is that the student does not need to go into debt to attend college. Rather, the student merely agrees to pay a fixed percentage of his or her future income for a set period of time. Because the repayment is tied to the student’s future income, if that student’s future income is low after graduation, then they will pay a small amount of money back as repayment; conversely, higher income earners pay more. Additionally, unlike under a traditional loan, participants that are unemployed are not committed to continue paying a particular repayment rate.⁶ This form of “financial aid” or way of paying for college eliminates the barrier to entry for those that are financially constrained as students that rely on their parents’ credit

⁴ Proposal was influenced by Jason Delisle of the American Enterprise Institute

⁵ Mumford (2020)

⁶ Participants of Purdue’s Back a Boiler program do not make payments if they are making less than \$20,000. The window to pay gets extended for every month in which the participant is earning less than the fixed amount; however, it cannot exceed the maximum term length designated in the ISA.

abilities may not have the option to take out additional loans such as the government sponsored Parent PLUS loan.⁷

In theory, an ISA may sound like a perfect way to increase access to higher education, but would students prefer such a program over a traditional loan? Delisle (2017) examines whether people hearing about ISAs leads them to prefer it over a traditional loan. In a survey conducted by Delisle, 23 to 53 percent of respondents favored ISAs over traditional loans, and those preferring ISAs liked the insurance aspect. If they entered the labor market after graduation unemployed or with a low paying salary, they may have lower financial obligations than under a loan. Delisle also finds a large increase in individuals considering the ISA when a detailed comparison was given between an ISA and traditional loan.

While ISAs may help eliminate or lessen the barrier to entry for those financially constrained, one reason ISAs may not be commonly implemented across higher education is the concern about adverse selection. In the case of ISAs, adverse selection is the problem that weaker students will be more likely to select into an ISA than stronger academic students. According to Burns (2015), in theory, there are three types of individuals who would gravitate towards choosing an ISA: those who are weaker academically, those enrolled in a major with lower marketability and future earnings expectations, or those financially constrained. This means that strong academic students and those with higher future expectations potentially have the incentive to choose a traditional loan instead of an ISA as they would pay less money in the long run. With weaker academic students or financially constrained students being the ones, in theory, to participate in the ISAs, this presents a question of sustainability for the college that

⁷ After receiving grants and federal student loans, individuals needing access to more liquidity must get outside loans. If the parents of an individual are not able to take out a loan, an individual may be financially constrained.

offers the ISA to students. If only the weaker academic students are participating in the program, the ISA generates less money for the college than a traditional loan as those students, on average, earn less and will pay less money back through the ISA. This would lead institutions to worry about the long-run viability of such a program as they would enter a death spiral of giving out more money than they receive back in return.

While Burns (2015) shows that adverse selection is an issue in a theoretical model, we can now see whether adverse selection is a problem in practice using the first few years of Purdue's Back a Boiler ISA program. For some background, Purdue offers ISAs to the students with the most demonstrated need: these students are being offered the ISA as an additional source of funding for their education, alongside grant scholarships and federal student loans. In their ISA program, the income share percentage is determined by a student's major. Majors with similar future salary expectations are placed in a cluster together, and all students participating in the ISA within the same cluster pay the same percentage of their future earnings. Also, only upperclassman are eligible to apply for Purdue's ISA as upperclassman tend to have a strong advantage over first-years in knowledge over relative salary levels.⁸

Mumford (2020) analyzes the first few years of data generated from Purdue's Back a Boiler program in order to test for the resulting degree of adverse selection. He finds that "there is no evidence of adverse selection by student ability, demographics, and a variety of other student characteristics."⁹ Mumford's paper does find evidence of adverse selection within clusters, however, where low-paying majors in a cluster have a greater ISA participation rate

⁸ Betts (1996) and Mumford (2020)

⁹ Mumford uses survey data from 860 students applying for the Back a Boiler program at Purdue University.

than high-paying majors within the same cluster. It is believed that expanding the number of clusters and offering more income share percentages would limit this adverse selection.¹⁰

Even though Purdue offers an ISA and it appears that adverse selection is not a problem in the short run, they do not yet fully understand the potential financial consequences of the program due to the long-term nature associated with students paying back the money. There are, however, some hints about those consequences that can be gleaned from other fields. Madonia and Smith (2020) analyze a short-term version of ISAs in the game of poker called “staking,” where individuals can receive money from investors to cover the costs to play in tournaments in exchange for a future percentage of their winnings. Looking across multiple tournaments, the authors compare the results of specific individuals that use staking in some tournaments and do not use staking in other tournaments. They find evidence that individuals play worse when they use staking. Specifically, around 20% of the decline in performance can be attributed to adverse selection, and most of the decline can be attributed to the diminished marginal incentive associated with staking. When a player uses staking, they have less of an incentive to finish higher in the tournament as they will not personally gain all the money associated with a higher placement. In both Mumford (2020) and Madonia and Smith (2020), decline in average starting salary and performance can mainly be attributed to moral hazard, which means that individuals are more likely to take a lower paying job or try less to beat one additional person in poker because the marginal return is not as great.¹¹ Considering ISAs in the long run, the presence of

¹⁰ Purdue’s Back a Boiler program has 8 major clusters. In a given cluster, all majors provide the same income percentage for the ISA.

¹¹ Mumford (2020) found that on average ISA participants have \$3,000 lower starting salary expectations than non-participants.

moral hazard suggests that students participating an ISA may aim for lower paying jobs, which in return would lower the total financial return for the college institutions offering the ISA.

One concern about these early empirical findings is that they are based on the behavior of an ignorant population: people do not understand ISAs at a deep level and therefore do not game the system as much as they might eventually once more knowledge spreads. While ISAs are not a new concept with schools such as Yale and Duke offering similar ISA programs in the 1980s, many individuals still have never heard of an ISA. This lack of knowledge introduces the key question to my research: how will greater knowledge about the financial outcomes of choosing an ISA impact an individual's perception of the program?

In this paper, I will combine aspects of the theory behind ISAs and the evidence found from ISAs in practice, with the goal of discovering whether adverse selection into an ISA worsens as individuals become more knowledgeable about this form of financial aid. Specifically, this paper will address these questions:

1. *In an experiment using college students at the College of the Holy Cross, does adverse selection into an ISA exist?*
2. *Does adverse selection into the ISA worsen as individuals learn more about the consequences of choosing an ISA?*

Results from my experiment will help us understand whether ISAs can be a viable form of financial aid in the long run. If I find that adverse selection does not worsen with greater understanding of ISAs, then more institutions might choose to implement this type of program and expand access to higher education for those financially constrained. However, I expect that

as individuals become more knowledgeable regarding ISAs, adverse selection will become more prevalent, and ISAs will not be sustainable. This result would then suggest that Mumford's findings are unlikely to persist as Purdue continues to offer the program over the years.

These predictions are based on the theoretical findings by Burns (2015); however, if the theory is correct about the type of students that are more likely to select into an ISA, I do believe that this potential adverse selection problem should be addressed as it is important as a society that we eliminate barriers to entry within higher education.

Experimental Design

To test for the existence of adverse selection in the choice of an ISA and the casual impact of knowledge on the degree of adverse selection, I designed an experiment. As a brief introduction to the experiment, each participant selected either an ISA or a traditional student loan in three separate rounds. Their choice between the two financing options depended on which they believed would be the better financial choice given their identity card for that specific round. Additionally, every participant was randomly assigned to one of three groups, where each group differed based on the degree of knowledge they received about the financial impact of their decision. I monitored each participant's choice to determine whether adverse selection worsened with greater knowledge. I describe more completely the design of this experiment below.

Members of the Class of 2024 and 2025 at the College of the Holy Cross who had previously applied for financial aid were invited to participate in the experiment. While Purdue University only typically offers the ISA to upperclassman, I specifically used underclassman to conduct my experiment. Limiting the experiment to underclassman is important as different class

years may have different background knowledge regarding future salary expectations that they could bring into the experiment. Also, by limiting the participants to only individuals that had previously applied for financial aid, I was able to focus the experiment on participants for whom college financing was a relevant consideration.

After signing up for the experiment, the first task was that all participants had to complete an informed consent document and give verbal consent to providing their best answers to questions in the experiment. After completing this, the participants were given a brief survey to measure their risk aversion and perception of luck. The questions in the survey, included in Figure 1 of the appendix, seek to understand whether an individual sees themselves as lucky and how they value money in the present day versus in the future when given investment opportunities.

Following the survey, participants were given written descriptions of the two college financing options: a traditional student loan and an ISA. Because a written description might not be fully internalized by the participants, the participants were also given visual graphics that displayed how much a hypothetical individual would pay, both in present discounted value terms and in total dollars paid, under the two options for a specific path of income after graduation. These graphics are included in Figure 2 of the appendix. The participants were given as much time as they needed to look over the documents. Finally, before beginning round one of the experiment, each participant was allowed to ask any questions about the financial programs, and the participants occasionally asked for clarification on the payments when the hypothetical individual was unemployed.

The main part of the experiment contained three rounds. In each round, the participant randomly selected one of four possible identity cards. I told each student to imagine that they had

the characteristics of the person described on the card. The card contained an academic major, range and median salary expectations for that given identity, and a grade point average (GPA). Figure 1 shows the possible identity cards participants could randomly select in round one. In each round, two of the identity cards assumed the student was a high-income major, while the other two assumed a lower-income major; the major with the higher salary expectation and median salary was deemed the high-income major. Additionally, in each round, there was an identity card that contained a high GPA and one that contained a lower GPA for each of the major options.

Figure 1

Identity Card	Identity Card	Identity Card	Identity Card
<ul style="list-style-type: none"> • Major: Studio Art • Salary Expectations <ul style="list-style-type: none"> ◦ Range: \$29,000 – \$59,000 ◦ Median: \$35,000 • GPA: 3.5 	<ul style="list-style-type: none"> • Major: Studio Art • Salary Expectations <ul style="list-style-type: none"> ◦ Range: \$29,000 – \$59,000 ◦ Median: \$35,000 • GPA: 2.7 	<ul style="list-style-type: none"> • Major: Chemistry • Salary Expectations <ul style="list-style-type: none"> ◦ Range: \$31,000 – \$75,000 ◦ Median: \$51,000 • GPA: 3.1 	<ul style="list-style-type: none"> • Major: Chemistry • Salary Expectations <ul style="list-style-type: none"> ◦ Range: \$31,000 – \$75,000 ◦ Median: \$51,000 • GPA: 3.7
1	2	3	4

After randomly choosing the identity card, the participant was given a financing option sheet that contained the specifics of the traditional student loan and ISA program that the participant could choose between. The student loan offered to each participant was exactly the same in all three rounds. The loan was for \$10,000 and contained a repayment plan spanning 10 years with a 6.28% interest rate and a loan fee of 4.228%. Additionally, the participant learned from the loan description that these loan terms implied a constant yearly payment of \$1505 for the 10 years. The financing option sheet also contained the specifics of the ISA being offered. For the ISA, it was tailored to the major of that participant's identity, as is done in Purdue's Back a Boiler program. As an example, if the participant randomly selected the identity card of a

Studio Art major with a high GPA, then the participant's options were between the student loan described above and an ISA with an income share of 3.85% for 9.33 years, shown in Figure 2.¹² However, if the participant randomly selected the identity of a Chemistry major with a high GPA, then the participant's options were between the student loan and an income share of 3.85% for 8.66 years. These ISA terms mirror the terms offered by Purdue for these given majors.

Figure 2: ISA Terms by Major

ID #	Major	High/Low GPA	Income Share (%)	Length of ISA (years)
1	Studio Art	High	3.85	9.33
2	Studio Art	Low	3.85	9.33
3	Chemistry	Low	3.85	8.66
4	Chemistry	High	3.85	8.66

Given the potential college financing options, participants were then asked the following question:

Q1: "If you were the person described in this identity card and thinking of attending college, which tuition payment plan would you choose?"

At this point, participants had unlimited time to study the identity card and the financing options and make their selection between the two programs. The participants had access to a calculator during this section of the experiment. Then, after selecting between the two financing options, the participants were asked:

Q2: "Are you confident that you made the correct choice or were you relatively indifferent?"

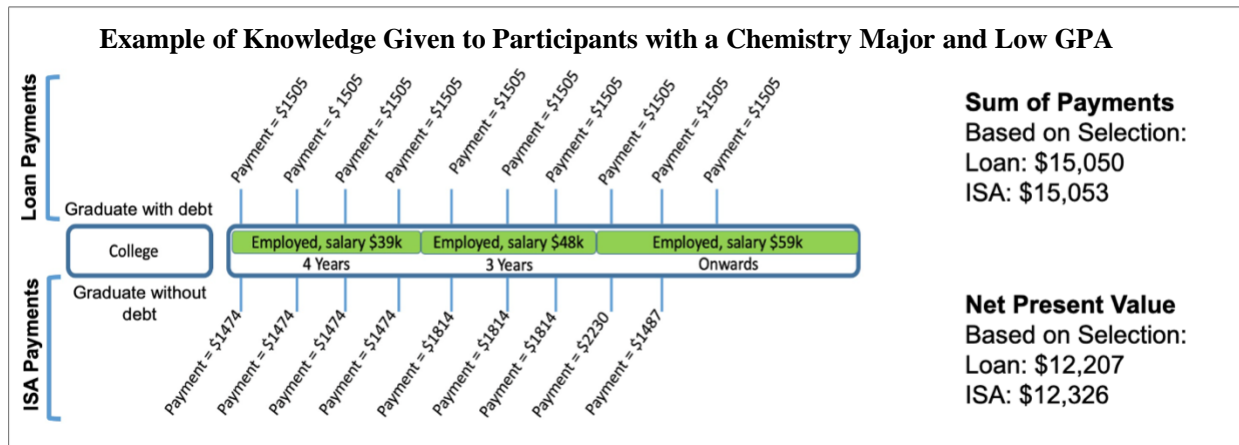
¹² The financing option sheets given to the participants based off their chosen identity are in the appendix. The details of the student loan are included in Figure 2 and Figure 5 of the appendix.

After recording the answers of the participants, we now arrive at the point in the experiment where there is exogenous variation in the information given to the subjects, variation that is critical to the experiment's design.

As I mentioned earlier, each participant was assigned to one of three groups at the start of the experiment. After making their financing selection in round one and announcing their confidence in this selection, participants in Group 3 were given knowledge about both the outcome of their selection and the alternative financing option that they had rejected, while participants in Groups 1 and 2 directly moved onto the next round.

An example of the knowledge received by the participants of Group 3 can be found in Figure 3. In the top half of the graphic, one can see the yearly payments that a hypothetical student (with an identity consistent with the one randomly chosen by the participant) would pay under the traditional student loan assuming a specific path of the person's annual income; the bottom half gives the yearly payments for that same hypothetical student under the ISA. As a reminder, the ISA is unique to each identity card, since each major has a different repayment timeline and percentage of income that is repaid. Finally, the far right of the graphic displays the sum of payments, as well as the net present value of these payments. In this experiment, I used a rate of 4% in the net present value calculations to discount each yearly payment to today's dollars and then sum each year.

Figure 3



In the knowledge sheet depicted above, the individual has a starting salary which changes after the fourth and seventh year. In each round, the starting salaries varied for all four identities. However, the time between raises or periods of unemployment stayed constant. Also, the percentage of salary raises was consistent across the four identities. All the knowledge sheets are included in Figure 3 of the appendix.

After the participants in Groups 1 and 2 answer “Q2” above and participants in Group 3 received knowledge about the consequences of their decision relative to the alternative, the first round is over.

In the following round, each participant will repeat the same process of randomly selecting an identity card, receiving a unique financing option sheet, and making their selection in round two and three. However, there are two differences for the subsequent rounds. Rounds one, two, and three all contain a different set of four identity cards. This means that the majors, salaries, and GPA combinations are different in rounds two and three. Also, in round two, both Group 2 and Group 3 participants receive knowledge on their decision, compared to only Group 3 receiving knowledge in the first round. Figure 4 is a table that lays out which groups receive knowledge depending on the round number.

Figure 4

		Group		
		1	2	3
Round	1	<ul style="list-style-type: none"> - Randomly chooses identity - Makes decision - Receives no knowledge 	<ul style="list-style-type: none"> - Randomly chooses identity - Makes decision - Receives no knowledge 	<ul style="list-style-type: none"> - Randomly chooses identity - Makes decision - Receives knowledge
	2	<ul style="list-style-type: none"> - Randomly chooses identity - Makes decision - Receives no knowledge 	<ul style="list-style-type: none"> - Randomly chooses identity - Makes decision - Receives knowledge 	<ul style="list-style-type: none"> - Randomly chooses identity - Makes decision - Receives knowledge
	3	<ul style="list-style-type: none"> - Randomly chooses identity - Makes decision 	<ul style="list-style-type: none"> - Randomly chooses identity - Makes decision 	<ul style="list-style-type: none"> - Randomly chooses identity - Makes decision

By comparing the likelihood that subjects in Group 3 choose the ISA in round 2 to the likelihood of the subjects in Group 1 and Group 2, I can test for whether greater knowledge about the ISA impacts the choice between the ISA and traditional loan: showing if adverse selection worsens or gets better in the presence of knowledge. Further, by comparing the likelihood that subjects in Group 2 and Group 3 choose the ISA in round 3 to the likelihood of the subjects in Group 1, I can test for whether knowledge, in at least one round, impacts the subject's financial decision.

Data

For this experiment, 31 students participated in each round. As mentioned above, in each round of the experiment, the participant received an identity card with background information. The backgrounds included student major, expected median range of starting salary, and GPA. I did not assign a class year or gender to the participant in each round, so I recorded the participant's own identity as the variables "year" and "gender" as this information could help influence their decision between the student loan and the ISA. Overall, 48.4% of participants

were members of the Class of 2025, and 54.8% of the participants identified as a female—as shown in Table 1.

Prior to the start of the first round, I had each participant complete a survey related to risk aversion and luck. From the results of this survey, I established a “luck” variable, where participants that perceived themselves as unlucky received a 1, neither lucky nor unlucky received a value of 2, and lucky got assigned a 3. As seen in Figure 4, the mean score of “luck” was a 1.97 with a standard deviation of 0.31, ergo the average participant viewed themselves as neither lucky nor unlucky.

I also used this survey to establish each participant’s degree of risk aversion. For this variable, participants were given a 1 if they were risk loving, 2 if leaned risk loving, 3 if risk neutral, 4 if leaned risk adverse, and a value of 5 if they were risk adverse. This variable had a mean of 2.52. Luck and risk aversion variables are important as I expect that individuals that view themselves as risk adverse would be more inclined to select the ISA as it serves as insurance on their education in case of a low salary or period of unemployment. Additionally, I expect that someone that sees themselves as lucky would expect to get a salary in the higher portion of the salary range provided.

Table 1: Participant Summary Statistics

Variables	Mean	St. Deviation	Min	Max
Gender	0.548	0.500	0	1
Luck	1.968	0.311	1	3
Year	0.484	0.502	0	1
Risk Aversion	2.516	1.551	1	5

Before starting the experiment, each participant was randomly assigned a group number that determined the amount of knowledge they would receive at the end of each round. With this

data, I created two dummy variables: “knowledge1” and “knowledge2.” Participants that received knowledge in the first round were given a value of 1 for knowledge1, and those that did not receive knowledge in this round given a value of 0. Similarly, in round two, participants that received knowledge after their selection received a value of 1 for knowledge2, while those that did not receive knowledge got a value of 0. Furthermore, 35.5% of participants received knowledge in the first round, and 64.5% of participants received knowledge in the second round.

There were two possible majors indicated in the set of identity cards for each round; out of these two majors, one was a high-earning major, and the other was a lower-earning major. All six majors included in the experiment are majors offered at Holy Cross. The range of salaries listed on the identity card were taken from the online calculator provided on Purdue’s Back a Boiler website. Furthermore, the median salaries listed on the identity cards are the median salary for that major from graduates of the Class of 2020 at Holy Cross.

When recording the majors during the experiment, they were recorded as a dummy variable “high income,” with a value of 1 if the participant’s identity card listed the higher-earning major and 0 if it listed the lower-earning major in that round. Similarly, for recording the GPA of a participant in each round, I used the dummy variable “high GPA” with a value of 1 if the individual received the higher GPA and a value of 0 if the participant received the lower GPA for that given major.

The final two variables that I collected in each round are “choice” and “confidence.” The choice variable is defined as a 1 if the participant selected the ISA and a 0 if they selected the traditional loan. Across all rounds of the experiment, 61.3% of individuals chose the ISA over the traditional student loan. After making the financing option choice, participants were asked about their confidence of that choice. Participants were given a value of 1 if they were confident

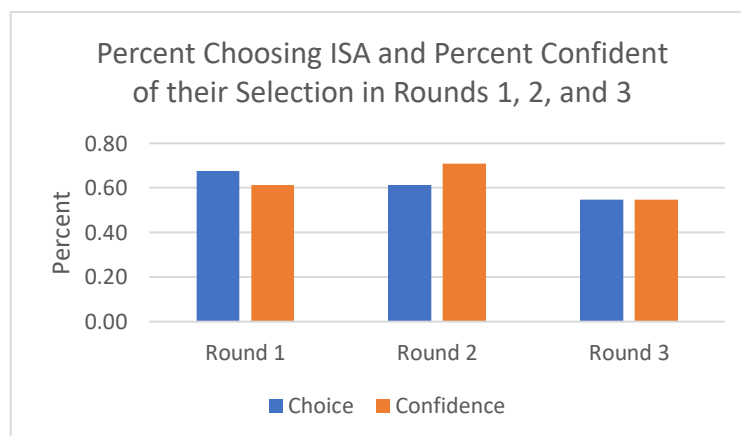
that their choice was the best option a value of 0 if they were indifferent between the two options. 62.4% of participants were confident in their financing selection.

Table 2: Summary Statistics

Variables	Mean	St. Deviation	Min	Max
Choice	0.613	0.490	0	1
Confidence	0.624	0.487	0	1
High GPA	0.527	0.502	0	1
High Income	0.581	0.496	0	1
Knowledge1	0.355	0.481	0	1
Knwoledge2	0.645	0.481	0	1

While the mean shows that 61% of individuals chose the ISA over the student loan, how does this change across rounds? In Figure 5, I plot the percent of individuals choosing the ISA and percent that were confident in their choice across the three rounds. As that figure shows, the percentage of individuals choosing the ISA decreases from round to round in the experiment, where from round one to round three, the participation falls by 13 percentage points, from 68% to 55%. Additionally, participants' confidence in selecting correctly between the ISA and student loans decreased 6 percentage points from round one to round three, with an increase in the second round.

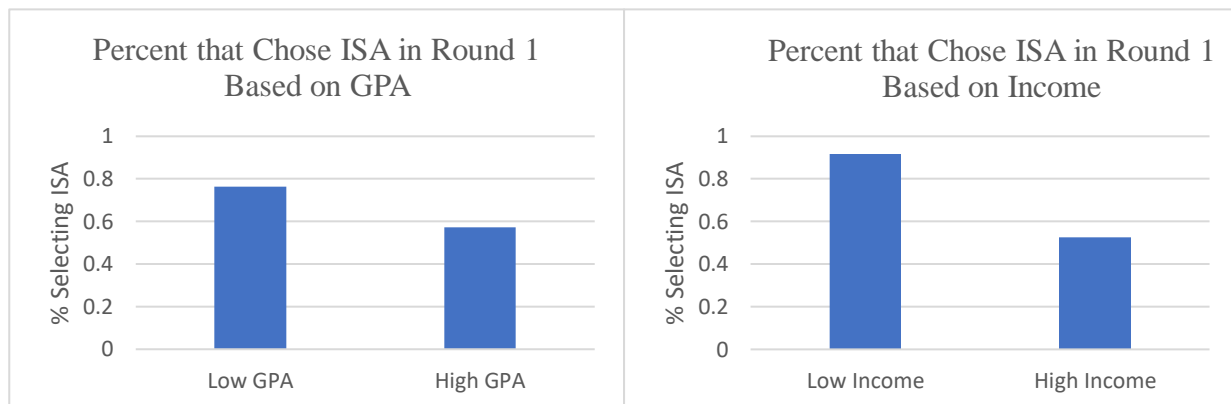
Figure 5



This graphic, however, does not show the impact of knowledge, having a high/low GPA, or having a higher/lower-earning major on a participant's choice. While I will describe my empirical strategy and display my results shortly, let me first visually display some of the correlations in my data.

In Figure 6, on the left, I plot the percentage of individuals that select the ISA in round one based on the student's assumed GPA; then on the right, I plot the percentage that chose the ISA in round one based on whether their identity chosen had the low or high earning major. In round one, no individuals were given knowledge before making their selection. These graphs show that in round one, participants who were given a low GPA selected the ISA more often than those with a high GPA. Similarly, the participants who picked an identity card with a lower-earning income also selected the ISA more often than those receiving an identity with a higher-earning income. These figures suggest that adverse selection into the ISA might be a concern.

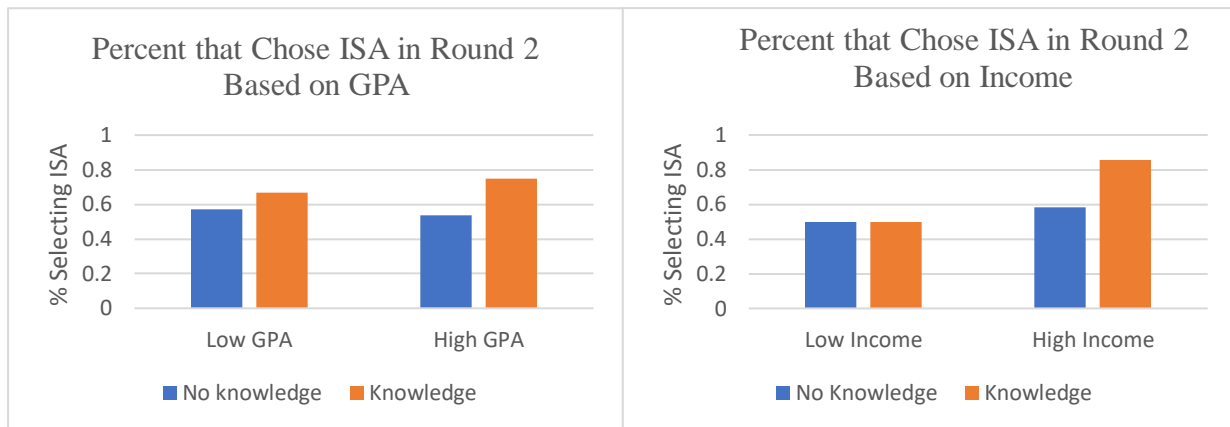
Figure 6



Since no individuals were given knowledge prior to the first round, we need to look at the second and third rounds to see the potential impact of knowledge. In Figure 7, I plot the same information as Figure 6, however, I break down the GPA and income each into two columns based on whether the participant received knowledge after their choice in the first round. In

round two, individuals that received knowledge after their first-round selection chose the ISA more often, regardless of whether their identity card listed a low or high GPA. Similarly, individuals that received knowledge on their first-round selection chose the ISA either at the same rate or more often when they received a lower-earning and higher earning major, respectively. Both results are different than expected because, if adverse selection is guiding decisions in round two, individuals that receive an identity card in which they have a high GPA or a high income should be less likely to choose the ISA; when an individual has a high GPA or high income, it typically means they will be placed in a better position to receive a higher paying job, making the ISA less attractive.

Figure 7

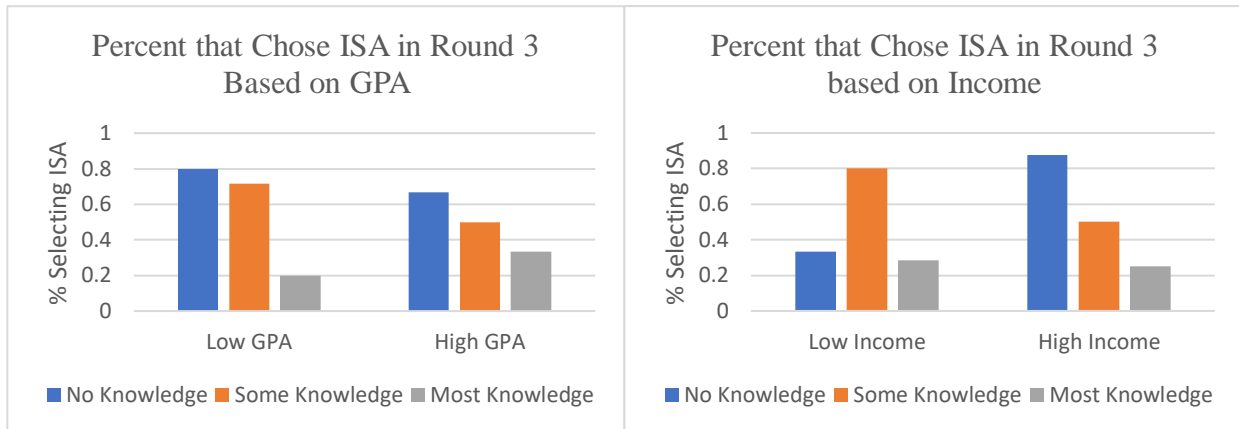


More relevant to the key question in my analysis, the figures also show that in round two, knowledge is not influencing participant's decision between the ISA and student loans, contradicting my prediction. I had expected that as subjects gained knowledge and learned more about their previous round decision, they would select into the ISA at a smaller rate than the traditional loan if they had a high GPA or high income.

With my prediction not holding visually based on the round two figures (though empirical tests will soon be described), I looked to round three to see if additional knowledge

changed the results. In Figure 8, I continue plotting the percentage of individuals choosing the ISA based on GPA and income, and I break down these two variables by whether the participant received no knowledge, knowledge only on the second round choice, or knowledge after their first and second round. The graphic on the left shows that for individuals that randomly chose an identity with a low GPA, the more knowledge they possess, the less likely they are to select the ISA. This goes against the theory behind ISAs as individuals with low GPAs should be more likely to take the ISA. It also goes against my hypothesis as more knowledge does not appear to lead individuals with low GPAs to select the ISA more often. Conversely, the theory behind ISAs holds true for individuals that received an identity with a high GPA as the more knowledge individuals received, the less likely they were to select into the ISA.

The graphic on the right suggests that individuals with a higher-earning major were less likely to select the ISA when they had more knowledge. The adverse selection into the ISA (as predicted by Burns (2015)) holds in this scenario. When considering individuals with lower-earning majors, they should select the ISA more. For the individuals that received information only from round two, this theory of lower-earning major individuals selecting into the ISA holds when compared to the participants that received no information. However, this does not hold for the participants that received knowledge on their first and second round decisions as the percent choosing the ISA increases.

Figure 8

All the above results are mere correlational results. In the next section, I turn to more formal, statistical tests of whether greater knowledge of the workings of the ISA generates a greater degree of adverse selection into the ISA.

Regressions and Analysis

To analyze the impact of knowledge on the degree of adverse selection into the ISA, I ran multiple dprobit regressions to obtain marginal effects of the variables. In addressing these marginal effects, I will use three claims to guide my analysis and three tables to show the empirical results from rounds one, two, and three. Each table contains three regressions from the given round of the experiment. Additionally, with the dependent variable being the subjects' choice of financial aid in each regression, the variation between the three regressions in each of the three rounds comes from the independent variables.

The following three equations represent the regressions used to analyze the data from round one and serve as the base to the three regressions found in each of the following rounds.

$$(1) \text{ Prob}(\text{Choice})_i = \alpha + \beta_1 \text{HighGPA}_i + \text{Controls} + \varepsilon_i$$

$$(2) \text{ Prob}(\text{Choice})_i = \alpha + \beta_2 \text{HighIncome}_i + \text{Controls} + \varepsilon_i$$

$$(3) \text{ Prob}(\text{Choice})_i = \alpha + \beta_1 \text{HighGPA}_i + \beta_2 \text{HighIncome}_i + \text{Controls} + \varepsilon_i$$

The first regression uses GPA and all covariates besides income, the second regression uses income and all covariates besides GPA, and the final regression uses all covariates. In doing so, the first regression tests for whether adverse selection occurs along the margin of GPA in the first round. Alternatively, the second regression tests for whether adverse selection occurs along the margin of income. Lastly, the third regression combines everything in one empirical model. The controls I use are class year, gender, confidence, risk aversion, and luck.

Question 1: Does adverse selection exist in the first round?

Considering Regressions 2 and 3 in Table 3, we see some evidence of adverse selection. Individuals randomly assigned an identity with a high-earning major are estimated to be approximately 42% less likely to select into the ISA than individuals with a low-earning major. This statistically significant result goes against Mumford's findings at Purdue; however, it is consistent with the theory of ISAs: students in majors that have high income expectations are less likely to select into an ISA as they expect to earn high wages after graduation, making the traditional student loan the more affordable option in the long run. While adverse selection does seem apparent based on income in Regressions 2 and 3, we do not find evidence of adverse selection in round one for individuals with a high GPA—meaning that better students in a given major do not disproportionately choose the traditional student loan. Additionally, in Regressions 2 and 3, Risk Aversion is significant with a positive marginal effect. This follows the theory of ISAs as it is expected that someone who is risk adverse will choose an ISA since it acts as insurance in case of a low wage or period of unemployment.

Table 3: Round 1 Regressions

	Regression 1	Regression 2	Regression 3
Variables	dF/dx (Robust Std. Error)	dF/dx (Robust Std. Error)	dF/dx (Robust Std. Error)
High GPA	-1.6729 (0.1629)		-0.0403 (0.1542)
High Income		-0.4274*** (0.1461)	-0.4212*** (0.1566)
Year	-0.1973 (0.1671)	-0.1152 (0.1775)	-0.1238 (0.1799)
Gender	0.0745 (0.1942)	0.1165 (0.1919)	0.1005 (0.1736)
Confidence	0.0301 (0.1776)	0.09897 (0.1829)	0.0874 (0.1913)
Risk Aversion	-0.1387** (0.0595)	0.14356*** (0.0591)	0.144*** (0.0593)
Luck	-0.06402 (0.1898)	-0.2448 (0.1552)	-0.2441 (0.16)

Significance codes: *** = 0.01, ** = 0.05, * = 0.1

Question 2: Does receiving knowledge regarding the participant's round one decision worsen adverse selection in the second round?

After considering the case of round one and experiencing hints of adverse selection when individuals randomly selected an identity with a high-earning major, let's consider the impact of knowledge₁ on ISA participation in the second round. This will test my paper's key hypothesis regarding whether greater knowledge of how an ISA works and who it favors exacerbates the degree of adverse selection that occurs into an ISA. To do this, I generated two new interaction terms. The first interaction term is "GPA*Knowledge₁" which returns a value of 1 when the individual received knowledge about their first-round choice and randomly selected an identity card in the second round with a high GPA; it returns a value of 0 otherwise. The other new interaction term is "Income*Knowledge₁"; this variable has a value of 1 when an individual received knowledge on their round one choice and selected an identity with the high-earning

major. Similarly, this variable has a value of 0 otherwise. These interaction terms were used to create the following three regressions to analyze the impact of knowledge in the first round on adverse selection.

$$(4) \text{ Prob(Choice)}_i = \alpha + \beta_1 \text{HighGPA}_i + \beta_2 \text{Knowledge1}_i + \beta_3 \text{GPA} * \text{Knowledge1}_i + \text{Controls} + \varepsilon_i$$

$$(5) \text{ Prob(Choice)}_i = \alpha + \beta_1 \text{HighIncome}_i + \beta_2 \text{Knowledge1}_i + \beta_3 \text{Income} * \text{Knowledge1}_i + \text{Controls} + \varepsilon_i$$

$$(6) \text{ Prob(Choice)}_i = \alpha + \beta_1 \text{HighIncome}_i + \beta_2 \text{HighGPA}_i + \beta_3 \text{Knowledge1}_i + \beta_4 \text{GPA} * \text{Knowledge1}_i + \beta_4 \text{Income} * \text{Knowledge1}_i + \text{Controls} + \varepsilon_i$$

Looking at Table 4, the coefficient on GPA*Knowledge1 is positive and statistically significant. Contrary to the theoretical predictions in Burns (2015), this suggests that adverse selection does not worsen with knowledge and, actually, it improves. In fact, judging the size of the coefficient, someone with knowledge is a lot more responsive to GPA than someone who was not given knowledge in the same round. Specifically, in the scenario, a subject with knowledge would be 66% more likely to choose the ISA when their GPA goes from low to high than someone who was not given knowledge.

When looking at income expectations, you can see that the coefficient is not statistically significant, meaning that knowledge given regarding the participant's round one decision does not alter the degree in round two of adverse selection with respect to income expectations.

Table 4: Round 2 Regressions

	Regression 4	Regression 5	Regression 6
Variables	dF/dx (Robust Std. Error)	dF/dx (Robust Std. Error)	dF/dx (Robust Std. Error)
High GPA	-0.1199 (0.2044)		-0.2797 (0.2015)

High Income		0.2604 (0.2796)	0.4094 (0.2591)
Knowledge1	-0.4757 (0.3501)	-0.452 (0.3354)	-0.9766* (0.0695)
GPA*Knowledge1	0.4905 (0.2151)		0.6603* (0.1411)
Income*Knowledge1		0.4541 (0.1773)	0.4532 (0.1589)
Year	-0.2241 (0.2071)	0.0716 (0.2268)	-0.1272 (0.3121)
Gender	-0.3498 (0.2167)	-0.4424** (0.1857)	-0.6679* (0.2098)
Confidence	0.2865 (0.2217)	0.4326* (0.2282)	0.345 (0.3205)
Risk Aversion	0.0239 (0.0579)	0.0042 (0.0684)	0.0355 (0.0712)
Luck	-0.1639 (0.345)	-0.137 (0.3066)	-0.6887* (0.3402)

Significance codes: *** = 0.01, ** = 0.05, * = 0.1

Claim 3: Does receiving knowledge regarding the participant's round two decision worsen adverse selection in the third round?

In round three, subjects either have no knowledge from their previous financial aid decisions, knowledge from the second round decision only, or knowledge from both the first and second rounds. Due to the limited sample size, I am unable to separate the impact between receiving knowledge in the second round and knowledge in both the first and second round; because of this constraint, Knowledge2 combines both of these effects into one variable.

Similar to round two, I created two new dummy variables in round three to examine the impact of knowledge from the second round on participation in the round three regressions. The first interaction term is "GPA*Knowledge2" which returns a value of 1 when the individual

received knowledge about their second round choice and randomly selected an identity card in the third round with a high GPA; it returns a value of 0 otherwise. The other new interaction term is “Income*Knowledge2”; this variable has a value of 1 when an individual received knowledge on their round two choice and selected an identity with the high-earning major in round three. Similarly, this variable has a value of 0 otherwise. Using these new interaction terms, I formed the following regressions to analyze the impact of knowledge in the second round on adverse selection.

$$(7) \text{ Prob(Choice)}_i = \alpha + \beta_1 \text{HighGPA}_i + \beta_2 \text{Knowledge2}_i + \beta_3 \text{GPA} * \text{Knowledge2}_i \\ + \text{Controls} + \varepsilon_i$$

$$(8) \text{ Prob(Choice)}_i = \alpha + \beta_1 \text{HighIncome}_i + \beta_2 \text{Knowledge2}_i + \beta_3 \text{Income} * \text{Knowledge2}_i \\ + \text{Controls} + \varepsilon_i$$

$$(9) \text{ Prob(Choice)}_i = \alpha + \beta_1 \text{HighIncome}_i + \beta_2 \text{HighGPA}_i + \beta_3 \text{Knowledge2}_i + \\ \beta_4 \text{GPA} * \text{Knowledge2}_i + \beta_4 \text{Income} * \text{Knowledge2}_i + \text{Controls} + \varepsilon_i$$

As shown in Table 5, GPA*Knowledge2 is positive and statistically significant; in fact, these are the same findings from round two. Based on the results from Regression 9, subjects receiving knowledge in the second round are nearly 72% more likely to select into an ISA when their GPA goes from low to high. This is extremely good news for institutions offering ISAs as they may avoid the death spiral that was predicted by theory. If students with knowledge are more likely to select into the ISA when their GPA is high, then universities may not need to be as worried about the financial sustainability of an ISA program. With the expectation that students with high GPAs are stronger candidates entering the labor market and may receive higher wages, institutions should expect to receive more money over the course of the ISA repayment period compared to traditional financial aid.

The coefficients related to income expectations, on the other hand, may tell a different story. In Regression 9, you can see that the coefficient for Income*Knowledge2 is negative and significant. Further, the magnitude of the coefficient suggests that knowledge in the second round causes adverse selection to worsen. A subject receiving knowledge in this round is 99% less likely to choose the ISA when they go from having a low-earning major to a high-earning major.

Conversely, we see the opposite result for participants with a high-income identity in round three that did not receive knowledge on their previous decision. The coefficient of High Income is positive and significant, and, in this case specifically, it means that someone without knowledge in round two is nearly 97% more likely to select into an ISA when their income goes from low to high. With these two coefficients, we see that adverse selection worsens in the presence of knowledge in terms of a participant in a high-income major.

Lastly, the variable Knowledge2 is positive and statistically significant in Regression 9 as well. This suggests that subjects, without a high income nor a high GPA, are 97% more likely to participate in an ISA when they go from not receiving knowledge to receiving knowledge on their previous decision. This result lines up exactly with the findings in Burns (2015) that individuals in majors with lower future income expectations or receiving grades that make them less competitive entering the workforce would prefer to take on an ISA than a traditional student loan.

Table 5: Round 3 Regressions

	Regression 7	Regression 8	Regression 9
Variables	dF/dx (Robust Std. Error)	dF/dx (Robust Std. Error)	dF/dx (Robust Std. Error)
High GPA	0.0203 (0.3554)		0.0249 (0.2324)

High Income		.9072*** (0.0876)	0.9664*** (0.04678)
Knowledge2	-0.066 (0.3318)	.7432*** (0.1729)	0.9678*** (0.0498)
GPA*Knowledge2	-0.3509 (0.3988)		0.7201** (0.2025)
Income*Knowledge2		-0.9599*** (0.0449)	-0.9927*** (0.0142)
Year	-0.2731 (0.1846)	-0.5095** (0.1878)	-0.5677** (0.1949)
Gender	0.3514 (0.2295)	.5294** (0.2254)	0.8005*** (0.1481)
Confidence	-0.1272 (0.2206)	0.2016 (0.2455)	0.1603 (0.2388)
Risk Aversion	-0.1913** (0.079)	-0.3139*** (0.1044)	-0.436*** (0.1213)
Luck	0.0892 (0.3619)	0.3932 (0.4779)	0.121 (0.4795)

Significance codes: *** = 0.01, ** = 0.05, * = 0.1

Limitations

When thinking through the implications of this experiment, the number of participants was the largest concern. With only 31 participants, it is hard to know whether my findings are representative of the broader population or whether the small sample size implies that my findings only hold for this select group of subjects. Considering all the participants attended Holy Cross, there is also the potential that having a participant pool of only students attending one liberal arts college may not be representative of the larger population as well. Ultimately, students of a liberal arts institution may have different perceptions about the potential incomes from a social science or humanities major than individuals that attend a different type of institution. That being said, I believe that the design of my experiment is the appropriate test of

whether knowledge of the ISA would lead to a worsening of the problem of adverse selection into the ISA.

Additionally, when considering the fundamentals of the ISA program, if one is unemployed, they do not pay anything. Alternatively, when someone has a student loan and they are unemployed, they still have payments. In real life, many individuals will become delinquent on their loan payments in times of no income or even limited income. However, in my experiment, all student loan payments were made on time regardless of periods of unemployment or lower income. Due to this, the student loan may have seemed like the more attractive option as the sum of payments was lower than it would have been if someone went through a period of low income while still making student loan payments. Ergo, if a participant received knowledge, it could have been impacted in a way that it would not have if someone defaulted on their loan. However, this limitation existed due to the overall complexity, the number of identities that would have been needed to include it, and the anticipated low number of participants.

Conclusion

At the start of the experiment, I had one goal: discover whether adverse selection into an ISA worsens as individuals become more knowledgeable about this form of financial aid. It was expected that as individuals became more knowledgeable, adverse selection into the ISA would become worse and worse. By using experimental data from 31 college participants at the College of the Holy Cross, I find that greater knowledge of the workings of the ISA actually does not lead to greater adverse selection and, in fact, might lessen it. In the first round of the experiment, I found that adverse selection was occurring for individuals that had a high-earning major. This was not true for the individuals with high GPAs. However, by round three with the addition of

knowledge, I found the adverse selection that was occurring in round one did not get worse, but potentially even improved.

As mentioned in the limitations section, one large shortcoming of my study was the small number of participants in the experiment. After seeing the significant results from round three, I believe that it is crucial to continue this study with a larger number of participants to determine if my findings reflect the behavior of the larger population or are skewed by the set of subjects in my experiment. With the ISA being a way to increase access to higher education and lowering the barrier to entry for those that are financially constrained, it is important that we continue researching and discovering the real effect of knowledge on adverse selection. While it is important to expand access to higher education, I do caution the selection into ISAs for some individuals as it seems to be more expensive in the long run in many situations. However, that is noted from the theory of ISAs; but in reality, we see individuals still preferring the ISA regardless of having high-earning majors or high GPAs. This brings us back to the final notion and largest takeaway from this experiment: additional knowledge may help adverse selection into an ISA, resulting in the potential for ISA programs to be sustainable for colleges and universities in the long run.

Acknowledgments

Thank you to Professor Justin Svec for helping me throughout the entire Economic Honors Program. From deciding on a research topic to designing the experiment, my ability to complete this thesis would not have been possible, and I am extremely grateful for your support. Additionally, thank you to the Holy Cross Ignite Fund for your financial support in the experiment and giving me the ability to offer incentives to gain participants in the study.

Appendix

Figure 1: Risk Aversion and Luck Survey Questions¹³

1. Suppose that a distant relative left you a share in a private business worth one hundred thousand dollars. You are immediately faced with a choice:

- (a) cash out now and take the \$100,000 or
- (b) wait until the company goes public in one month which would give you a 50 percent chance of doubling your money to \$200,000, and a 50 percent chance of losing one-third of it, leaving you with \$66,000.

Would you cash out immediately or wait until after the company goes public?

- cash out
- wait
- don't know

If you selected wait in question 1, complete the following question:

1a. Suppose that a distant relative left you a share in a private business worth one hundred thousand dollars. You are immediately faced with a choice:

- (a) cash out now and take the \$100,000 or
- (b) wait until the company goes public in one month which would give you a 50 percent chance of doubling your money to \$200,000, and a 50 percent chance of losing one-half of it, leaving you with \$50,000.

Would you cash out immediately or wait until after the company goes public?

- cash out
- wait
- don't know

¹³ Questions taken from Mumford (2020)

If you selected cash-out in question 1, complete the following question:

1b. Suppose that a distant relative left you a share in a private business worth one hundred thousand dollars. You are immediately faced with a choice:

- (a) cash out now and take the \$100,000 or
- (b) wait until the company goes public in one month which would give you a 50 percent chance of doubling your money to \$200,000, and a 50 percent chance of losing one-fifth of it, leaving you with \$80,000.

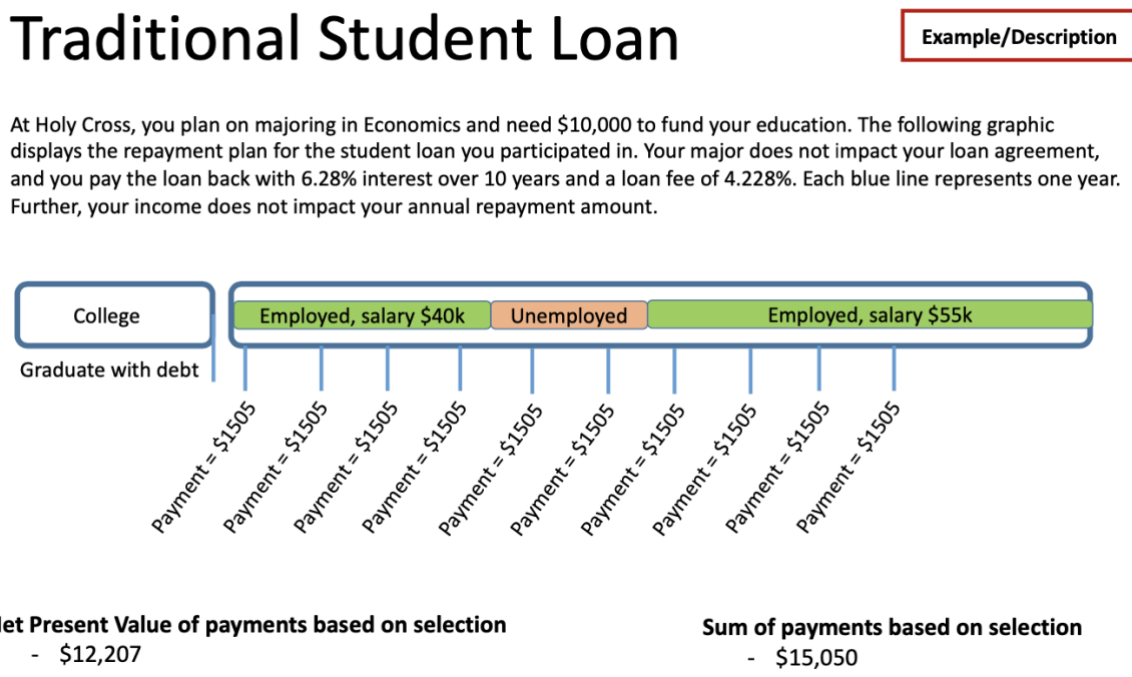
Would you cash out immediately or wait until after the company goes public?

- cash out
- wait
- don't know

2. Imagine that a coin will be flipped 10 times. Each time, if heads, you win \$10. What is your own estimation, according to your experience and your luck, of the number of times heads will occur (i.e. how many times (out of ten) do you think you are going to win and get \$10)?

Answer: _____

Figure 2: Descriptions of Student Loan and ISA



Income Share Agreement (ISA)

Example/Description

At Holy Cross, you plan on majoring in Economics and need \$10,000 to fund your education. If you choose the ISA option as an Economics major, then to repay the plan, you will pay 3.78% of your annual income for 8.75 years. For example, if you earn \$40,000 each year, then you would pay \$1512 each year as repayment. Importantly, each blue line represents one year, and the repayment depends on your income. If your earnings increase, your payment increases. If your earnings decrease, your payment decreases. Similarly, if you are unemployed and do not have an income, the payments pause, and you do not make any payment during that time.

The following diagram is one possible career trajectory, but each ISA repayment is unique to an individual's annual salary.

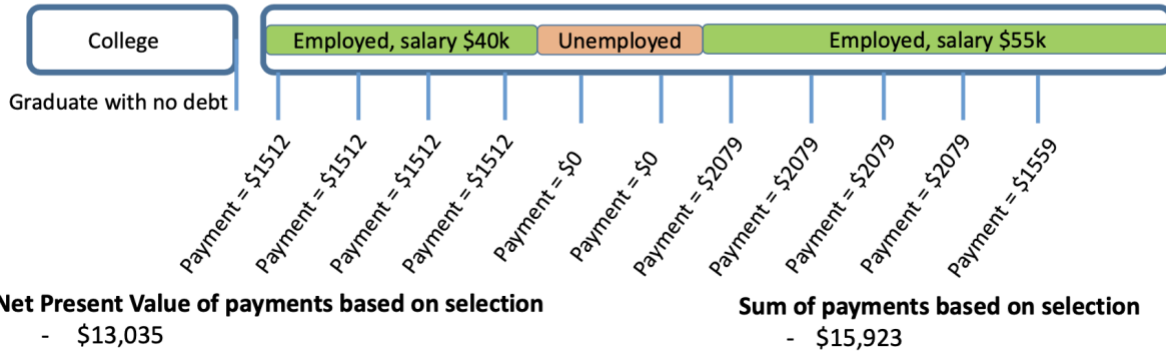
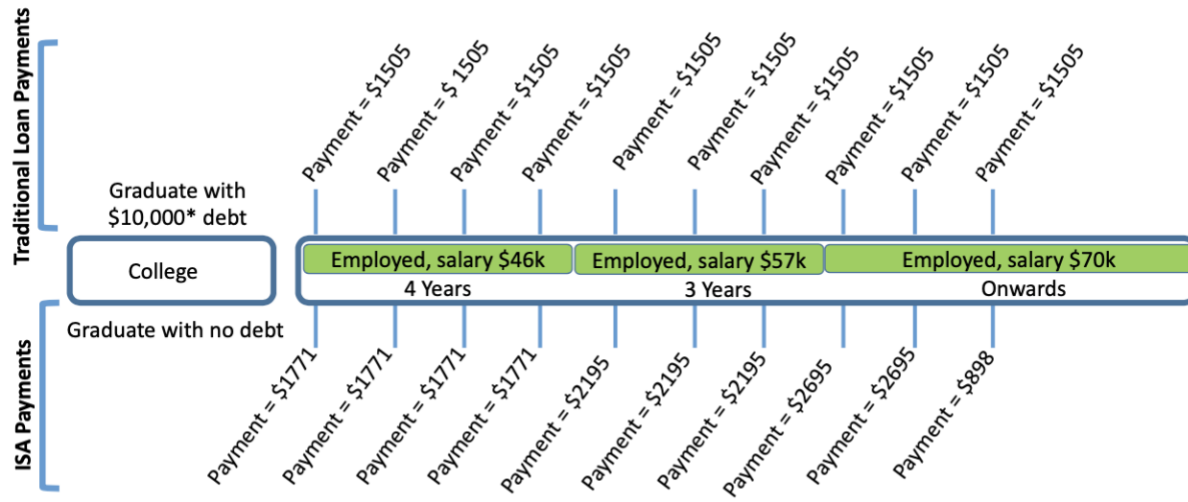


Figure 3: Breakdown of Majors and Income Share Percentage

ID #	Major	High/Low GPA	Income Share (%)	Length of ISA (years)
1	Studio Art	High	3.85	9.33
2	Studio Art	Low	3.85	9.33
3	Chemistry	Low	3.85	8.66
4	Chemistry	High	3.85	8.66
5	Computer Science	Low	2.3	7.33
6	Computer Science	High	2.3	7.33
7	Political Science	Low	3.85	9.33
8	Political Science	High	3.85	9.33
9	Accounting	High	3.11	8.33
10	Accounting	Low	3.11	8.33
11	German	High	3.78	8.66
12	German	Low	3.78	8.66

Figure 4: Knowledge Sheets for Identities in Round 1 and Round 2

#1



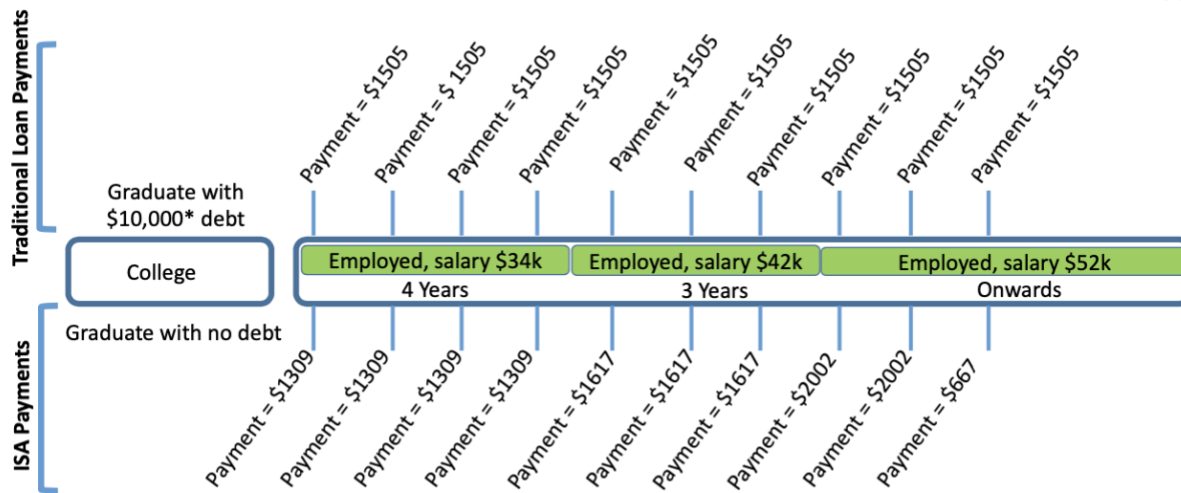
Net Present Value of payments based on selection

- Traditional Student Loan: \$12,207
- Income Share Agreement: \$16,105

Sum of payments based on selection

- Traditional Student Loan: \$15,050
- Income Share Agreement: \$19,957

#2



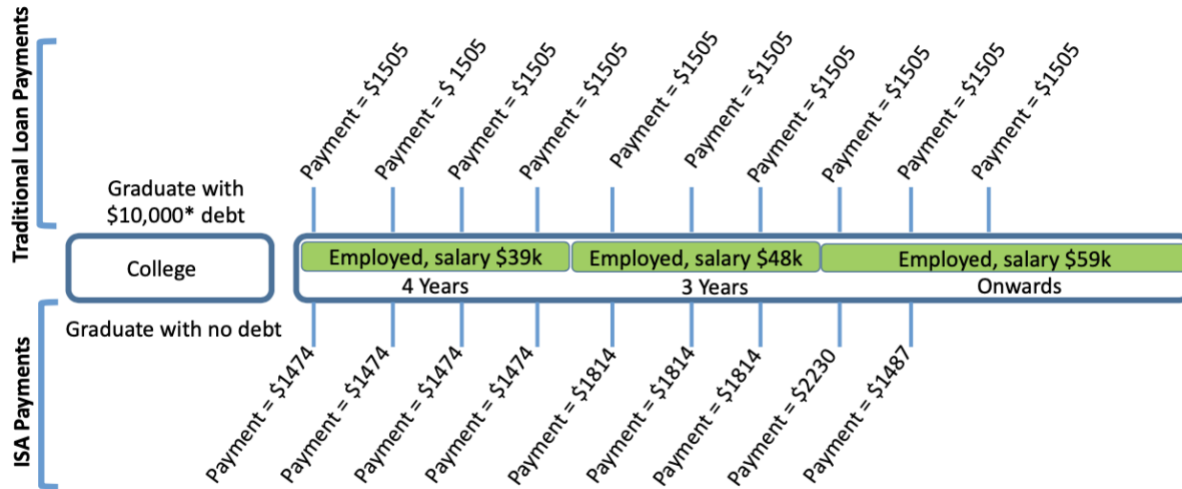
Net Present Value of payments based on selection

- Traditional Student Loan: \$12,207
- Income Share Agreement: \$11,907

Sum of payments based on selection

- Traditional Student Loan: \$15,050
- Income Share Agreement: \$14,758

#3



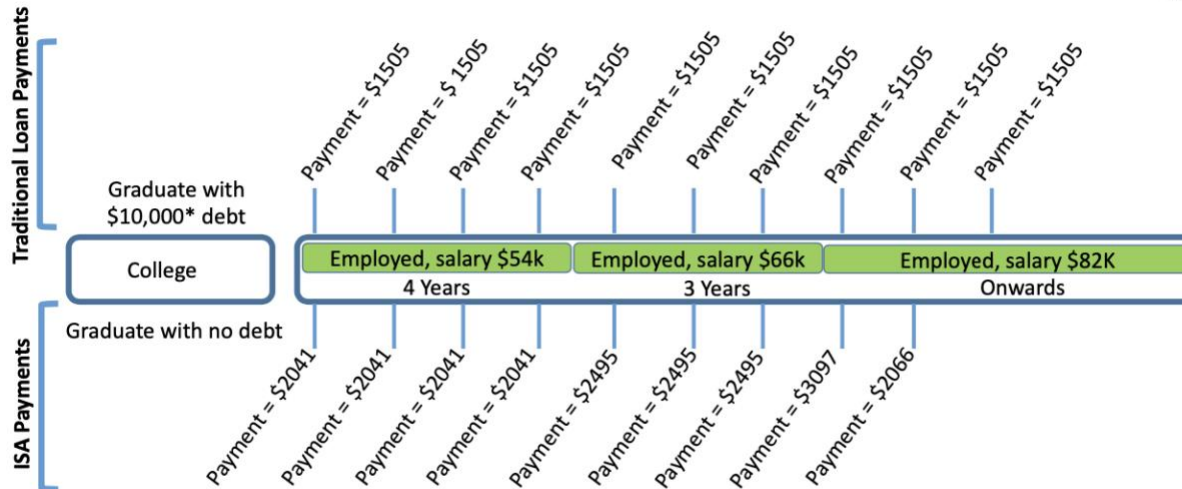
Net Present Value of payments based on selection

- Traditional Student Loan: \$12,207
- Income Share Agreement: \$12,326

Sum of payments based on selection

- Traditional Student Loan: \$15,050
- Income Share Agreement: \$15,053

#4



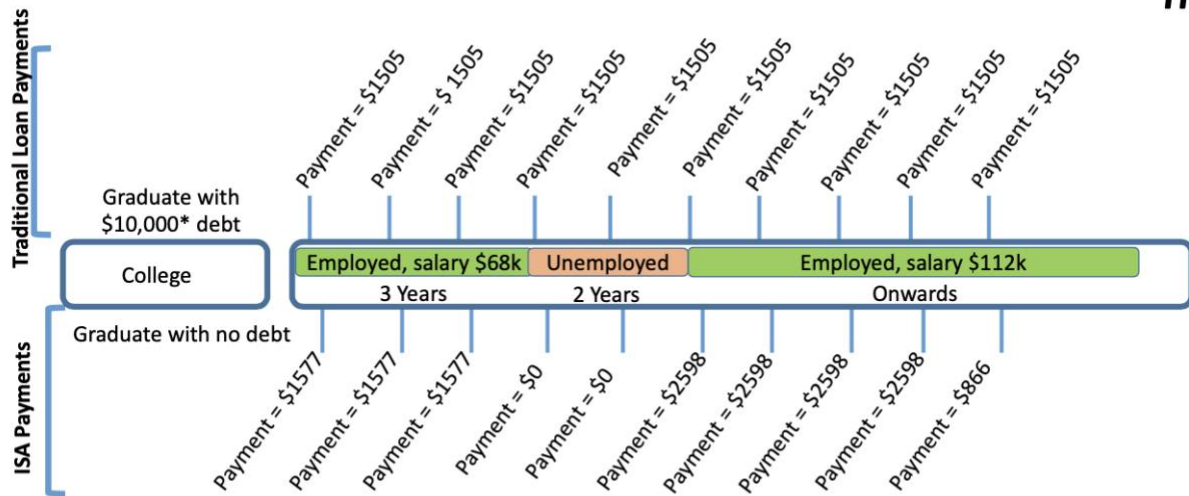
Net Present Value of payments based on selection

- Traditional Student Loan: \$12,207
- Income Share Agreement: \$17,042

Sum of payments based on selection

- Traditional Student Loan: \$15,050
- Income Share Agreement: \$20,812

#5



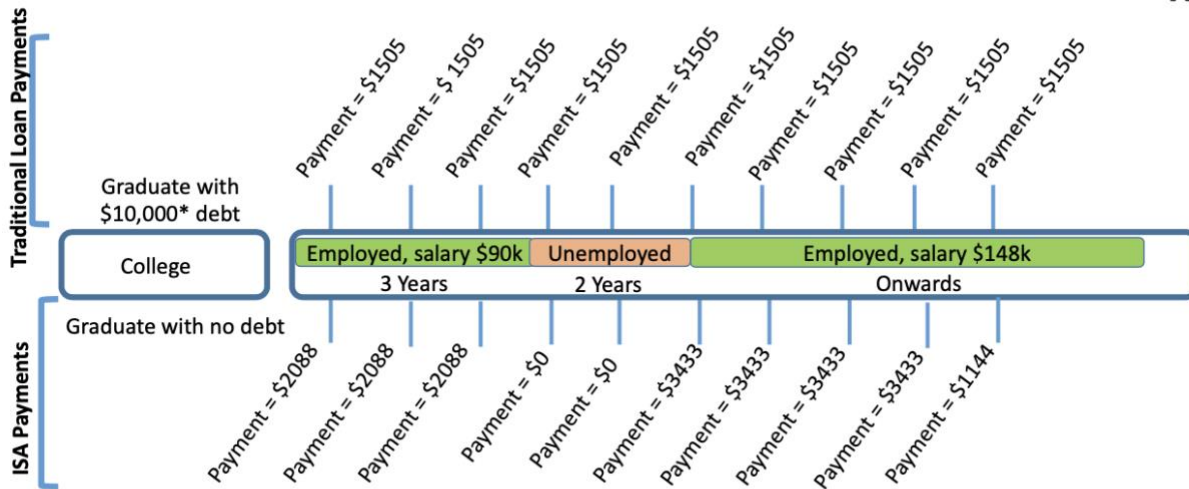
Net Present Value of payments based on selection

- Traditional Student Loan: \$12,207
- Income Share Agreement: \$12,713

Sum of payments based on selection

- Traditional Student Loan: \$15,050
- Income Share Agreement: \$15,989

#6



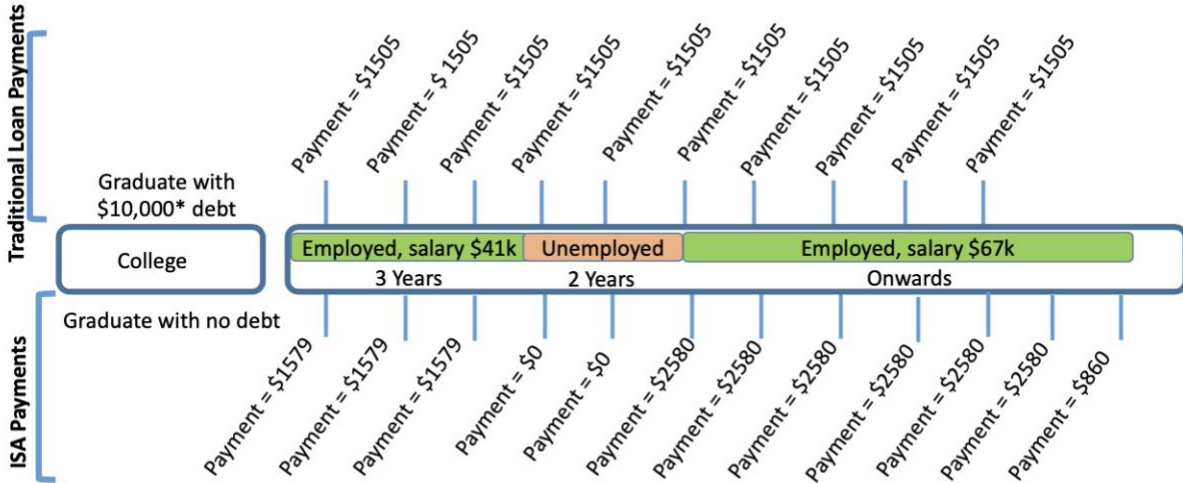
Net Present Value of payments based on selection

- Traditional Student Loan: \$12,207
- Income Share Agreement: \$16,810

Sum of payments based on selection

- Traditional Student Loan: \$15,050
- Income Share Agreement: \$21,140

#7



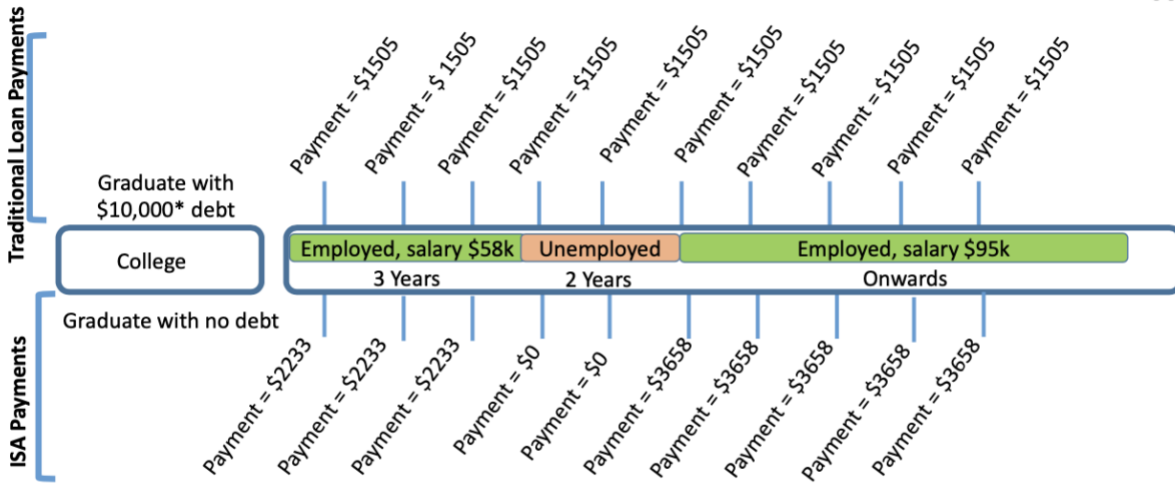
Net Present Value of payments based on selection

- Traditional Student Loan: \$12,207
- Income Share Agreement: \$16,035

Sum of payments based on selection

- Traditional Student Loan: \$15,050
- Income Share Agreement: \$21,077

#8



Net Present Value of payments based on selection

- Traditional Student Loan: \$12,207
- Income Share Agreement: \$19,582

Sum of payments based on selection

- Traditional Student Loan: \$15,050
- Income Share Agreement: \$25,000

Figure 5: Example of Financing Option Sheet

Financing Options

#2

Traditional Student Loan

You receive a loan for \$10,000 to help finance your education.

You will be required to pay back the loan with 6.28% interest over 10 years and a loan fee of 4.28%. If payments are made on time, each annual payment will equal \$1505.

Income Share Agreement

You receive \$10,000 to help finance your education and will not have any debt but enter a repayment plan with the school based off your annual income after graduation.

You will be required to pay 3.85% of your annual income for 9.33 years after graduation. Payments will depend upon your actual income.

References

- Baum, S. R., Elliott, D. C., and Ma, J. (2014). "Trends in Student Aid." 2014. *The College Board*.
- Betts, J. R. (1996). "What Do Students Know about Wages. Evidence from a Survey of Undergraduate." *Journal of Human Resources*, 31(1): 27-56.
- Burns, M. (2015). "Evaluating New Tuition Payment Plans: A Closer Look at Michigan's Proposal."
- Delavande, A., Zafar, B. (2014). "University Choice: The Role of Expected Earnings, Non-pecuniary Outcomes, and Financial Constraints." *Federal Reserve Bank of New York Staff Report NO. 683*.
- Delisile, J. D. (2017). "Student and Parent Perspectives on Higher Education Financing." *AEI Series on Private Financing in Higher Education*.
- Madonia, G., Smith, A. C. (2019). "All-in or checked-out? Disincentives and Selection in Income Share Agreements." *Journal of Economic Behavior and Organization* 161 (2019) 52-67.
- Mumford, K. J., (2020). "Student Selection into an Income Share Agreement."
- U.S. Department of Education. 2020. "Federal Student Loan Portfolio."
<https://studentaid.gov/data-center/student/portfolio>. [Accessed: June 1, 2018].
- Zhang, L. (2013). "Effects of College Educational Debt on Graduate School Attendance and Early Career and Lifestyle Choices." *Education Economics*, 21(2), 154-175.
<https://www.tandfonline.com/doi/abs/10.1080/09645292.2010.545204>.