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THE NEXT CRISIS? A SYSTEMIC ANALYSIS OF HIGHER EDUCATION AND STUDENT LOAN DEBT IN THE UNITED STATES

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ABSTRACT

This paper approximates student loan systemic risk, building off the hypothesis that student loans could potentially prop up a bubble in higher education. Price bubbles reflect increasing prices above fundamental value. With future wages' signaling a quantifiable fundamental value as a return to education, a higher education price bubble would exhibit inflated tuition prices increasing at a faster rate than that of future wages. I identified possible bubble movement in comparing student loans and 2008 mortgages, whereby I created a model to analogize these market movements. Furthermore, I estimated consequential market leverage, returning results that reflected greatest increases in leverage for ranges that generally fall in line with "jumbo loans" in the United States. Finally, I expanded off of a Federal Reserve staff paper to further examine the influence of student loan supply on debt and tuition, whereby I identified a structural break that occurred with student loan policy changes in 2008.

I concluded that the greatest concern for a bubble falls with students in generally lower-earning fields of study. A higher education price bubble could be fueled by the relationship between tuition and expected future wages, with student loans' assisting tuition increases. Student loans magnify education returns, expanding students' current budget constraints to cover higher education costs, but posing a challenge to students who cannot timely repay their loans. The overall average return to education remains positive, thereby suggesting that a price bubble in higher education may not exist. However, broken down, the returns to higher education are sometimes negative for students in lower-earning fields of study. If students with lower expected future wages continue to invest in higher education, then tuition prices would be increasing at a faster rate than that of the expected future returns, suggesting inflated tuition prices relative to immediate future wages and suggesting a potential price bubble.

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Chapter 1 Introduction

History repeats itself. People considered the housing market to be stable prior to 2008, justifying increased subprime mortgage debt because of the stability of the housing market. In the crash of 2008, the economy realized that regardless of the perceived stability of a market, bubble and market crashes are possible. The higher education market is considered to be largely stable based on the belief in constantly increasing benefits from higher education, meaning that taking on overwhelming debt is often justified by expected future return payoff. Noting a similar scenario in 2008, I question the actual stability of the higher education market compared to its perceived stability. Could higher education be in a price bubble? Is there a point at which the future returns to education can be overwhelmed by the immediate costs of higher education? Are student loans contributing to tuition increases?

To explore these questions, I examined the 2008 United States housing bubble as my primary theoretical benchmark. Credit booms commonly contribute to bubbles, increasing credit demand and availability that influence rising asset prices (Mishkin 2008). Prior to 2008, banks lent subprime mortgage loans, thereby increasing market risk exposure as more subprime borrowers borrowed to purchase more expensive houses. The problem heightened when federal interest rates increased, adjustable rate mortgages kicked in, and people had to pay back their loans, many of who could not fully pay off their loans and defaulted. Prior to the crash, the bubble grew as people engaged in borrowing and lending based on expectations of future price increases that secured the loans. The student loan market is undergoing a similar situation. Average initial wages for certain fields of study tend to increase at or below the rate of inflation, though the average price of posted tuition has been increasing at a rate constantly above the rate of inflation. With increasing loan supply, more students can take on greater debt. Additionally, with combined availability of both private and federal loans, virtually any native U.S. student has the ability to take out a student loan, reflecting a similar subprime-borrowing pattern as took place during the housing bubble. Now in the United States, student loan debt has officially surpassed credit card debt as the highest non-mortgage percentage of total debt. The housing bubble grew out of increasing debt, echoed by an eerily similar pattern with leveraged borrowing in the current student loan market. Of this leveraged borrowing, both the housing and higher education markets exhibit a smaller share of high-risk borrowers holding the vast majority of loan debt, reflecting higher systemic risk based on debt distribution.

Default risk is one area of difference between the housing and higher education markets, whereby default on a mortgage is much easier and more common than default on a student loan. When a borrower defaults on a mortgage, the borrower loses his or her house; when a student loan borrower defaults, he or she still has to pay off the loan in some form, often through government seizure of portions of wages or Social Security as means of repayment. Consequently, though the process of default is different, the borrower still loses assets with default in both markets. Correspondingly, lenders in the housing market were compensated by the collateralized house in the case of mortgage default, whereas lenders in the student loan market are compensated by government guarantees in the case of student loan default. Though the housing and higher education markets do pose differences, which I will further explore later in this paper, the framework for market interactions is fairly similar between these two models. Therefore, based on several similar patterns, my hypothesis is that student loans in our current economy have the potential to be propping up a similarly-styled bubble in the price of higher education and/or could pose systemic risk to the economy at large.

Chapter 2 Overview

Overview of Bubbles

A traditional bubble generally exhibits rapid inflationary asset price movement, increasing to an arbitrary point after which the economy suffers downturn. Equating to higher education, a bubble would theoretically occur if tuition increased to a point that would be too extreme for students to afford, thereby causing a subsequent reaction in the economy through reduced economic investment. This rapid price increase can generally be attributed to an overinflated price or perception of price, allowing for bubble development that may be problematic based on the degree of leveraged borrowing and high systemic risk. Common belief about future price changes often drives bubbles (Tirole, 1985), which I focused on as a primary driver of the 2008 housing bubble and as one explanation for tuition price movements.

Karl Shell (1971) devises an overlapping generations model that shows how a bubble can develop based on future expectations, modeling a world with a pure one-to-one exchange of chocolate and cash. In his model, he assumes that: 1) there are only two types of individuals living in each period, separated into an older and a younger generation, 2) the exchange of assets will occur at the end of each period so that each generation gets full use out of the asset, and 3) each group can only live for two periods. The model suggests that the older generation will give up cash in exchange for chocolate at the end of each period, allowing a bubble to develop over time as the expected value of cash continues to increase. Incorporating inflation, this perceived value of money continues to increase up to the point at which the younger generation no longer accepts cash as of equal value, at which point the bubble would deflate. This model shows how expectations of future price increases can fuel a price bubble, where consumers will continue to trade an asset as long as they believe that the value of the asset today is less than the future price.

Barlevy (2007) expands by explaining how cash in itself is worthless. Money is a store-of-value asset that gains value based on public perception, which suggests that bubbles do not have to solely exist in the traditional sense of asset purchase and resale. Barlevy explains that an asset like money still accrues a capital gain, which adapts the definition of a bubble to be based on accrued capital gain from utility rather than financial gains. By this argument, a household achieves capital gains by choosing money in exchange for a low utility good and trading that money for a high utility good, determined by consumer preferences. Incorporating Barlevy's model of utility into Shell's model, utility preferences can carry over time based on external factors such as peer effects or based on internal factors such as expectations of higher utility. This idea of bubble development for intangibles based on perceived future value and preferences will be important later in this paper in examining the current market for higher education and student loans, a market driven by common belief rather than asset resale over time.

Overview of Higher Education

The rapid rate of increase of tuition prices preliminarily signifies the possibility of a price bubble. I focused on private nonprofit and public four-year institutions as the most predominantly attended higher education institutions. Both private and public higher education institutions would be susceptible to a price bubble, noting that graduates from different institutions generally compete for the same post-graduation job positions and obtain similar immediate future wages based on the obtained job position. Average per person tuition, fees, and room and board for private nonprofits have on average increased from $3,000 to $47,000 from 1971 through today. Public institutions have similarly increased on average from $1,500 to $21,000 annually, both recorded in current dollars (College Board, 2017). Assuming that the students remain fully for four consecutive years, accumulated over four-years, this difference equates to approximate increases from around $12,000 to $188,000 and $6,000 to $84,000 in total per student for private nonprofit and public four-year institutions, not accounting for yearly inflation. Four-year institutions have exhibited average per year posted tuition increases of over 6%, noting an average yearly increase of up to 4 – 5% over the past decade alone. Average inflation (both core and headline) post-recession has averaged lower at around 1.8% (Bureau of Labor Statistics), meaning that the average real rate of tuition increase each year post-recession is around 2 – 3%.

Though average tuition has trended upward at a faster rate than that of inflation, many students justify attendance based on increasing expected returns to higher education in the form of higher expected future wages. I later estimate loan repayment amounts in conjunction with yearly earned wages based on the assumption that a rational student would want to pay off loans as quickly as possible post-graduation in order to minimize recurring high interest payments on remaining student loan balances accrued each month. I focused on average salaries of undergraduates across an approximate 10-year time frame to standardize an immediate estimated return to higher education. I pulled data from the NCES reflecting median annual earnings for full-time year-round workers ages 25 to 34, accounting for an estimated 10- to 15-year grace period during which student borrowers may be working to pay off accumulated undergraduate student debt (2016). According to the Pew Research Center, the NCES, and FRED, graduates with a Bachelor's degree tend to on average make about $20,000 more than high school graduates, with the potential of making up to $30,000 more per year on average. The median salary for workers with Bachelor's degrees ages 25 to 29 is around $50,000 (NCES, 2016; FRED, 2018; National Average Wage Index). Broken down, the median salary for STEM fields is higher than that of non-STEM fields, with average starting salaries around $50,000 – $70,000 for STEM compared to around $30,000 – $50,000 for non-STEM majors.

College-level graduates exhibit average yearly wage increases of around 2.2 – 4% compared to 1 – 2% yearly increases for high school graduates. The average yearly increase in median earnings since 1979 was around 3.54%, compared to a slightly lower 2.24% increase since 2000 (NCES 2016). As long as the returns to higher education continue to exceed those of high school, higher education will continue to be worthwhile. However, the concern lies in the marginal cost of higher education compared to the marginal benefit. The average yearly percent increase in returns since 1990 is approximately 3.75%, compared to a lower 2.83% since 2000 and around 2.92 – 3% since 2008. Lower average inflation is one contributor to the decreasing yearly wage increases in recent years, noting a drop in average inflation of about 3.91% since 1963 compared to about 2.17% since 2000. The other major contributor is the growing gap between returns to education based on field of study. The average percent increase in wages for STEM and higher earning majors is upwards of 7 – 9%, compared to a lower 2 – 3% for many lower wage majors (NCES 2016). The concern is that the national average skews the data in a way that makes it seem that the returns to higher education outweigh the costs. However, broken down, different returns to higher education for different fields of study pose a systemic challenge of economic well-being for recent graduates, especially considering that the cost of living has been increasing by an average of 2% each year. Therefore, a potential price bubble in higher education would be more likely to develop for students in fields of study that may not offset the immediate tuition and student loan repayment costs associated with obtaining a higher education degree.

Overview of Student Loans

Student loans subsidize higher education, helping students to afford currently rising tuition prices. The United States experienced a near 92% increase in the number of student loan borrowers from 2004 to 2014, increasing the number of total borrowers to approximately 43 million with around $27,000 in debt per borrower (Brown et al., 2015; Bricker et al., 2015). In aggregate, total student loan debt has increased from around $241 billion in 2003 to nearly $1.34 trillion by 2017, surpassing aggregate credit card debt as of 2010. 90+ day student loan delinquency (i.e. late on a loan payment) has also surpassed credit card delinquency as of 2012 (FRBNY Credit Panel/Equifax 2018). Student loan debt is increasing at a faster rate than that of other types of consumer debt, demonstrated by the fact that student loan debt as a percent of total debt has skyrocketed over the past 10+ years. Student debt now comprises nearly 10% of total outstanding debt in the United States, comprising 35% of all non-housing debt. Additionally, based on data for 2015 trends, the nation has witnessed a decline in the number of borrowers borrowing under $10,000, subsequently increasing the number of borrowers borrowing closer to $25,000 (FRBNY Credit

Panel/Equifax 2018). This shift shows a pattern that reflects how higher tuition coupled with stable demand for higher education could potentially drive increased borrowing to compensate for increasing tuition. The number of student loan borrowers under age 35 has increased from around 15.3 million to 24.3 million from 2005 to 2015, reflecting about a 60% increase in the number of borrowers over this decade. Total student loan debt for borrowers under age 35 has increased almost 160% from about $233B to $602B from 2005 to 2015, reflecting a rapid shift in higher education borrowing trends (FRBNY Credit Panel/Equifax 2018).

The four major types of higher-education loans include federal loans to students, federal loans to parents, private loans, and consolidated loans (Ergungor & Hathaway, 2008). Federal loans to students allow students to borrow up to a certain amount at a low, fixed interest rate and are federally insured (Avery & Turner, 2012), with Stafford loans comprising the largest portion of student loan borrowing. Though comprising a smaller segment, private sector loans grew from an approximate total of about $1.5 billion in 1996 to around $21.8 billion by 2008 to nearly $108 billion now (Cowley & Silver-Greenberg, 2017). The loan approval and borrowing-limit decisions with private loans are primarily based on the borrower's risk profile. Consolidated loans allow both private and government lenders to combine multiple loans into a single loan package between when a student graduates and repays the loan in full, with an interest rate calculated as the weighted average of each loan rate in the package.

A shift in private loan borrowing has presented an interesting change in borrowing patterns over the past two decades. Undergraduate borrowing through primarily private lenders generally hovered below 10% in the early part of the century (Lochner & Monge-Naranjo, 2014). However, private lending peaked at around 25% of student loan borrowing around the recession in 2008 before dropping to pre-recession levels during the post-crisis recovery period. With a growing demand for credit, students are shifting again towards more private lending where private lenders profit off of the net interest margin and profits from application and borrowing fees (Birken, 2016). Private lenders obtain initial funding from investors (banks from depositors), which in turn is used to lend to student borrowers. Investors loan the lenders money because they can receive an interest payment on their deposits, though the rate that lenders return to investors is typically lower than the rate that student borrowers return to the lenders.

Student Loan Delinquency and Default

Student loan delinquency and default provide the most descriptive measure of the leverage posed by student loans in the higher education market. Student loan delinquency refers to a student's being late on a loan repayment in general, whereas a student loan is generally considered in default if a payment is 270 days late. Regarding comparison, the nature of loan default is a primary difference in comparing the 2008 mortgage market and the current student loan market. The mortgage market experienced a major jump in default rates leading up to the crisis, jumping from around 6% in mid-2005 to around 29% by mid-2008 (Mayer et al., 2008). Students, on the other hand, can very rarely get rid of their federal student loans, even in the case of bankruptcy. Private nonprofits and public four-year institutions have the lowest average default rates compared to for-profit institutions and 2-year institutions. Default rates fall at around 7% for private nonprofit and 8.6% for public four-year institutions for graduates ages 20 to 30. Default rates are about double for for-profit institutions, falling around 15.5% for ages 20 to 30. Most student loan borrowers fall under the age of 30; however, it is important to note that the default rate significantly increases as age increases. For the same types of universities, average default rates increase to around 9%, 11.2%, and 20.3% respectively when considering graduates ages 20 to 33. Additionally, the default rate on student loans significantly increases based on degree, noting a default rate of around 4.4% for graduates ages 20 to 30 with Bachelor's degrees compared to around 9.3% for graduates with Associate's degrees. Another important aspect of default to consider is default based on family background. As of end of the year 2017, default rates for students with families above the mean income ranged at around 13% for private nonprofit, 20% for public, and 35% for private for-profit institutions. Default rates notably increased for students with family incomes below the average, noting around 21%, 30%, and 42% for private nonprofit, public, and private for-profit institutions respectively (Consumer Credit Panel/Equifax 2018).

Potential toxicity refers to the nature of the loan being subprime, whereby lenders are willing to lend student loans, though often subprime, because they are assured by expectations of rising earnings potential, coupled by a government guarantee on these loans. The delinquency rate on student loans has nearly doubled for each age group from 2005 to 2015, and high interest rate loans continue to be supplied at an increasing rate. Lenders perceive that even if students default, they will still get their money back because of the government guarantee on approximately 80 – 85% of all student loans. Therefore, the students absorb the burden of debt payback, still having to pay off the debt in full somehow even in the case of default. An important point to note is that these systems of perceivably secure lending remain secure only as long as the government continues to guarantee the loans. During the 2008 crisis, the government decided to not bail out Lehman Brothers, which lead to a spiral of widespread economic downturn. If the student loan market were to experience a downturn and if the federal government decided to not bail out some of the big lenders such as Sallie Mae, then the student loan market could potentially experience a similar institutional spiral effect as had happened in 2008. If a student defaults or simply stops making payments, the federal government can compensate in various ways, including seizing Social Security payments and collecting up to 15% of a borrower's disposable earnings without requiring a court order (Lochner & Monge-Naranjo, 2014).

Part of the increase in per student debt levels can be attributed to an increase in college enrollment over the past 30 years. Part is attributed to the fact that many students are staying in college longer. The remaining increase can be attributed to an increase in the number of available loans and increasingly higher tuition costs. Student loan debt has officially surpassed total credit card debt in the United States at an outstanding value of approximately $1.2 trillion (Bricker et al., 2015; Brown et al., 2015). Additionally, post-recession, student loan default and delinquency rates have begun increasing again. According to Lochner and Monge-Naranjo (2014), government and private student loan debt in the

United States has nearly quadrupled from around 2003 to 2013, increasing from a nominal $250 billion to about $1.2 trillion. Broken down, this equates to a near 90% increase in average student debt for students right out of college around the ages of 22 to 25, increasing from about $11,000 to $21,000 per student on average. In total, increasing loan availability, higher enrollment, and increased costs of education have resulted in over double the amount of per student debt from the 1990s through around 2012, debt levels that continue to grow each year.

Lochner and Monge-Naranjo (2014) furthermore detail the shift in the amount per student borrowed, reflecting a shift in borrowing patterns. In 1990, nearly 5% of students borrowed over $30,000, compared to about 15% in 2000 and 30% in 2010. This change shows the heightened financial burden on an increasing number of students in more recent years, with the number of student defaults nearly doubling over the past 10 to 15 years. The major concern surrounds repayment from students with college degrees that tend to return lower average wages. With lower expected incomes out of college, some students are struggling more than others to pay off student loans, comprising a large portion of the default rate. As of the end of 2017, default rates for selective institutions were around 12% for STEM, 11.5% for business, and 14.6% for arts and humanities majors. These default rates skyrocketed for non-selective institutions at around 17.3% for STEM, 21.3% for business, and 26.3% for arts and humanities majors.

Chapter 3

Theoretical Model for Housing

Because it is challenging to determine if a bubble could exist in the moment, I decided to examine the existence of a potential price bubble in higher education by comparing the extent of the similarities between this market and another market that we can confirm had bubbled in the past. Having a base theory model helps to identify similar patterns that reflect similar market movements that could potentially lead to similar outcomes. I therefore created a generalized theoretical model of the United States housing and mortgage markets respectively in order to establish a base for how a bubble can be fueled over time. I used a basic framework for the housing bubble and then imposed this same model on higher education to see if the market interactions are comparable enough to suggest potential bubble development in higher education.

To model the various interactions surrounding the housing market, I used a multi-market model to display how the markets for housing prices and housing loans feed into each other, thereby influencing the potential ability for an asset bubble to grow. I started the model in the housing market, which in turn has an effect on the supply and demand for mortgages with a subsequent reaction in the seller's securitization market. In this multi-market model, I incorporated Brunnermeir's model for credit borrowing, focusing on the exchanges between a bank and a borrower and on how these transactions can lead to a liquidity spiral. I imposed mortgages on this model and then examined this multi-market model as a cycle over one period, which I then incorporated into Shell's overlapping generations model to show how this cycle continues to fuel itself over time.

3.1 Markets for Housing, Mortgages, and Securitization

Assuming that an individual will get the full utility out of his/her house before selling at the end of the period, the supply curve is fairly inelastic, meaning that minimal price changes will not cause individuals to sell because of the utility gained from living in their house until the end of the period. The demand curve is therefore the driving force in this model and is a traditional, downward-sloping curve. The demand curve for housing H is dependent upon a few factors: household income w, mortgage interest rates i, the price of a house today P_t, and the expected future price P^e_{t+1}, where $H = \phi\ (w, i, P_t, P^e_{t+1})$. All else constant, the total value increases as the price at which a house could be sold in the next period increases compared to the price paid today. Therefore, if expected future price increases, then the demand for a house today will increase, thereby driving up aggregate prices today.

As house prices today increase, all else equal, people need to find ways to pay for the higher prices, requiring them to reduce spending preferences elsewhere in their current household budget constraints. Instead of reducing consumption preferences elsewhere, people can compensate by increasing borrowing in order to maintain their same lifestyle preferences. The demand curve for mortgages is dependent on the price of a house today P_t, the expected future price of a house P^e_{t+1}, and the interest rate on the loan i. The supply curve for an individual borrower is fairly elastic due to the fact that benchmarked federal rates are standardized across all mortgage borrowers. However, the market supply curve for mortgages is fairly inelastic due to the fact that at any given number of borrowers, the lenders are going to distribute mortgages to different people at different rates based on credentials. The supply curve is also dependent on future expected housing prices, $S = \phi(P^e_{t+1})$ because higher expected house prices help to secure the loan today. This corresponding shift in both supply and demand explains how the approximate average equilibrium mortgage rates only increased minimally as the number of subprime borrowers and housing prices increased.

Brunnermeir et al. (2017) modeled a framework to show how loan supply would increase, basing their model on the assumption that an income effect is dominating rather than a substitution effect and suggesting that an increase in current wealth encourages greater economic activity. They established a model in a simple economy, consisting of three involved players: a bank, a borrower, and a saver. The bank acts as the lender, recording reserves and credit as assets and deposits and equity as liabilities on its theoretical balance sheet. The reserves act as safe asset investments for banks, recorded as an asset to the lending bank and a corresponding liability to the Federal Reserve. Credit, however, is the risky asset because of its associated default and liquidity run risk. In this model, banks make credit loans to borrowers, who in turn spend the money, which can be modeled as going to the savers who then deposit that money in a bank as an essentially risk-free and liquid exchange deposit.

In 2008, mortgage securitization increased loan supply. More borrowers entered the market because of low borrowing standards, meaning that banks were engaging in more subprime lending, thereby taking on more risk. This means that these banks had more risk on the asset side of their balance sheets. In order to get the risk off of their balance sheet, banks created collateralized debt obligations (CDOs). CDOs were packaged subprime mortgage loan bundles that consisted of a perceptively diversified portfolio of these risky junk bonds. Divided into different tranches and in spite of the fact that the majority of the underlying bonds were junk, this division and separation was enough to reward these packages with AAA ratings, falsely deeming them as safe investments. The banks sold these CDOs to investors, which largely consisted of other large financial institutions, who in turn purchased these diversified portfolios in exchange for cash, thereby offloading the risk on the balance sheet. Furthermore, these large lenders issued corresponding credit default swaps (CDS) as insurance against failing loans, though the circling process of CDO investment continued. This process allowed lenders to increase capital, which in turn was used to increase the supply of credit available to borrowers and facilitated subprime borrowers' ability to access credit.

With increased lending capital available, more subprime borrowers could take on riskier loans, which were also made more affordable to risky borrowers by adjustable rate mortgages. Adjustable rate mortgages allowed borrowers to have smaller interest payments at first, which encouraged increased borrowing at the time, though these mortgages later became an issue when the rates adjusted substantially with some up to nearly 10%, adjusted rates that many borrowers could not afford. Using the borrowed credit, borrowers could then use these loans to purchase houses, which were more expensive because of rising housing prices at the time. However, people continued taking out loans because the housing market was thought to be stable, meaning that people believed they could repay their loans as long as house prices, and therefore the resale value, continued to rise. The result was an increase in leverage, reflected by an increase in the debt-to-equity ratio where bank deposits increased while equity remained constant. Eventually when the adjustable rate mortgages kicked in, borrowers could no longer pay off their loans, setting off a large downward spiral of default.

3.2 Multi-Market Interaction

The housing bubble was able to grow because people expected future resale value to continue increasing, spurring a bullish mentality on the market. I later equate this driving future expectation in higher education to a future expectation of increasing returns in the form of education-driven wages. The resulting increase in loan supply and demand for housing propped up the bubble in 2008 by keeping prices within borrowers' current budget constraints. Housing demand could increase with loans being more affordable, thereby contributing to inflated housing prices. This circle between housing and mortgages continued fueling itself to the point that the housing bubble could grow, growing up to the point around 2007 at which adjustable mortgage rates kicked in, more borrowers could not afford to pay off their mortgages, and loan defaults consequently increased as housing prices began to fall. Therefore, a bubble in housing was able to develop based on increasing price expectations and loan availability, bursting when housing prices fell, loan demand decreased, and borrowers had to default because housing prices were no longer affordable.

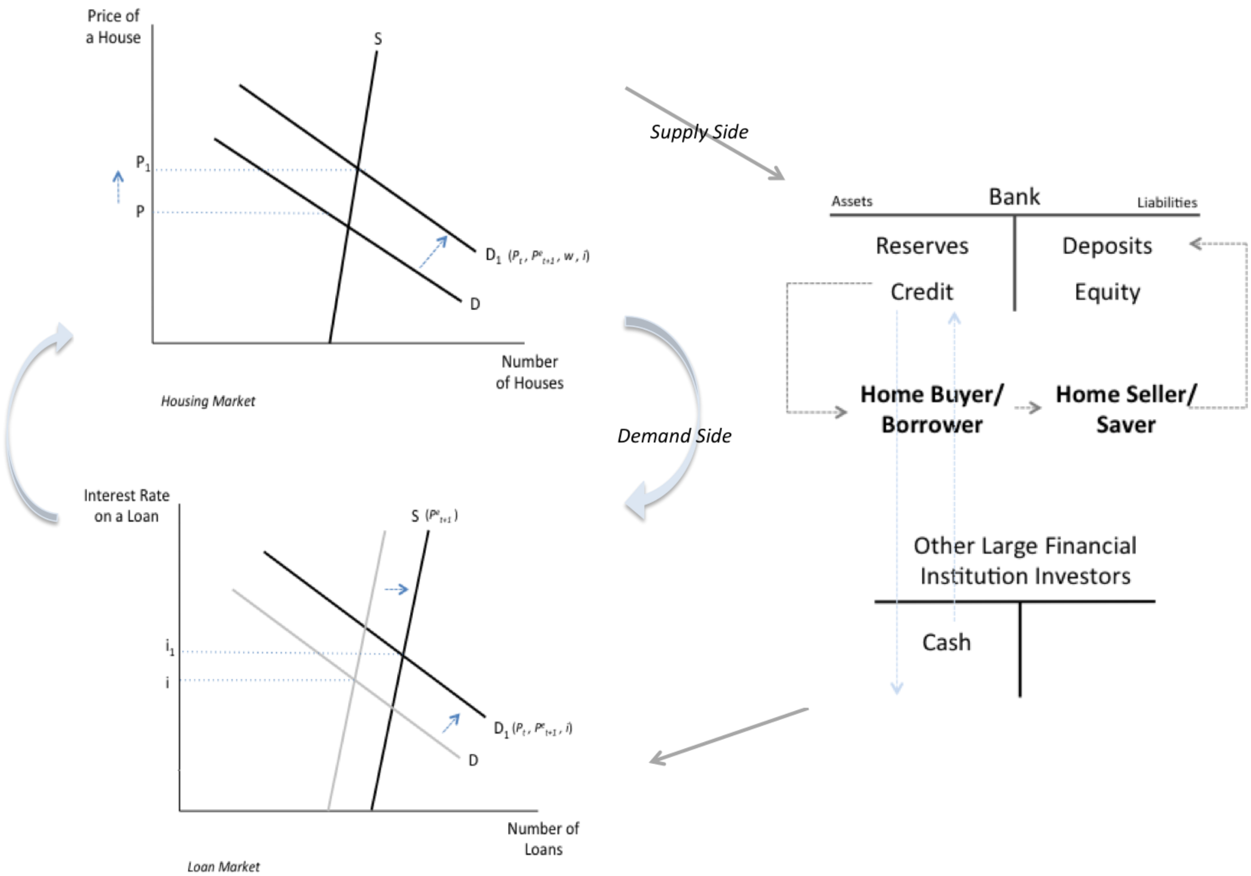

Figure 1. Multi-Market Housing Model

Overlapping Generations

This multi-market model reflects market interactions within one snapshot of time. The 2008 housing bubble was able to fuel itself over time based on how perceived future housing prices continued to increase. I modeled this interaction in the dynamic setting by imposing my multi-market model on Shell's overlapping generations model. Assuming that an individual will get the full utility out of a house before selling, this cycle takes place at the end of each period. In a two-period world with two generations living in each period, the younger generation will trade cash in exchange for the house from the older generation. The exchange occurs based on two factors: 1) the older generation already received the full utility from the house at the end of the period, and 2) the younger generation expects the price of that house to continue to increase in the following period, which can then be resold for a higher price. The demand curve for a house shifts right with the purchase of the house based on this expectation of future price increases, thereby setting off the multi-market cycle between housing and mortgages. This exchange across generations over time will continue to occur to the point that the younger generation no longer believes that the price of the house will continue to increase. Just before the 2008 crash, housing prices began to decrease, more borrowers could not sell their houses or pay off their mortgages, and the housing bubble burst.

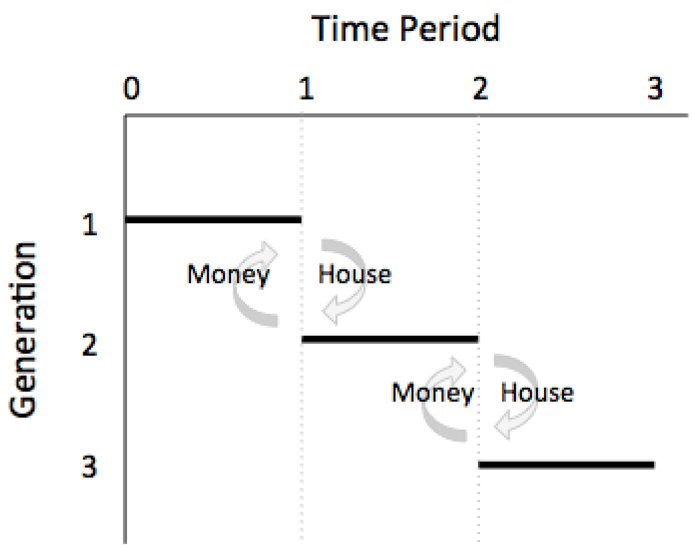

Figure 2. Overlapping Generations Housing Model

Chapter 4

Theoretical Model for Student Loans

The housing and higher education markets are different, but the market movements do reflect noteworthy similarities. I imposed the 2008 housing bubble model on the current market for higher education and student loans to show a similarity in potential bubble development if a bubble in higher education were able to grow. I used the same multi-market structure from the housing model, focusing on how expectations of future wage increases influence the market for higher education and a subsequent reaction in the student loan market.

One of the major differences between the housing and higher education markets is that these markets feed into themselves differently over time, displaying a slight difference in how a potential bubble in higher education could grow compared to the bubble in the housing market. In the housing model, demand for a house increased with expectations of future price increases because of expected future resale value. Correspondingly, future house prices also continued to rise because of increasing current demand for houses, thereby fueling a self-fulfilling cycle over time. Higher education is slightly different, though it reflects a similar cycle that feeds into itself over time. Demand for higher education increases with expectations of future wage increases because more students want to obtain a Bachelor's degree to capture those future higher expected wages. However, future higher wages are more indirectly driven by increasing current demand for higher education. Higher future wages are driven by increasing demand for specialized human capital skill sets. Increasing demand for specialized human capital derives from increased competition in the workforce because the rate of innovation is increasing, employers expect innovative insight from recent graduates, and the greater number of graduates drives up the necessity for graduates to find ways to stand out in terms of marketable labor skill sets. The increased competition continues to increase because of the increased demand for higher education, whereby a more competitive hiring process in the workforce requires more students to obtain higher education in order to compete for the same job positions with their peers.

One argument on the other end is that an increase in skilled labor would depress the average wage of skilled labor. I argue that technology is counteracting this general economic relationship. The National Bureau of Economic Research details how previous studies have found industry wages and technological change to be positively correlated, largely based on greater selectivity and increased sorting of skilled workers in technology-focused industries (Bartel & Sicherman, 2018). Many largely technical industries use higher wage offerings as incentives to further separate and attract the most skilled labor among the competitive pool of higher education graduates, thereby explaining an increase in wages in spite of the increase in labor supply. Certain fields of study target the development of skill sets with technology in order to make graduates more marketable, though other fields of study do not emphasize the importance of gaining highly technical skill sets as heavily. As the market increasingly demands new and young labor with technological skill sets for greater innovation, employers are willing to pay more for recent graduates who can bring these more highly technological skill sets to the workforce that current employees do not all necessarily have due to the rapid pace of improvement with technology. Consequently, though the total number of students obtaining higher education and obtaining higher skill sets is increasing, the number of students obtaining very specialized skillsets, especially with technology, is not increasing so quickly as to depress the returned future wages. This phenomenon can be seen through the data that shows that STEM majors in particular are reflecting near exponentially increasing wage increases each year. Therefore, the increasing competition among more graduates entering the workforce and specialized human capital derived from increasing current demand for higher education drive higher future expected wages. Consequently, the cycle between higher education demand and future expected wages similarly fuels itself as well, reflecting how a potential bubble could continue to grow over time.

Another noteworthy difference between the models is in how loan supply increases in response to future expected price increases. Federal loans have generally standard rates across all borrowers; private loans undergo a similar process of securitization, but reflect a smaller portion of the student loan market. Therefore, the supply curve and securitization process for student loans undergo a slightly different process from mortgages, specifically in terms of scale of the market. Benchmarking against my model for the 2008 housing bubble, this model for higher education shows how these markets interact similarly, displaying how another bubble has the potential to arise.

4.1 Markets for Higher Education, Student Loans, and Loan Securitization

Market for Higher Education

The demand curve for education *e* is dependent upon a few factors, including expected returns to education *h(e)*, income *w*, tuition *p*, future labor force competition *c*, and the nominal interest rate *R*, where e = ϕ (h(e), w, p, c, R). Incorporating these variables, the value function, denoted as $V = w_1(1-e) + \frac{w_2 h(e)}{R} - pe$, incorporates the period 1 opportunity cost, the period 2 discounted expected returns, and the price of education. Similar to in the housing market, the driving force behind changes in demand is expected returns, this time identified as expected future wages in the higher education market. With returns to post-secondary education being increasingly higher than those of secondary education, the aggregate higher education demand curve shifts rightward. I examined higher education from the perspective of its being monopolistically competitive. The market is not a perfect monopoly because multiple higher education institutions operate in the market, meaning that if one university sets its tuition prices too high, then another university will undercut it and will attract more students who can attain a similar Bachelor's degree at a lower price. However, the market is also not perfectly competitive due to the fact that degrees from different universities are not perfect substitutes. Therefore, assuming the demand for education increases based on increasing expected returns to higher education, the demand curve for education will continue to shift right, and institutions are able to increase tuition prices by operating at the enrollment point where marginal revenue equals marginal cost.

As tuition increases, the opportunity cost *$w_1(1–e)$* of obtaining higher education increases to reflect the lost earnings that an individual incurs by attending school instead of taking a job right away. An increase in opportunity cost increases the marginal cost of education relative to the marginal benefit, denoted in the first order condition as $w_1 + p = \frac{w_2 h^1(e)}{R}$. Because an increasing opportunity cost reduces period 1 consumption, in order to maintain the same level of consumption in period 1, students take out loans to increase relative wealth in period 1, expecting to be able to pay off their loans later based increasing expected returns to higher education. Loans offset the price of education in period 1, but period 2 consumption is dependent on the returns to education and repayment of period 1 loans. If the initial returns to education are not increasing at or above the rate of borrowing, then the borrower's consumption in period 2 will continue to fall. If the repayment of borrowing continues to creep closer to or surpass the returns to education, then consumption in period 2 lowers and may result in loan default to avoid dropping negative. I used an imperfect capital markets model with a relaxed budget constraint to model this relationship.

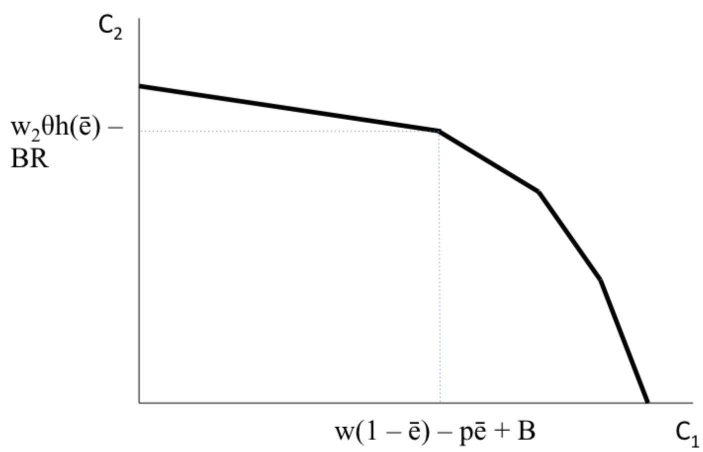

Figure 3. Student Loan Borrowing Constraint

Market for Student Loans

I modeled the borrower's budget constraint for student loans in a two-period dynamic setting, reflecting the implications of loan rates on consumption in period 1 versus in period 2. Unlike the budget constraint for mortgage loans, the budget constraint for student loans is kinked at multiple points. Each additional kink in the budget constraint reflects the arbitrary point at which a student has maxed out borrowing of a certain type of loan and has to take on a new loan with a higher interest rate, under the assumption that a rational borrower will max out borrowing of loans with the lowest interest rates before sequentially taking on higher interest rate loans. The budget constraint for period 1 is a function of wage *w*, average education $\bar{e}$, and the borrowing constraint *B*, where $C_1 = w(1–\bar{e}) - p\bar{e} + B$. Period 2 consumption is reflected as $C_2 = \phi(w, \theta, \bar{e}, B, R)$, where consumption is also dependent on ability and loan rate, denoted $C_2 = w_2\theta h(\bar{e}) – BR$. Therefore, borrowers would generally first exhaust federal subsidized loans before borrowing unsubsidized and private loans in order to optimize both current and future consumption. As can be seen in the equation for C_1, as tuition increases at a rate above the rate of inflation and above the rate of increase of initial earnings, consumption in period 1 would decrease. In order to maintain the same level of consumption in period 1, the borrowing amount must increase to offset higher costs.

The demand curve for student loans is dependent on the price of tuition today P_t, the expected returns to higher education *h(e)*, and the interest rate on the loans *i*. As the expected returns to higher education increases the current demand for post-secondary education, tuition today increases, thereby decreasing the borrower's relative current budget constraint in period 1. To shift the borrower's current budget constraint outward, borrowers need to take out more loans, thereby increasing loan demand, similar to how increasing house prices in 2008 influenced a rightward shift in demand for mortgages. The supply curve for student loans is kinked because of the difference between federal and private student loans. With federal loans, the supply curve is fairly elastic because any borrower can borrow at the same rate set by the government. The curve kinks at the point that the borrower has exhausted federal loans and takes on loans with higher interest rates, continuing to kink as loans with lower rates are exhausted. The supply curve becomes more inelastic with each kink to reflect the higher and more discretionary rates on loans in the private sector. Once all forms of federal loans are exhausted, the inelastic part of the supply curve for student loans looks fairly similar to the inelastic supply curve for mortgages due to the fact that the private sector provides loans to different students at different rates based on borrowers' credentials. The supply curve is also dependent on future expected returns to education because higher expected returns help to secure the loan with regards to students' ability to later pay off the loan. Private sector loans have been increasing at a faster rate than that of federal loans as average tuition prices continue to increase, largely due to the fact that the federal government has a budget for loan distribution and all remaining loans would therefore be distributed by the private sector. While the federal sector increases loan supply through policy changes, the private sector uses a process of loan securitization similar to that of mortgage securitization in 2008.

Market for Loan Securitization

Federal student loans do not undergo a process of securitization. Though the private student loan market comprises a much smaller portion of only around 10% of the loan market compared to federal student loans and mortgages, private student lending is growing and reflects similarities to mortgage securitization in 2008. Imposing my model for mortgage securitization on student loans, lenders make similar credit loans to student loan borrowers who in turn use these loans to fund higher education. Lenders hold debt on their balance sheets, which they seek to remove by repackaging student loan debt into student loan asset backed securities (SLABS). SLABS are the student loan analog to mortgage backed securities. Lenders such as Sallie Mae and large banks package student loans into SLABS and sell them off to investors, often other large financial institutions, in exchange for immediate cash payments and commission charges. SLABS have an associated variable interest rate based on borrowers' credit eligibility. Prior to being sold off to investors, SLABS are broken down into tranches and rated by credit agencies, historically paying off high interest rates for investors. The lenders sell off SLABS in exchange for safe assets on their balance sheets, accruing capital gains to be used as additional financing. This increase in financial assets allows lenders to increase the supply of credit, thereby allowing them to make more subprime loans and shifting the loan supply curve rightward.

Both 2008 mortgage lending and student loan lending are highly subprime; however, the difference between SLABS and MBS is how the difference in default affects investors' losses. Default in MBS cuts off the investor, meaning that when the subprime borrowers defaulted during the housing crisis, the investors lost out. Mortgage default resulted in house foreclosure, which caused a drop in housing prices as banks sold off the foreclosed properties. When a student loan borrower defaults, he/she still has to pay off the loan in some way over a very long period of time. A student is considered in default after a period of at least 270 days of late payments. Default on student loans means that the student loan is no longer eligible for aid and changes in repayment plans, in addition to the fact that the default is reported to credit bureaus. Because a student still needs to pay off the debt balance and accrued interest in the case of default, money is retrieved often in the form of the government's dipping into wages, unemployment benefits, tax refunds, and even Social Security ("Understanding Delinquency and Default, 2017). Therefore, in spite of the fact that the Department of Education secures these student loans, default on loans could still cause a liquidity spiral if default rates increased rapidly enough to impact a large segment of investors' portfolios. Additionally, investors similarly have the option to purchase credit default swaps on student loans, a fairly new way of shorting the student loan market for large institutions.

4.2 Multi-Market Interaction

A student loan bubble has the potential to form based on a similar reaction to the 2008 housing bubble among similar markets. As expectations of future returns to education continue to increase, demand for higher education increases. Initial tuition prices are therefore able to increase, as more students demand higher education, in turn spurring increased demand for student loans to finance higher education. Theoretically, the cycle could stop here if loan supply were to remain constant. However, interest rates on private student loans are higher than those of federal loans. Seeing the potential wealth associated with interest rates on private loans, lenders are able to increase student loan supply through a process of private loan securitization with student loan asset backed securities, which follow the eerily same process as 2008 mortgage backed securities. With student loans becoming more available to virtually any borrower regardless of borrowing credibility, more students can afford college. Consequently, more loans increase current relative wealth for students, thereby allowing universities to continue raising tuition prices in being propped up by student loan availability. Similar to in 2008, if a bubble were to exist in student loans, the bubble would burst as soon as loan demand decreases where expected returns to education no longer outweigh the costs of education. Higher interest rates on loans require larger monthly repayments, thereby reducing graduates' future budget constraints by pulling money out of graduates' future wages. However, though the interest rates on student loans remain high, as long as the expectation of future wage increases continues to dominate as the driving force in this model, demand for higher education will continue to increase from more prospective students.

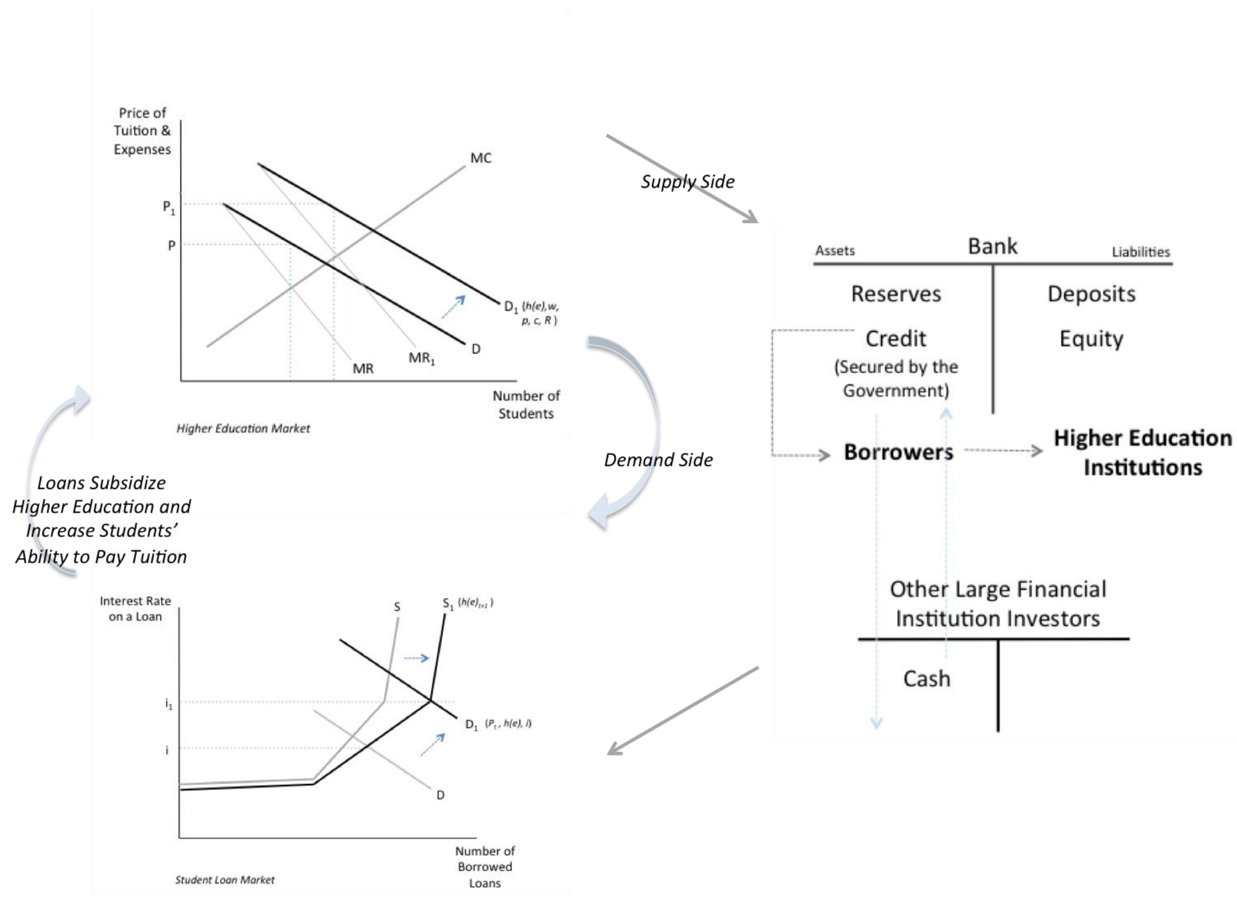

Figure 4. Multi-Market Higher Education Model

Overlapping Generations

I imposed this multi-market model on Shell's model (1971), taking the housing bubble model to show how a potential education bubble could grow. The housing model is zero-sum where the purchase of a house was contingent upon its resale. Contrastingly, education is not zero-sum in a physical sense because it is not driven by a physical asset exchange, but rather by perceivably increasing societal utility from a more educated workforce. Barlevy's model (2007) examined how a bubble has the ability to develop based on accrued capital gains from utility, which I argue could reflect an education bubble based on utility gained from increasing human capital over time. Therefore, the analog to generational house resale during the 2008 housing bubble is reflected by a human capital "resale" with higher education.

With education, this generational exchange is driven by expected wage return increases over time. That is, students will continue to invest in higher education as long as they continue to expect future wage increases. Correspondingly, employers will continue to pay higher wages as long as they continue to expect increasing future utility from acquiring new human capital. Theoretically, this effect suggests that any possible bubble in higher education would burst at the point at which employers do not value the new human capital as of equal value to higher wages. This idea funnels into a systemic issue surrounding pursued fields of study that I further examine later in this paper.

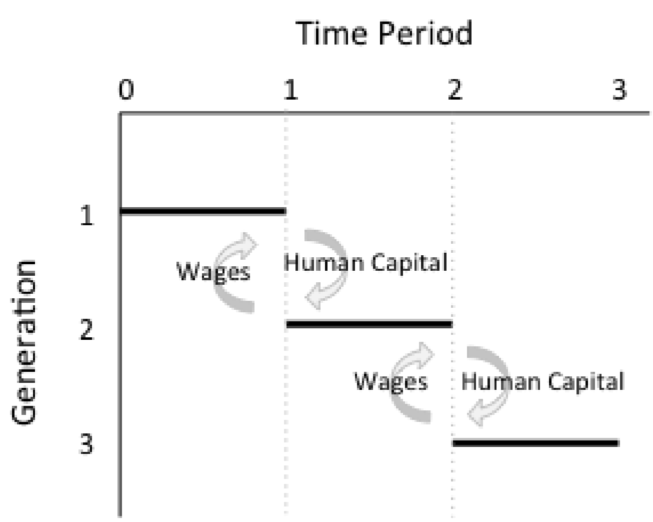

Figure 5. Overlapping Generations Higher Education Model

Chapter 5

NPV Analysis

I conducted an NPV analysis to estimate a risk profile of the higher education market based on student loans. My goal was to estimate leverage for the economy at large by analyzing various combinations of average tuition and borrowed student loan ranges, assessing default probabilities and discounted future wage net present values to examine the points at which the returns to higher education no longer exceed the costs. I hypothesized that the returned borrowed loan and tuition ranges of greatest leverage would fall slightly above the current averages in the economy at present. These forecasted average borrowed loan and tuition ranges should presumably draw the most concern for the economy at large if it were to ever reach these points, largely based on the associated leverage from increasing delinquency and default rates and the consequential effects on general economic spending if more recent graduates were strained by increasing student loan repayments.

Therefore, due to the difficulty in empirically determining bubbles and the uncertainty with results, I focused my analysis risk profiles on individual simulated borrowers to examine consequential systemic risk based on individual risk of default. Using a net present value analysis, I could examine comparative immediate returns to higher education as a function of receiving a Bachelor's degree compared to solely receiving a high school degree, with the intention of assessing at what point and with what probability the immediate returns to higher education no longer exceed the costs. Through this analysis, I was able to simulate returned approximate delinquency/default rates and 10-year post-graduation NPVs based on different tuition and borrowed loan amounts, pinpointing definitive points at which student loan default and delinquency could have a heavy systemic impact.

5.1 Methodology

I created a Monte Carlo simulation in Microsoft Excel to get a preliminary sense of borrower exposure to default.[1] I set up a simulation with an arbitrary 541 iterations over an isolated 14-year time horizon to account for four years in college, followed by 10 years of earning a salary and paying off debt post-graduation. Each iteration equivalently represents a randomized student loan borrower who attends a four-year higher education institution and graduates with a Bachelor's degree. The benefit of a Monte Carlo is that it allows for randomized results, specifically randomizing values for returns to higher education to account for the fact that different borrowers have different initial wages. It also allows me to get a sense for the large-scale impact of these changing variables on total net present value.

I benchmarked average tuition per year and average loan amount borrowed per year off of actual data. To account for the spread of in-state, out-of-state, public, and private tuition costs, I examined average net present values and probabilities of default based on a combination of tuition values ranging from $10,000 to $70,000 and a combination of per year borrowed loan amounts ranging from $5,000 to $35,000, both increasing by increments of $5,000 respectively. Based on actual data from the Federal Reserve and the College Board, I randomized the returns to higher education variable based on an average initial wage of $55,000 and an approximate standard deviation of $15,000 to account for differential salaries across various fields of study. I increased the starting tuition value each year at the average yearly tuition rate of increase. I similarly tried to account for a constant increase in salary, assuming that the student's starting salary increases at the average yearly rate of return for 10 years following graduation.

I did have to make a few assumptions with this model. First, I assumed that the graduate would hold the same job over the 10-year period post-graduation in order to maintain the same base salary. Second, I had to assume that the yearly rate of increase in wages was constant for the sake of creating a standard calculation to reflect averages for borrowers in aggregate. To standardize loan repayment, I made a few assumptions about the loan repayment plan. Time horizons and interest rates on loans vary

[1] See Appendix B for formulas

based on each individual borrower's repayment plan. For analysis, I standardized the repayment plan to cover 10 years, suggesting full repayment over my simulated 10-year time horizon post-graduation to analyze the approximate immediate returns to higher education with a Bachelor's degree. For this simulation, I used a loan interest rate of 4.5% based off of the actual reported average on student loans, though the rate is highly exposed to changes based on borrowers' credentials, particularly in the private sector and with unsubsidized loans. Loan repayment per month varies as time passes; however, for the sake of this model, I assumed a constant and equal monthly loan payment over this 10-year period, estimating a total monthly payment for both the loan and the interest on the loan as:

$$\left[\frac{(Per\ Year\ Borrowed\ Amount)(4\ years)}{\#\ Years\ in\ Repayment\ Plan} * \frac{1}{12\ months}\right] + \left[\frac{Interest\ rate}{12\ months} * (yearly\ loan\ amount * 4)\right]$$

I estimated the discount rate to incorporate both the risk-free rate and an arbitrary risk premium. I estimated an average discount rate based on an assumption of the associated risk-premium. The discount rate should not fall below the 20-year Treasury rate, which is currently around 2.9%. I therefore made the assumption that accounting for an arbitrary risk premium, the discount rate could presumably fall between 3% and 6%, based on which I estimated an average 4.5% discount rate.

Each simulation reflects a random sequence of different simulated borrowers who begin under the same tuition payment and borrowed loan conditions, assessing how the varying wage returns to higher education influence rate of default on loans and net present value. I set up my calculation beginning at time 0, representing the equivalent of cash flows at the beginning of the first year of college. Positive cash flow at time 0 comes from the yearly loan amount that a student borrows. Negative cash flow comes from the yearly tuition payment. The cash flows in the following three years include a constant positive cash flow from borrowed loans and a negative cash flow from yearly tuition that grows each year respectively at the recorded average rate of increase. The fifth year cash flow reflects the cash flows beginning in the first year out of college. The randomized wages derived from different returns to higher education reflect the positive cash flow, while yearly loan repayment and interest comprise a negative cash flow, assuming that repayment begins immediately post-graduation. In this simulation, I allowed the initial salary to grow at the average rate of yearly wage increase for the remaining nine years as a positive cash flow, whereas the negative cash flow from loan and interest repayment remain constant each year.

I created a Monte Carlo data table where the sum of discounted cash flows across each year for each borrower respectively returns the total net present value of that borrower's net earnings. According to the Organization for Economic Cooperation and Development (OECD), about 70% of an individual's income should ideally go toward spending essentials and savings, meaning that under the assumption that a rational borrower will need to hold 70% of his or her income, only 30% of an individual's income can be used to pay off student loan debt for the year. Based on this assumption, I created an Excel *IF* statement for each borrower in the years that would reflect post-graduation cash flows. I set up the input to calculate the fifth year net present value if the difference between the initial wages and the loan plus interest repayment for that year is greater than or equal to 70% of the initial wage being received, meaning that the yearly student loan payment could theoretically be paid off within the 30% margin of disposable income. If the difference returns a value less than 70% of wages earned, then the borrower would not have enough disposable income to maintain that lifestyle and still pay off the loans on time for the year, thereby returning "default" for that year. Though in actuality, many students have the ability to defer payment or would be labeled as "delinquent" on their loans due to the difficult process in actually defaulting on a student loan, I reflected the inability to repay the loan as a simulated default in order to examine the likelihood of inability to make a loan payment on time for borrowers with different incomes.

5.2 Results

My returned results include a list of 14-year NPVs for each simulated borrower, calculated as a sum of discounted cash flows for each year in college and for 10 years of working out of college. If the simulated borrower could not make a payment on the loan for a year following graduation, I counted the borrower as having been in default/delinquent. If a simulated default on a payment occurred at any point over the 10 years post-graduation, the default carried over to total NPV and would be counted as a borrower in default. For each change in loan amount borrowed per year and tuition amount per year, I analyzed the average total NPV across all borrowers, the average number of students who defaulted within the 10-year period post-graduation, and the probability of default/delinquency based on the percent of total students who would have defaulted. Based on the returned total NPVs for each borrower in the simulation, I calculated the number of defaults and negative NPVs out of the 541 simulated borrowers, the probability of default based on the number of defaults compared to the total number of simulated borrowers, and the average NPV under the underlying assumption that the wages are randomized around an average initial wage of $55,000 with a standard deviation of $15,000.

To analyze the impact of loan amount borrowed and tuition per year respectively on default probability and NPV as a measure of success in returns to higher education, I created tables to show the relationships. I created three tables: 1) probabilities of default or negative NPV, 2) average NPV, and 3) approximate number of defaults and/or negative 10-year NPVs, all assuming average initial wages of $55,000 with a standard deviation of $15,000 to acknowledge the difference in average starting salaries based on field of study. I increased both loan and tuition amounts by increments of $5,000, ranging from $5,000 to $35,000 in student loans borrowed per year and from $10,000 to $70,000 in tuition per year.

Assuming that a rational borrower would not borrow a per year loan amount greater than the per year tuition amount, across all tested tuition values, I found that the average probability of default or delinquency on a student loan payment increased from around 2.27% for an average borrowed amount per year of $5,000 to around 76.06% for an average borrowed amount per year of $35,000.

Table 1. Probability of Default

Probabilities of Default or Negative NPV (Assuming Average Initial Wages of $55,000 with Standard Deviation of $15,000)

		Loan Amount Borrowed Per Year							
		$5,000	$10,000	$15,000	$20,000	$25,000	$30,000	$35,000	Average
Tuition Per Year	$10,000	0.00%	0.74%						0.37%
	$15,000	0.00%	0.18%	3.88%					1.35%
	$20,000	0.37%	0.18%	4.07%	11.46%				4.02%
	$25,000	0.74%	0.37%	3.33%	12.20%	27.36%			8.80%
	$30,000	0.37%	0.74%	3.51%	9.80%	26.43%	55.08%		15.99%
	$35,000	0.92%	0.55%	2.59%	10.54%	29.94%	51.57%	79.67%	25.11%
	$40,000	0.74%	1.48%	5.36%	10.17%	28.47%	50.65%	74.86%	24.53%
	$45,000	2.22%	2.22%	3.33%	10.35%	28.47%	56.19%	74.86%	25.38%
	$50,000	1.48%	3.33%	4.99%	11.28%	27.73%	53.79%	76.34%	25.56%
	$55,000	3.14%	3.33%	4.81%	11.65%	30.68%	55.27%	75.60%	26.35%
	$60,000	4.99%	3.88%	6.10%	11.83%	29.76%	53.42%	77.63%	26.80%
	$65,000	6.10%	5.55%	5.73%	12.57%	32.16%	52.68%	73.20%	26.86%
	$70,000	8.50%	8.69%	11.65%	13.12%	30.68%	52.31%	76.34%	28.76%
Avg % Change by Loan Bracket			5.65%	105.81%	129.71%	156.74%	83.21%	42.33%	
Average rate		2.27%	2.40%	4.95%	11.36%	29.17%	53.44%	76.06%	

Table 2. Number of Defaults

**Sample size = 541 borrowers*
Approximate Number of Defaults and/or Negative 10-year NPV (Assuming Average Initial Wages of $55,000 with Standard Deviation of $15,000)

		Loan Amount Borrowed Per Year							
		$5,000	$10,000	$15,000	$20,000	$25,000	$30,000	$35,000	Average
Tuition Per Year	$10,000	0	4						2
	$15,000	0	1	21					7
	$20,000	2	1	22	62				22
	$25,000	4	2	18	66	148			48
	$30,000	2	4	19	53	143	298		87
	$35,000	5	3	14	57	162	279	431	136
	$40,000	4	8	29	55	154	274	405	133
	$45,000	12	12	18	56	154	304	405	137
	$50,000	9	18	27	61	150	299	413	140
	$55,000	17	18	26	63	166	326	409	146
	$60,000	27	21	33	64	161	289	420	145
	$65,000	33	30	31	68	174	285	396	145
	$70,000	46	47	63	71	166	283	413	156
Avg Change by Loan Bracket			4.97%	105.77%	129.74%	156.78%	85.68%	40.44%	
Average Difference			0.62	13.75	34.70	96.35	135.20	118.50	
Average		12	13	27	61	158	293	412	

The average total NPV value 10 years out of college increased about 36% from ~$266,250 to ~$362,566 for an average per year borrowed amount of $5,000 compared to $35,000. This relationship displays a prevalent systemic issue. As the average loan amount borrowed per year increases, both the average default/delinquency rate and the average NPV of 14-year cash flows increase. NPV increases as the default rate increases because the students who are missing loan payments are the ones with lower wage-earning jobs, resulting in delinquent loan payments. Consequently, default pulls the lower wage earners out of the NPV mix, thereby driving up the average NPV of higher wage earners. The concern with this situation is that the income gap is getting larger based on field of study. The problem is that though the average rate of return to higher education is still increasing, the average incorporates the exponentially increasing rate of return of higher earning majors, meaning that students with lower-earning majors are increasingly running into issues with paying off loans as tuition becomes more expensive.

Table 3. Average Total NPV

Average NPV (Assuming Average Initial Wages of $55,000 with Standard Deviation of $15,000)

	Loan Amount Borrowed Per Year								
Tuition Per Year	$5,000	$10,000	$15,000	$20,000	$25,000	$30,000	$35,000	Average	% Change in Average
$10,000	$380,189	$387,275						$383,732	
$15,000	$356,897	$367,288	$380,637					$368,274	-4%
$20,000	$337,403	$327,520	$351,210	$364,545				$345,170	-6%
$25,000	$319,102	$326,566	$335,830	$353,586	$375,321			$342,081	-1%
$30,000	$311,261	$315,468	$312,524	$335,419	$355,817	$398,552		$338,173	-1%
$35,000	$281,335	$283,862	$287,574	$308,866	$336,679	$379,592	$424,940	$328,978	-3%
$40,000	$263,435	$264,701	$277,911	$296,926	$317,683	$360,307	$407,292	$312,608	-5%
$45,000	$244,021	$248,361	$261,987	$270,184	$297,435	$349,264	$404,104	$296,479	-5%
$50,000	$234,815	$227,457	$233,747	$258,614	$280,741	$327,903	$383,540	$278,117	-6%
$55,000	$206,340	$222,857	$212,513	$239,908	$260,553	$303,054	$350,978	$256,600	-8%
$60,000	$190,563	$199,689	$199,242	$213,906	$240,400	$289,347	$330,030	$237,597	-7%
$65,000	$174,320	$181,639	$183,726	$195,250	$219,511	$265,295	$310,169	$218,559	-8%
$70,000	$161,568	$157,755	$156,222	$177,669	$205,499	$243,782	$289,471	$198,852	-9%
Avg % Change by Loan Bracket		1.42%	-1.46%	3.00%	5.43%	12.17%	11.86%		
Average Difference		$3,784	$3,940	$7,986	$14,885	$35,158	$38,444		
Average	$266,250	$270,034	$266,094	$274,079	$288,964	$324,122	$362,566		

This simulation shows an approximate 36% increase in total average 14-year NPV from $5,000 to $35,000 in student loans borrowed per year, all else constant. Additionally, there is an approximate -48% increase in total average 14-year NPV from $10,000 to $70,000 in per-year tuition for the first four years, all else constant. Total average NPV increases with increased borrowed amounts as people with lower wages default, thereby pulling them out of the total NPV calculation and reflecting increasing total NPVs for remaining high wage earners. Therefore, these results suggest that under these parameters, per year tuition has a larger effect than per year borrowed loan amount on total immediate NPV 10-years post-Bachelor's. Additionally, probabilities of default appear to converge to a certain default rate across all tuition values for each loan bracket, a converged value that increases rather exponentially across different loan brackets as the average per year loan amount increases by $5,000.

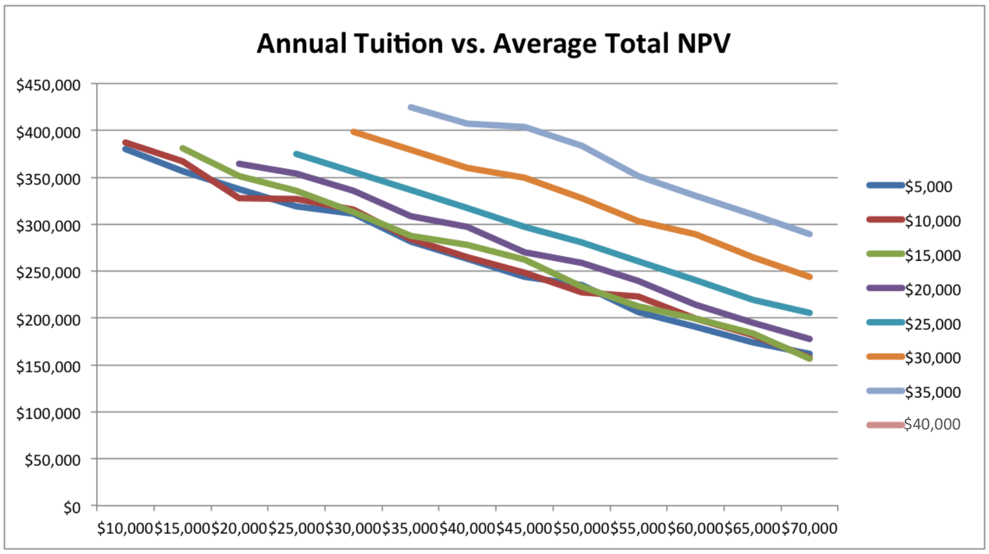

Figure 6. Average Total NPV (Assuming Initial Wages of $55,000 with Standard Deviation of $15,000)

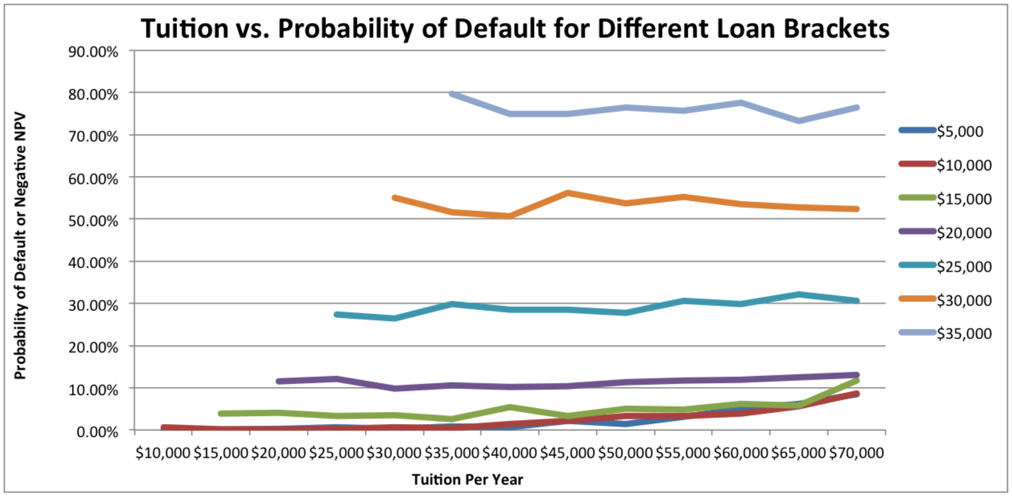

Figure 7. Leverage of the Student Loan Market (Average Initial Wages of $55,000 with Standard Deviation of $15,000)

The largest average increases in probability of default occur around tuition changes between $25,000 and $35,000, after which the probability of default tends to hover slightly over 25% with a presumable ceiling of about 30%. On the other hand, a change in the average loan bracket per year has an exponential effect on the average default rate. The greatest percent increase in the probability of default and/or total negative NPVs on average occurs in the increase of borrowed loan brackets from $20,000 to $25,000, followed by the jump from the $15,000 to $20,000 borrowed per year loan bracket. The average was taken with respect to each average loan amount borrowed as a bracket across all tuition values ranging from $10,000 to $70,000. All else constant, a jump in average per year loans borrowed from $20,000 to $25,000 resulted in an aggregate 156.74% average increase in the probability of default or negative NPV over the course of 10 years post-graduation, jumping from an average default rate of around 11.36% across all tuition values for an average loan bracket of $20,000 to an average default rate of around 29.17% for the $25,000 loan bracket, resulting in an approximate increase in the number of defaults over this sample of 541 borrowers from 61 to 158 borrowers.

These findings present a fairly accurate representation of the current market. Over the past decade, average tuition, student debt, and the 90+ day student delinquency rate have all increased. Currently, the most common loan bracket for students ranges from around $5,000 to $15,000 in student loans borrowed per year. The current default rate is fairly low below 5% due to the difficulty in defaulting, but the 90+ day delinquency rate has increased to about 10 to 11% for 2017. From my simulation, I found that the largest jump in delinquency/default rate occurred around the range of $15,000 to $25,000 in loans borrowed per year, equating to around $60,000 to $100,000 in loans after four years of higher education. This range falls just above the benchmark labeled “jumbo loans” in the United States, referring to loans in excess of $50,000 in total held by individual students.

The WSJ released an article in February, 2018 pertaining to student loan debt (Mitchell 2018), focusing on how jumbo student loans reflect similar 2008 mortgage patterns. Citing a Brookings Institution study, the article mentions that the majority of borrowers with $50,000+ in student loans were unable to pay off their debt in addition to the near 5% interest payments on their debt. Though the number of borrowers with such large loan balances is only about 1/8th of the total number of student loan borrowers, these borrowers currently hold over 50% of the total student loan balance in the United States. Consequently, a benchmarked debt balance threshold exists that marks a high increase in systemic risk, suggesting that the greatest increase in systemic risk from increased student loan debt would presumably occur as the average amount of loans borrowed per year increases to within the $15,000 to $25,000 per year range. Therefore, while default and delinquency on student loans seem fairly low now, I argue that the issue will heighten when the average amount of student loans borrowed per year surpasses the $15,000 to $25,000 mark, the range at which the largest percent increase in probability of default is likely to occur as the probability of loan delinquency heightens.

At–Risk Expanded Results

I expanded my NPV analysis through a program called *At-Risk* with the goal of examining the benefit of receiving a Bachelor’s degree over a high school degree. I set up the net present value equation in the same fashion as my previous model, this time subtracting out the total NPV of returns from a high school degree, meaning that lost wages over the four years in college turn into an opportunity cost of higher education. Using this model, I sought to examine how often higher education as a difference between returns to college and a high school education will return a positive NPV, incorporating three inputs of uncertainty in the calculation of total net present value: tuition, salary, and the discount rate. I benchmarked my estimations for tuition and salary off of actual data collected from the NCES, the College Board, and FRED, estimating the discount rate based on an approximation of the risk premium. The discount rate should be higher than the 20-year Treasure rate, which is currently around 2.90%. Allowing for a risk premium, I therefore estimated a potential discount range window of around 3 to 6%.

I ran five sequences of Monte Carlo simulations that randomized these three variables within specified parameters. Each sequence of simulations examined the impact of a $5,000 increase in student loans, ranging from a total borrowed loan amount per year of $10,000 to $50,000. I ran this same progression for each sequence of tests, each of which reflected a different combination of STEM versus non-STEM and public versus private institutions, in addition to one test that incorporated the total range of possible inputs. Each simulation ran 10,000 iterations analogous to different individual borrowers, meaning that the tuition, salary, and discount rates varied across each borrower within specified parameters. This Monte Carlo simulation returns a random distribution of NPV values based on these varying inputs, which I modeled in the form of a histogram. The histogram reflects a probability density function, whereby $\int p(x_1)dx_1 = 1$ reflects the area under the graph from negative infinity to infinity. The y-axis reflects relative probabilities, displaying the relative frequency of occurrence for each NPV value. The y-axis values are so small because each simulation is comprised of 10,000 iterations. Added together, the probabilities of each returned NPV equal 1 to reflect the area under the chart.

My first test was an NPV analysis of returns to higher education for STEM majors who attend a four-year public institution. I standardized starting tuition at $20,770, the current average enrollment-weighted value of a public four-year institution, according to the College Board. I set the randomized discount rate parameters with a .03 minimum, .06 maximum, and .04 highest probability value to account for an estimated risk premium. I estimated a range of potential wages based on NCES data for STEM majors, ranging from $50,000 to $90,000 with a $70,000 mean value. I next ran an NPV analysis of returns to higher education for STEM majors who attended a private four-year institution. I maintained the same parameters for the randomized discount rate and returns to higher education for STEM majors, this time changing the starting tuition value to a standardized $46,950 based on the aggregate average.

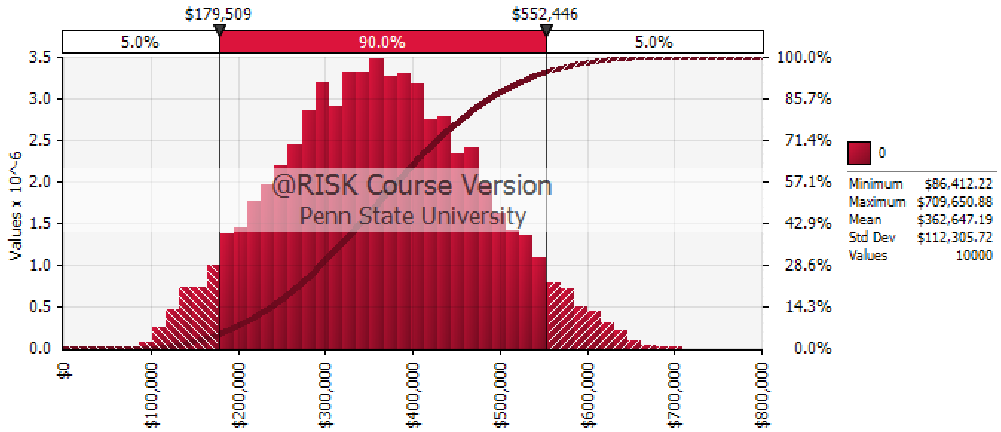

Figure 8. NPV of Returns to Education (STEM Major; Public Four-Year; $10,000 in borrowed loans per year)

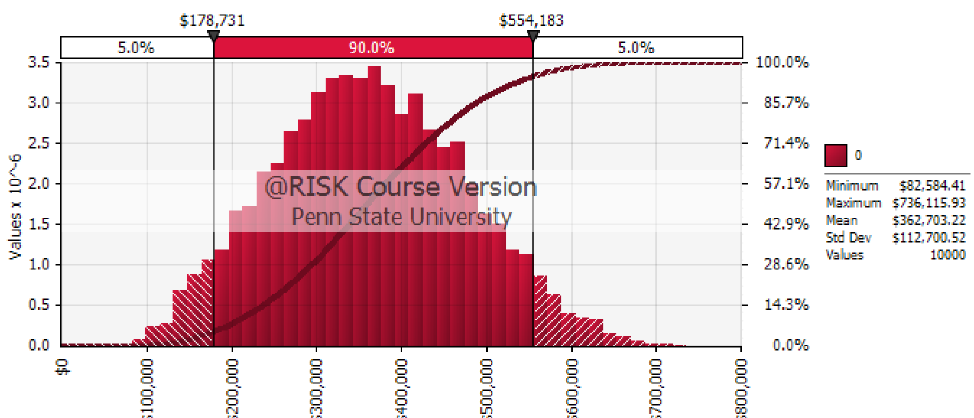

Figure 9. NPV of Returns to Education (STEM Major; Public Four-Year; $50,000 in borrowed loans per year)

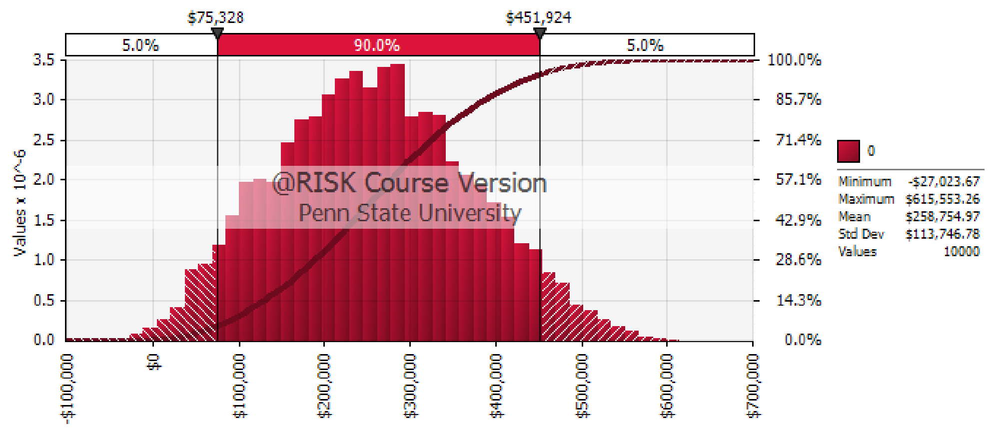

Figure 10. NPV of Returns to Education (STEM Major; Private Four-Year; $10,000 in borrowed loans per year)

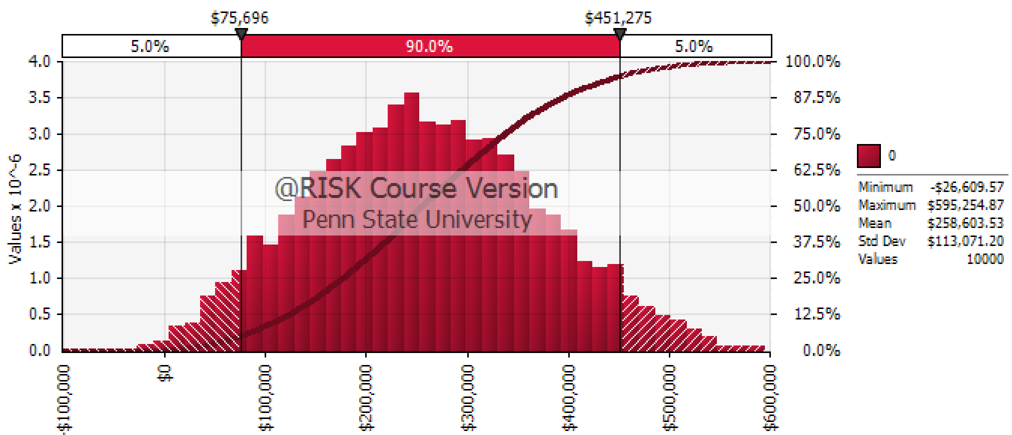

Figure 11. NPV of Returns to Education (STEM Major; Private Four-Year; $50,000 in borrowed loans per year)

An approximate 70% of students attend public institutions compared to an estimated 20% who attend private institutions. Enrollment-weighted, an average student loan borrower of around $10,000 per year with a STEM degree would fall within the parameters of an estimated $55,084 minimum, a $619,866 maximum, and a $305,604 mean NPV value 10 years post-graduation. The average enrollment-weighted returns for a student borrowing $50,000 per year are around a $52,462 minimum, a $634,332 maximum, and a $305,613 mean. Though the minimum simulated NPV is slightly lower for the $50,000 per year borrower compared to the $10,000 per year borrower, the maximum potential NPV is higher, showing the benefit of student loans in helping students to achieve greater returns to education. Additionally, regardless of the amount borrowed, this simulated analysis shows that because the average NPV as a difference in returns remains positive 10 years post-graduation, the benefits of receiving a Bachelor's degree still outweigh the costs for students pursuing fields of study with higher expected returns.

I next ran an NPV analysis of returns to higher education for non-STEM majors. I again ran two simulations of 10,000 iterations each to return the average NPVs of higher education for public versus private higher education institutions. Again utilizing standardized tuition values of $20,770 and $46,950 for public and private tuition respectively, I changed the parameters for the returns to higher education based on actual collected data. The new parameter exhibited a minimum salary value of $25,000, and maximum of $55,000, and a mean of $40,000 for average starting salaries for non-STEM majors.

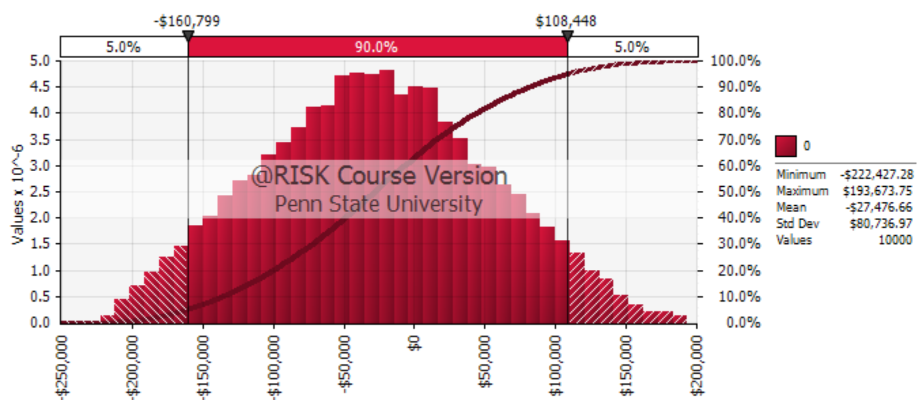

Figure 12. NPV (Non-STEM Major; Public Four-Year; $10,000 in per year loans)

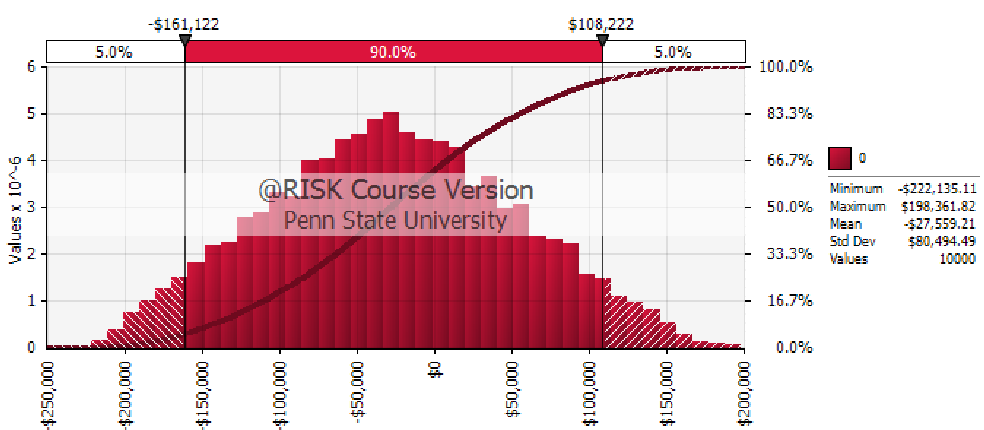

Figure 13. NPV (Non-STEM Major; Public Four-Year; $50,000 in per year loans)

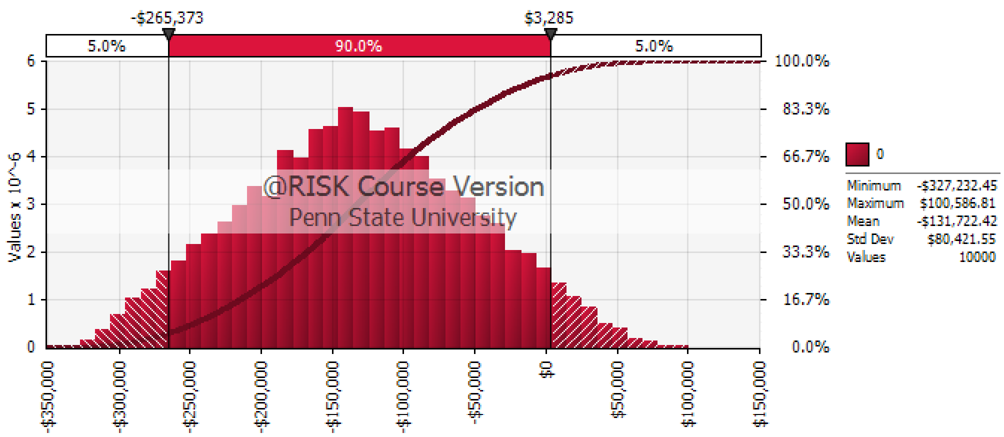

Figure 14. NPV (Non-STEM Major; Private Four-Year; $10,000 in per year loans)

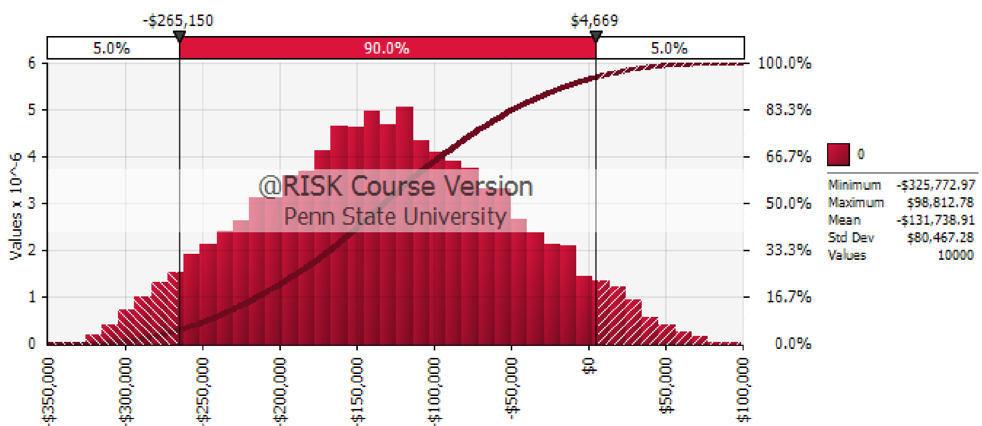

Figure 15. NPV (Non-STEM Major; Private Four-Year; $50,000 in per year loans)

Again assuming that approximately 70% of students attend public institutions and about 20% attend private institutions, enrollment-weighted, an average borrower taking out $10,000 per year in student loans would fall within the parameters of around a -$221,146 minimum, a $155,689 maximum, and a -$45,578 mean as the 10-year post-graduation NPV of returns to higher education. Under the same assumptions for a student loan borrower taking out $50,000 per year in student loans, the approximate range of NPVs of returns to higher education is -$220,649 to $158,616 with a mean of around -$45,639.

I ran a final test where I randomized tuition in attempt to capture higher education per year costs for all students in four-year institutions, allowing for randomized differences in tuition based on factors such as private versus public tuition, in-state versus out-of-state costs, state funding, etc. I therefore expanded the parameters to capture a tuition range from $15,000 to $70,000 with a mean of $30,000. Additionally, I expanded the parameters for returns to higher education to capture average starting wages for students with different majors, bounding the range from $30,000 to $110,000 with a mean of $50,000. The returned probability distribution returned a range of returns to education NPVs of around -$307,850 to $938,348 with a $206,105 mean for borrowers with an average loan amount borrowed per year of $10,000. Testing for borrowers with an average borrowed amount of $50,000 in loans per year, the range of NPVs ranged similarly from around -$324,935 to $963,717 with a mean of $205,947.

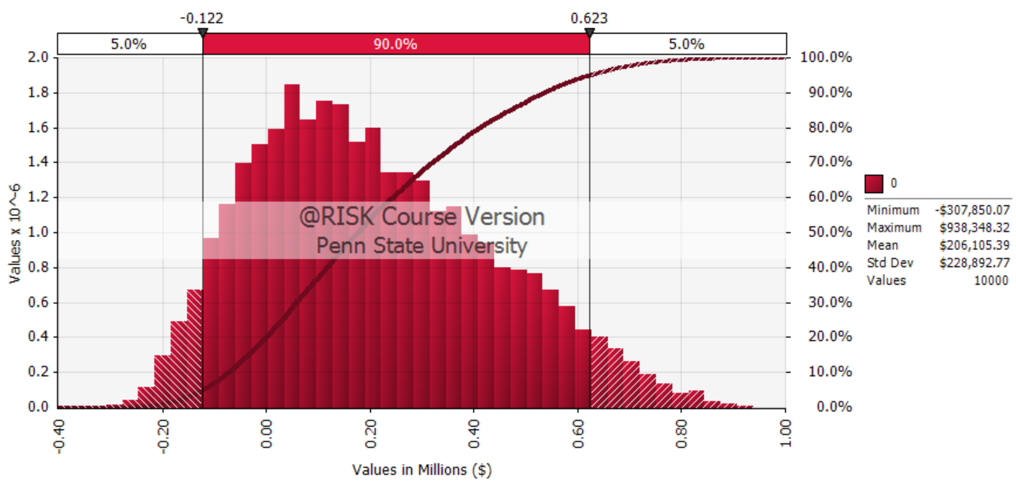

Figure 16. Combined NPV Distribution ($10,000 in per year student loans borrowed)

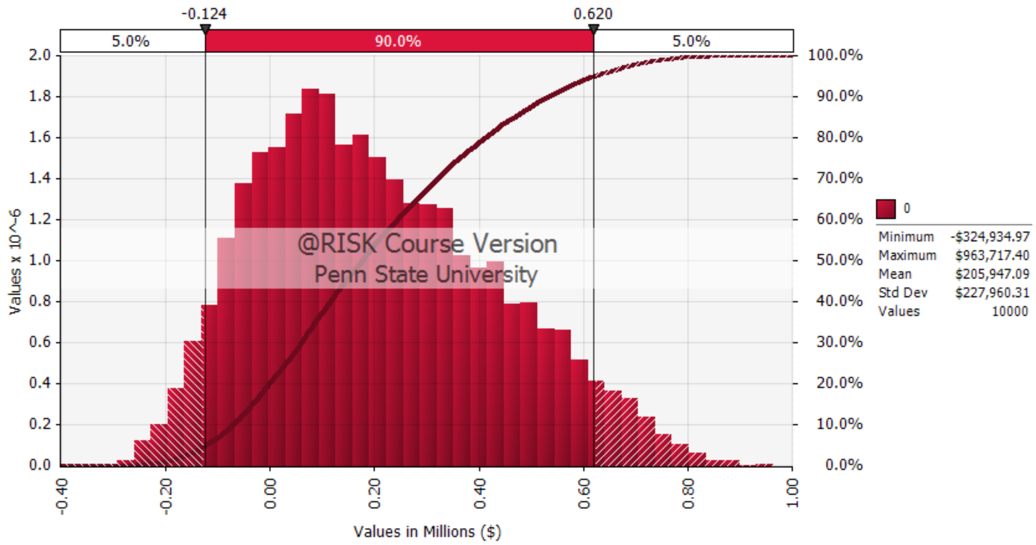

Figure 17. Combined NPV Distribution ($50,000 in per year student loans borrowed)

These results do touch on an important problem caused by increasing tuition and student loans. While the amount borrowed per year had a smaller impact on the difference in range of NPV values of returns to higher education, the difference in wages had the strongest impact. That is, wages for STEM and higher-earning majors had much more significant increases in NPV ranges compared to non-STEM and lower-earning majors. Particularly noteworthy is that average NPV was consistently positive for higher-earning majors; however, for lower earning majors, the minimum NPV dips negative. Specifically, the mean NPV for STEM majors is positive while the mean NPV for non-STEM majors is negative, suggesting that for some majors, the 10-year post-graduation return to education is actually not positive, where the opportunity cost of going to school outweighs the marginal benefit. However, important to note is that this is strictly over a 10-year time horizon, so these results would vary as the horizon is expanded.

Areas for Analysis Improvement

This financial analysis provides a starting overview of the systemic risk in the education market at present. Though this model provides a framework for the market, several factors could not be incorporated, though they are still important to consider and could be potential areas for future improvement on this analysis. First, my analysis makes assumptions about students' mobility, repayment abilities, and salary increases, factors that change year to year for many recent graduates. Additionally, the model does not account for decision factors such as parents' choosing to save more to help students afford higher education or students' choosing to attend or not to attend higher education or different types of institutions because of costs and other relevant factors. Finally, I modeled under the assumption that a student would attend and graduate a four-year higher education within a full four years. The model therefore does not capture students who drop out early or attend two-year or technical institutions, which would likely drive up the overall probability of default, and on the other hand also does not capture students who graduate early, which would likely drive down the probability of default. Going forward, these factors, upon others such as success factors based on family income or institution prestige, would be considerable factors for areas of improvement if they could somehow be quantitatively incorporated in this or another similar model.

Chapter 6 Regression Analysis

6.1 Testing Relationships Between Student Loans, Debt, and Tuition

I conducted a regression analysis to assess the changing relationship between student loan debt and net tuition with the goal of examining whether or not student loan supply may have some sort of potential effect on this relationship. My hypothesis was that if student loans were to actually help fuel some sort of potential price bubble in higher education, then there should be quantitative evidence of a correlated relationship between increasing student loans and tuition prices. The Federal Reserve Bank of New York earlier released a staff report examining the relationship between changes in loan supply and rising tuition prices by isolating a structural break based on a change in student loan supply (Lucca et al, 2017). The United States federal government imposed policy changes during the 2007-08 and 2008-09 school years. The policy changes increased federal student loan credit supply by around $1,000 per year in subsidized loans for underclassmen and by $2,000 per year in unsubsidized loans for all undergraduates. In total, federal loans for undergraduates increased by around $3,000 per year, subject to changes based on year in school (Lucca et al, 2017). Using the policy-in-effect years as the segment differentiator, this paper examined the superficial effect of student loans on published tuition. I expanded on this model to get a better sense for the relationship, using net tuition rather than published tuition to analyze what students are actually paying for higher education less grants.

6.2 Methodology and Results

I used this paper's model as a basis for my regression analysis to examine the relationship between net tuition and student loan debt. Rather than examine published tuition prices, I examined inflation-adjusted net tuition, fees, and room and board (net TFRB) to represent what students are actually paying for higher education, using yearly CPI data for inflation adjustments. I incorporated total student loan debt as an additional outcome variable to examine the effect of student loans on the relationship between rising tuition and student loan debt. Similar to as in the Federal Reserve staff report, I isolated the effect of loan supply on student loan debt and net tuition using the 2008 student loan policy changes as a benchmark across which I could test for structural breaks that may have occurred with these policy changes. I collected time series data for both total student loan debt and net tuition and related fees over an approximate 10-year time horizon, which I divided CPI into to adjust for inflation.

I tested for the structural break by creating dummy variables, with 0 representing the years before and 1 representing the years after the policy change-in-effect year. I created separate sequences of dummy variables for each year from 2006 to 2010, covering the years surrounding the policy change to see where the structural break occurred. Using STATA, I ran a multivariate regression to test for the effect of the dummy variable year sequence on real net TFRB and real total student loan debt as two co-dependent outcome variables. I found that, with high significance, the F-statistic on these multivariate regressions increased up until 2008.[2] The F-statistics for the two years both before and after 2008 fell within similar ranges, all under 20, while the F-statistic for the regression reflecting a change in 2008 skyrocketed over 100% to 40.71. Therefore, these results show that a structural break occurred in 2008.

Noting a clear structural break in 2008, I wanted to see if the relationship between net tuition and student loan debt changed before and after the policy changes. Ignoring 2008 as the outlier, I examined the correlation coefficient between net TFRB and student loan debt in the approximate five years before and after the structural break. Prior to 2008, these variables returned a correlation coefficient of 0.13 compared to a post-2008 correlation coefficient of 0.84.[3] A major jump in correlation occurred before and after the policy changes, showing that the relationship between net TFRB prices and student loan debt heavily strengthened after 2008 with increasing federal student loan availability. Increasing the amount a

[2] See table of regression values in Appendix A
[3] See table of correlation values in Appendix A

student can borrow therefore has an income effect, shifting receipts forward and payments backward in time. Whether this income effect is positive or negative would depend on factors such as the student's subjective discount factor, level of risk aversion, the real interest rate, the rate on the loan, and the student's ability to pay off the loan.

Important to note is that this analysis generalizes across all students at all institutions. To make a sure claim about the relationship, the analysis would have to account for factors such as enrollment patterns, changing demographics, and recruitment of foreign students and out-of-state students who pay higher tuition rates, upon other subjective factors. However, this analysis does provide a basis for the fact that higher loan availability influences a change in the relationship between higher education costs and debt, one that could continue to feed off itself as more students take out more student loans.

Conclusion

7.1 Conclusion of Results

The 2008 housing bubble revealed the importance of acknowledging signs of bubbles or areas for potential economic distress before they spiral out of control. Examining the theoretical model for the 2008 housing bubble, an analog is present in the multi-market interaction within the current markets for higher education and student loans in how these markets have the ability to feed into each other. Though I cannot make a sure causal statement about the existence of a bubble in the current higher education market, these findings reveal concerns with the leverage in the market that could potentially lead to further claims about the potential existence of a bubble with more available data. That is, if a bubble in higher education were to exist, we could pinpoint it by examining the rate of increase of net tuition against student loans relative to the rate of increase of post-graduation wages, notably for fields of study with often lower immediate wages. Data analysis could also be improved by considering different factors such as demographics, enrollment patterns, borrowing characteristics, and grant distribution considerations, upon other factors.

Regardless of whether or not a bubble in higher education exists, the models and findings reveal an evident systemic impact. Total net present value and default rates both increased as tuition and student loans per year increased, thereby posing an income gap issue for recent graduates with different majors. Additionally, average 10-year post-graduation NPV returns to higher education tend to be negative for students with low-wage returns, raising the question surrounding the immediate worth and viability of obtaining a Bachelor’s degree for students of certain majors. The negative returns also pose a systemic concern, whereby students with lower returns to higher education may consequently invest less in the economy at large post-graduation, thereby driving down overall economic activity.

Student loans do not pose a major area of concern for the Federal Reserve at the moment because the default rate is still very low. However, I found that the largest default/delinquency rate jump increased in the loan amount borrowed per year of $20,000 to $25,000 borrowed per year, followed by the jump from $15,000 to $20,000 borrowed per year. Though the national average for loan amount borrowed per year is still slightly lower, and therefore returns lower default rates, the range of $15,000 to $25,000 in debt per year is on par with current status for students who are classified as having “jumbo loans”, which comprises the majority of the market for student loan debt at present. This situation of a few borrowers holding the majority of subprime debt eerily echoes mortgage debt in 2008.

7.2 Systemic Impact

ASA and NAR Survey of Student Loan Borrowers

Pinpointing asset bubbles poses a major challenge for U.S. regulators, which is why bubbles often go unnoticed. Regardless of whether or not higher education and student loans are bubbled, these markets impact other aspects of the economy that will continue to weigh down on the economy at large even more. According to the National Association of Realtors *Profile of Home Buyers and Sellers*, nearly 27% of recent home buyers remain with at least some student loan debt, noting a higher rate of nearly 40% of all first-time homebuyers. Causation is a tricky topic to acknowledge, but the correlation is definitely worth noting. The American Student Assistance and the National Association of Realtors conducted a survey in August 2017 for student loan borrowers ages 22 to 35 who are currently in repayment (NAR & ASA, 2017), providing insight as to how student loan debt impacts the rest of the economy.

32% of the respondents reported having defaulted or pushed off repayment on their loans, with the median student loan debt value falling around $41,200. The majority of respondents attended public, four-year higher education institutions and reflected a median income of around $38,800. The primary findings concluded that student loan debt heavily impacts new homeowners’ home purchase decisions.

The survey found that more than seven in ten student loan borrowers believe that their student loan debt has impacted their ability to purchase a home. Specifically, among non-homeowners, which comprised about 80% of the survey respondents, 83% noted that student loan debt was a primary factor in delaying home ownership, noting that student loan debt was inhibiting savings on a down payment for a house. Consequently, the survey concluded that the delay in buying a home for non-homeowners could be up to seven years. This survey is not full-proof, and the results would be more representative of the borrowing population at large with more responses. However, while this survey only provides a snapshot of the issue, it does address the concern that student loans could be impacting other aspects of the economy.

So Now What?

I foresee two potential impacts of the problem with increasing student loan debt:

1) Tuition will eventually become too unaffordable based on immediate earnings.
2) The economy will suffer from delayed investment from recent graduates in certain industries.

Noting the change in the relationship between student loan debt and net tuition, fees, and room and board pre- and post-2008, we can see that loan availability has a strong effect on debt and price correlation. One policy suggestion is to reduce the strength of this correlated relationship by slightly reducing federal loan availability. Even a slight reduction in federal loan supply per student per year would likely encourage further borrowing in the private sector. The higher rates in the private sector could likely place more pressure on universities to make higher education more affordable in the form of available grants and scholarships if high private loan interest rates were to drive down demand for borrowing based on increasing unaffordability. Additionally, the private sector tends to exhibit lower default and delinquency rates because of increased requirements for credit borrowing, lower default rates that would allow for more stable investment post-graduation in the economy at large.

I therefore argue that though the market may not pose a large systemic threat at the moment, the Federal Reserve should keep an eye on the market, noting the exponential increase in market leverage if average loans borrowed per year were to jump into the $15,000 to $25,000 range, coupled with increasing net tuition prices. There was clearly a structural break in 2008, showing that the increased federal loan supply may have contributed to strengthening the correlated relationship between student loan debt and net tuition, fees, and room and board. Noting this effect, the Federal Reserve should be mindful of potential policy changes that may help to mitigate the leverage of the market.

One suggestion would be to loosen the relationship between net tuition and student loan debt. The marginal benefit continues to exceed the marginal cost of higher education for all students based on the fact that students with Bachelor’s degrees consistently earn more than students with high school and degrees and also based on the fact that higher education only benefits society as a whole. Therefore, the government could potentially place more pressure on higher education institutions by slightly reducing federal loan supply (not to pre-2008 levels, but to a medium average between the pre- and post-2008 change). Doing so would increase demand for private sector loans, most of which have much higher rates. If more students were pressured to enter the private sector loan market, more would reconsider the affordability of college, thereby increasing demand for universities with lower and more affordable net tuition prices. Noting that the market for higher education is monopolistically competitive, increased demand for universities with lower net tuition values would place pressure on other universities to reduce their net tuition values as to not lose demand from the best applicants based on price. Therefore, universities would likely have to increase internal funding in the form of grants and scholarships in order to continue attracting the best students. For a fully appropriate policy recommendation, improved analysis would require greater research on borrowing trends and characteristics, borrower demographics, net tuition trends, and the loan supply process.

Appendix A

Table 4. Multivariate Regression 2006

```
manova realnetTFRB realstudentloandebt = c.changein2006
```

Number of obs = 12

W = Wilks' lambda L = Lawley-Hotelling trace
P = Pillai's trace R = Roy's largest root

Source	Statistic		df	F(df1,	df2) =	F	Prob>F	
change~2006	W	0.3130	1	2.0	9.0	9.88	0.0054	e
	P	0.6870		2.0	9.0	9.88	0.0054	e
	L	2.1946		2.0	9.0	9.88	0.0054	e
	R	2.1946		2.0	9.0	9.88	0.0054	e
Residual			10					
Total			11					

e = exact, a = approximate, u = upper bound on F

Table 5. Multivariate Regression 2007

```
manova realnetTFRB realstudentloandebt = c.changein2007

                    Number of obs =          12

                    W = Wilks' lambda       L = Lawley-Hotelling trace
                    P = Pillai's trace      R = Roy's largest root

           Source | Statistic          df    F(df1,      df2) =    F    Prob>F
     -------------+------------------------------------------------------------
     change~2007  | W    0.1974         1      2.0        9.0      18.30 0.0007 e
                  | P    0.8026                2.0        9.0      18.30 0.0007 e
                  | L    4.0668                2.0        9.0      18.30 0.0007 e
                  | R    4.0668                2.0        9.0      18.30 0.0007 e
                  |------------------------------------------------------------
         Residual |                    10
     -------------+------------------------------------------------------------
            Total |                    11
     -------------+------------------------------------------------------------
                    e = exact, a = approximate, u = upper bound on F
```

Table 6. Multivariate Regression 2008

```
. manova realnetTFRB realstudentloandebt = c.changein2008

                    Number of obs =          12

                    W = Wilks' lambda       L = Lawley-Hotelling trace
                    P = Pillai's trace      R = Roy's largest root

           Source | Statistic          df    F(df1,      df2) =    F    Prob>F
     -------------+------------------------------------------------------------
     change~2008  | W    0.0995         1      2.0        9.0      40.71 0.0000 e
                  | P    0.9005                2.0        9.0      40.71 0.0000 e
                  | L    9.0466                2.0        9.0      40.71 0.0000 e
                  | R    9.0466                2.0        9.0      40.71 0.0000 e
                  |------------------------------------------------------------
         Residual |                    10
     -------------+------------------------------------------------------------
            Total |                    11
     -------------+------------------------------------------------------------
                    e = exact, a = approximate, u = upper bound on F

.
```

Table 7. Multivariate Regression 2009

```
manova realnetTFRB realstudentloandebt = c.changein2009

                          Number of obs =          12

                          W = Wilks' lambda      L = Lawley-Hotelling trace
                          P = Pillai's trace     R = Roy's largest root

                   Source | Statistic          df   F(df1,     df2) =   F   Prob>F
              ------------+--------------------------------------------------------
              change~2009 |W   0.2208           1     2.0       9.0    15.88 0.0011 e
                          |P   0.7792                 2.0       9.0    15.88 0.0011 e
                          |L   3.5299                 2.0       9.0    15.88 0.0011 e
                          |R   3.5299                 2.0       9.0    15.88 0.0011 e
                          |--------------------------------------------------------
                 Residual |                    10
              ------------+--------------------------------------------------------
                    Total |                    11
              ---------------------------------------------------------------------
                          e = exact, a = approximate, u = upper bound on F
```

Table 8. Multivariate Regression 2010

```
manova realnetTFRB realstudentloandebt = c.changein2010

                          Number of obs =          12

                          W = Wilks' lambda      L = Lawley-Hotelling trace
                          P = Pillai's trace     R = Roy's largest root

                   Source | Statistic          df   F(df1,     df2) =   F   Prob>F
              ------------+--------------------------------------------------------
              change~2010 |W   0.1903           1     2.0       9.0    19.14 0.0006 e
                          |P   0.8097                 2.0       9.0    19.14 0.0006 e
                          |L   4.2543                 2.0       9.0    19.14 0.0006 e
                          |R   4.2543                 2.0       9.0    19.14 0.0006 e
                          |--------------------------------------------------------
                 Residual |                    10
              ------------+--------------------------------------------------------
                    Total |                    11
              ---------------------------------------------------------------------
                          e = exact, a = approximate, u = upper bound on F
```

```
. correlate realnetTFRB realstudentloandebt if date<2008
(obs=5)

             | realne~B realst~t
-------------+------------------
 realnetTFRB |   1.0000
realstuden~t |   0.1324   1.0000
```

```
. correlate realnetTFRB realstudentloandebt if date>2008
(obs=6)

             | realne~B realst~t
-------------+------------------
 realnetTFRB |   1.0000
realstuden~t |   0.8394   1.0000
```

Table 9. Real Net TFRB vs. Real Student Loan Debt Correlation Matrix

Appendix B

Tuition** = NORM.INV(RAND(), Forecasted Returns = $55,000, Stdev = $15,000)

Returns to Education** = Bachelor's Degree Avg. Wages – High School Degree Avg. Wages

Estimated Monthly Loan Payment = $\frac{(Per\ Year\ Loan\ Amount*4) / Number\ of\ Years\ in\ Repayment\ Plan}{12}$

Estimated Per Month Interest on Loan = $\left(\frac{Interest\ Rate\ on\ Loan}{12}\right) * (Per\ Year\ Loan\ Amount * 4)$

Discretionary Spending = (1 – %Income for Spending Essentials and Savings) * Returns to Education

Yearly student loan repayment = Yearly Loan Repayment – Yearly Interest on Loan

"Default" = IF[(Returns to Education – Loan Repayment) ≥ (%Income for Essentials*Education Returns),

Yearly NPV = Education Returns – Loan Repayment, otherwise "default")]

Yearly NPV in College = Student Loans – Lost High School Degree Wages – Tuition

Yearly NPV Post-College = (College Wages – High School Wages) – Yearly Loan Repayment

Total NPV = IF("Default" then NPV = "_") otherwise NPV = Discounted Yearly Cash Flows

***Subject to consistent growth rate each year*

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EDUCATION

Schreyer Honors College, The Pennsylvania State University, University Park, PA — Graduation: May 2018
Paterno Fellows Honors Program, The College of the Liberal Arts — Dean's List
B.A. in Economics (honors) and B.S. in Finance

Honors Thesis: *The Next Crisis? A Systemic Analysis of Higher Education and Student Loan Debt in the United States*

PROFESSIONAL EXPERIENCE

Grant Thornton LLP — **Washington, DC**
Risk Advisory Intern — June – August 2017
- Tested process and IT controls for various clients
- Worked directly with different project teams to test client controls in the industries of hospitality, real estate investment, financial services, and IT
- Extended Grant Thornton relationships to one of our company's key clients of interest by creating a relationship map and establishing further initial contacts with the client
- Collaborated with a team and presented to a panel of partners in a company-wide case competition to establish relationships and provide suggestions to initiate a working relationship with a key client

The Board of Governors of the Federal Reserve System — **Washington, DC**
Office of Inspector General, Division of Supervision and Regulation, Audit Intern — May – August 2016
- Collaborated with team members to evaluate the procedures for mitigating conflict of interest risks within a division of the CFPB
- Reached out to other OIGs and pitched suggestions in a workgroup to help with the office's product development
- Contributed to drafting a published Federal Reserve Board OIG evaluation report
- Prepared and delivered an informative presentation to all division staff on shadow banking
- Prepared and presented one of the team's summary findings to Senior Management

Department Of Commerce
Pittsburgh, PA
U.S. Commercial Service, Student Intern — May – August 2015
- Conducted research and composed reports on exporting opportunities in foreign markets for startup companies
- Compiled global market data in Microsoft Excel and worked with trade specialists to organize information to present to clients

LEADERSHIP

The Pennsylvania State University Club Travel Tennis Team — 2014 - Present
- Compete as a team member in regional tournaments
- Participate in THON by helping to raise money and interacting with our THON child

Research Experiences for Undergraduates Program, Department of Economics — Fall 2016
- Conducted research and data compilation in collaboration with a department professor each week using the statistics package, EViews, for time-series data and econometric analysis
- Focused my work on analyzing and creating time-series models for primary economic benchmark variables

Undergraduate Learning Assistant and Grader, Macroeconomics — 2015 - 2016
- Interact with students to help better understand concepts
- Work with the professor to organize notes, proctor exams, and assist with grading

ADDITIONAL SKILLS

- Experience with Microsoft Office – Excel, Word, and PowerPoint
- Communication skills with a focus on client relations
- Experience with TeamMate and Sharepoint and limited exposure to SQL and Python