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ABSTRACT

The purpose of this thesis is to investigate the four percent rule that was introduced by William Bengen in 1994. Being that the finding was later popularized by the Trinity Study in 1998, Bengen himself deemed four percent the "Safemax". Many critics of the four percent withdrawal rate have claimed that the study performed by Bengen may not apply in more recent years, due to an increase in life expectancy as well as a different economic state. Because of these critiques, many other economists have designed their own studies changing different factors to discover their own results, which have been outlined in this paper. This safe withdrawal rate is crucial to the success of a retiree in ensuring they do not run short of money before their death, but also allowing them to consume as much as they possibly can each year. I have performed my own simulation of a safe withdrawal rate, using a 5% withdrawal rate and returns of the S&P 500 and T-bonds from the years 1926-2012. However, in my study, I used portfolio allocations that change every 5 years of a retirees' 35 year expected retirement, first gradually increasing stock exposure every five years, and then gradually increasing bond exposure every five years. What I discovered challenges the traditional belief that the shorter the time horizon, the less exposure a portfolio should have to stocks because of their higher risk. From my simulation, I can conclude that it is most beneficial to increase your stock exposure through the years, while decreasing your bond exposure. Bengen laid the foundation for a safe rate in 1994 but it is time to modernize his findings.

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Chapter 1

Background Information

In early 2003, a UBS study asked its readers what their top financial concern was. Almost all of the top ten responses were regarding strategies for dealing with retirement planning. They ranged from "How do I know if I'm saving enough?" to "How do I know if I'll outlive my assets?" to "How do I ensure the financial well-being of my children and grandchildren?" Since the economic crisis in 2008 and 2009, retirement funding has rose to the forefront as a major concern for most workers. As the article points out, it is important to begin planning for retirement whether you are 25 or 55, and the earlier one begins saving, the better off he/she will ultimately end up.

As this is a top concern for many workers today, it is important to discover what research has been done on the topic. Many financial planners have completed their own studies to determine what "safe rate" can be used in each year of retirement so as to not run out of money before death. These investors include Ervin and Chatterjee, but most notable is William Bengen, who ran a study that concluded that a 4 percent withdrawal rate was the perfect amount so as to not run out of money, but also not to have a surplus at death. For years, many retirees relied on this "golden number" even as more and more studies came out contradicting Bengen's results.

1.1 Bengen's Study

William Bengen was a certified financial planner who studied the historical returns of stocks and bonds. Bengen's 4 percent rule states that a retiree should be able to draw down their assets by four percent in their first year of retirement, and then the same amount adjusted for inflation each year following, allowing funds to last for 30 years. He has said that as long as the portfolio is rebalanced regularly, this 4 percent should remain a "safe" rate in nearly all market conditions. He concluded that the portfolio should be invested in stocks and bonds at relatively equal amounts. The issue that many critics have pointed to is that if you withdraw the same inflation-adjusted amount each year and your returns vary, you may run out of funds too early if your portfolio underperforms, whereas you could be taking on unnecessary risk if your portfolio grows more than expected. Many critics have said that there is no "one-size-fits-all" when it comes to retirement investing. However, most would agree that the 4 percent rule is a reasonable, conservative guideline that is easy enough for the average investor to understand.

Bengen based his 4 percent rule upon many assumptions. To begin, only US data was used, with a longevity prediction of 30 years after retirement. The portfolio was static and consisted of only stocks and bonds, and it assumed no investment expenses were incurred by using historical data. He assumed a fixed spending amount, controlling for inflation, but not changing based on portfolio performance or age. Finally, there had to be 30 years of data available from the date or retirement to know if the withdrawal rate was truly safe.

The reason accuracy is so critical when it comes to a withdrawal rate is that even a one percent difference in the amount withdrawn each year is the difference between running out of assets before you die or having way too much left over. The difference in a 4 percent versus a 5 percent withdrawal rate could mean choosing to take your grandchildren on vacation or not for

example, which ultimately affects one's quality of life. It is a difficult concept to grasp being that

the numbers are so small, but on such large sums of assets, that equates to a lot of money. The 4

percent rule became the "sacred" number for a reason. After Bengen completed his study called

"Trinity study," many other researchers wanted to do their own calculations to find what results

they would get. Although the results all vary slightly based on asset allocation and data sources,

each study used the same basic premises, making the results seem credible and consistent. Daniel

Ervin performed the first of these studies that I will discuss.

1.2 Ervin's Study

It is a well-known phenomenon that diversification should improve the performance of a

portfolio. This study done by Ervin, Filer, and Smolira investigates whether the inclusion of

international stocks, as opposed to only domestic stocks, would help or hurt the value of a

retirement fund. For retirement in the earlier years of the study, they found that inclusion of

international stocks actually increased the likelihood of running out of funds. However, for the

later years of the study, the portfolios with international stocks performed comparably and

ultimately had a greater terminal value. The study was done for the years 1930-2001, and the

portfolios consisted of the S&P 500 Index, S&P/IFC Global Stock Index, and U.S. long-term

corporate bonds, all with various portfolio weights. The withdrawal rates were considered

successes if the portfolio never had a value less than zero, and it had a terminal value of zero or

more. The success rate was then calculated by dividing the number of successful portfolio by the

number of portfolios with the same withdrawal length and asset weights.

Out of the 144 portfolios instances, only 2 had a greater success rate with a combination of global stocks and US bonds over the US stocks and US bonds portfolio. The portfolios made up of US stocks had success rates of almost twice as much as portfolios constructed with global stocks. Comparing equity portfolios of 100% US stocks versus 100% global stocks, there is a difference in success rate of 70 percent versus only 18 percent under all the same conditions. As predicted, the benefit of diversification of adding US bonds was found for US stock portfolios, but the same was not found for global stock portfolios. Adding US bonds to a portfolio of global stocks actually decreased its success rate, especially for high withdrawal rates and longer periods of withdrawal.

Interestingly, there were similar success rates for portfolios consisting of US stocks and US bonds and portfolios of US stocks and global stocks. This indicates that global stocks provide a diversification benefit similar to US bonds. Finally, the study concluded that timing is a very important factor in retirement. For example, a 25-year withdrawal period beginning in June 1965 had only $176,000 remaining, whereas the same withdrawal period beginning only a month later in July 1965 had about $375,000 remaining. The graph depicting returns has very dramatic peaks and troughs signaling that timing is in fact very important. Again, the chosen withdrawal rate of funds is a decision that is based on the retiree's consumption and risk tolerance. The study shows that delaying retirement by even a month could have profound effects on the terminal value of your fund depending on returns.

1.3 Pfau's Study

Most studies done on "safe" withdrawal rates are based on US data, which may prove inefficient for foreign investors. Wade D Pfau explored whether this safe rate was actually safe internationally as well. His study uses 109 years of financial market data for 17 developed market countries to provide a broader outlook for financial planners and their clients outside the US, in regards to a "safe" rate. The assumed retirement duration is 30 years and the data ends with 2008, so the retirements in this study take place between 1900 and 1979. The paper optimizes financial assets for each country for every retirement year, finding the fixed asset allocation that will provide the highest "safe" rate of withdrawal.

Pfau stated that only looking at past US data would lead to both success bias and sampling error. Throughout the 20th century, the United States sustained excellent growth and success in the stock market, which cannot be assumed for the future, as it could not have been predicted in 1900. The sampling error is due to the fact that the US data does not expand throughout a long enough time period. Because of the recent low dividend yields and a high price-multiple earnings, many are skeptical about basing expected future market returns on historical performance.

While the original intent of the study was to provide guidance for investors in the 17 countries whose data was studied, the researchers quickly realized that these could be 17 similar scenarios faced by Americans in the future. They acknowledge that not all of their readers will accept the fact that these scenarios from other countries are real possibilities in the US, but remind readers that future investors in the US may not be able to enjoy the same growth and performance that past investors did. The paper uses the Dimson, Marsh, and Staunten (DMS) dataset for the annual data between 1900 and 2008. The results show that the United States had

very favorable conditions relative to the other 16 countries, as we consistently had among the highest returns and lowest volatilities of all the countries for stocks, bonds, bills, and inflation. The only countries that sustained a higher safe withdrawal rate than the US were Canada, Sweden, and Denmark. This shows that rates calculated for international use using US data are not the most reliable.

1.4 Chaterjee's Study

Chaterjee's study is important because it takes into account an issue that is often overlooked. While many studies used withdrawal periods of 30 years, which was thought to be way longer than necessary, Chatterjee addresses the issue of increased longevity. He tested sustainable withdrawal rates for up to 50 years of retirement. Further, he tested exact timing of the year of retirement. The retirement periods of this study were 1990-2008. While a 5% withdrawal rate was sustainable over a 35 year retirement period for those who retired between 1990 and 1997, that rate was not safe for retirees after, except for retirees in 2003. This is because there was a substantial increase in market returns in 2003 that was very beneficial to accounts in their first year. For retirees in years 1997-2002 and 2004-2008, a 4% withdrawal rate was sustainable for a 35-year time horizon. More recent retirees have had to face two market downturns in the early years of their retirement, which means they face a greater chance of exhausting their portfolios quicker than retirees in earlier years, due to the time value of money. The results of this study indicate the importance of revisiting the sustainable withdrawal rates of portfolios on an annual basis to evaluate the portfolio's performance.

Chapter 2

Problems with Existing Studies

The decision of when to retire is very critical when it comes to retirement funds. Not only will you be receiving little to no income once you retire, you also can continue to grow your fund if you remain working past age 65. Although many studies have shown that a higher percentage of stocks in a portfolio relative to bonds will generate higher returns, this is still dependent on the person's risk tolerance. Stocks are riskier than bonds, and therefore though you could grow your fund fast with more stocks, you could lose your savings just as quickly. This is a trade-off that is personal to every retiree when it comes to building his or her portfolio.

The next issue is that most studies that have been done on retirement planning have used a median life expectancy for the longevity of retirement. The problem with using a median age is that half of the retirees will live beyond that age, so this number can be misleading. Numbers taken from the Human Mortality database show that households should be preparing for at least one member of the household to live well into old age, and that longevity has become much more certain than it once was.

Many retirees have noted that the 4 percent rule is simple and easy to apply. However, many may be surprised to hear that the rate usually winds up being too conservative and then retirees are actually left with assets that could have been used over the course of retirement to improve their standard of living. This is because while the rate is adjusted for inflation each year, it does not consider how soundly or poorly the portfolio performed. Because it does not take into

account the performance of the portfolio, it must be based on the worst-case scenario, leaving too much money at the end.

While retirees are facing many risks, some are more prevalent than others and require more immediate attention. The two largest risks are interest rates and inflation. Investors today must incorporate lower than usual bond returns into their planning. The risk of rising inflation is large because small changes in the annual inflation can lead to big issues over many decades. Equity volatility is the next largest risk and early negative returns are much more detrimental to a portfolio than are negative returns later on. This risk can be mitigated through proper diversification. Rate volatility and withdrawal rate are tied for the bottom risks, followed lastly by correlations, which can be easily diverted with a well-balanced, diversified portfolio. As one can see, withdrawal rates should not be the largest concern of a worker, due to the possibility of the integration of a dynamic safe depletion rate.

There are several reasons a 4 percent withdrawal rate could be too high. A phenomenon known as Sequencing of Returns can help explain why the real safe withdrawal rate in the US actually varies between 3 percent and 10 percent. This problem leads to a large variation of withdrawal rates, solely due to the timing of the exact same returns. If you start your retirement with 15 straight winning years as opposed to 15 straight losing years, you can safely withdraw 24.86% to a mere 1.86%. This cannot be predicted in advance, and will ultimately be one of the most influential factors when it comes to your financial security.

A decision had to be made at the beginning of many of the studies as to whether to include the period prior to 1946 because of the state of the economy during the Great Depression and World War II. Many researchers have left this period of time out of their studies, stating that 1930-1945 should be ignored because it was a unique economy that is unlikely to repeat.

However, others argue that the bull market of the 1990s was also a unique economy that is unlikely to repeat. In addition, many people argue that the market risk premium was too high throughout the entire century of the 1900s, so it would be smart to include the period of low market premiums to help leverage the data. Finally, excluding data is a form of data mining, which would denounce the results. For all of these reasons, the period of 1930-1945 is included in most studies.

Chapter 3

Possible Solutions for Moving Forward

The dynamic safe depletion rate (DSDR) encourages prudent spending, but allows for an increase in consumption when a portfolio performs well. Essentially, it is a way to help ensure that a retiree is living their life to maximum living standards without outliving their assets. The DSDR works like a safe withdrawal rate in that it is an inflation-adjusted rate that can be used throughout retirement, but it is different in that it is revised on an annual basis. Each year a new DSDR is calculated based on market conditions and how well the portfolio performed in the past year, and essentially the retiree spends the greater amount of either last year's spending adjusted for inflation (the safe withdrawal rate) or the portfolio value multiplied by the new DSDR. The new spending level sets a floor for future years of spending, and can continue to increase in future years based on portfolio performance. Ultimately, this will lead to a smaller bequest, but the advantage of the DSDR is that it can be adjusted to incorporate a desire for a bequest.

Personal pensions are another option workers have, but this option is optimal in that one can efficiently avoid inflation risk and longevity risk. Even if a worker does not attain a pension from their employer, they can "create" their own pension through annuitization of their portfolios, but this is a step that is rarely taken by investors. The author hypothesizes that while investors may want to convert their assets to an annuity, they may struggle with deciding what amount to annuitize. He breaks down expenses into three categories- needs, wants, and wishes; he defines needs as those expenses that cannot easily be changed, and suggests that the expected amount of "needs" that one will have each year can be the amount that gets annuitized.

Many investment companies have begun capitalizing on this rising desire among investors to annuitize their portfolios. Fidelity started income-replacement funds, which are similar to annuities for the first year in that they make a monthly payment in the amount of your share of the investment, but in the years following, these monthly payments are adjusted for portfolio performance. They increase the payment percentage as the fund ages, so many retirees are receiving more than 20% payout towards the end. Another option is Vanguard's Managed Payout, where the investor chooses between three different risk levels, as opposed to choosing the time horizon. These funds have many advantages over annuities such as the option to withdraw your money at any time and the feature that leaves any money left over at your death to your heirs.

A commonly cited recommendation is spending more money in the first two or three years of retirement, because as you age you will naturally spend less money. Spending in almost every category declines besides healthcare, according to data from the Bureau of Labor Statistics' Consumer Expenditure Survey. People who are 75 years old and older spend an average of half as much on consumer goods than those in the 65-74 year old category. It is noted in the article that future market prices are unknown, and therefore nobody can predict the increase that could occur in healthcare costs.

Chapter 4

Methodology

William Bengen performed his study using a portfolio with a 50 stocks-50 bonds allocation. I decided to perform my calculations with not only a 50 stocks-50 bonds portfolio for all 35 years of retirement, but I also incorporated the concept of Target Date Funds, as well as the Wade Pfau approach. The purpose of Target Date Funds is to take into account the year a worker will retire in order to calculate the ideal portfolio allocation. The conventional approach has been that a worker with a relatively longer time horizon to retirement will likely have a portfolio made up of more stocks than bonds, while a worker with a shorter time horizon will prefer a less volatile portfolio dominated mostly by bonds than stocks. The younger worker with a longer time horizon would gradually decrease their exposure to stock while simultaneously increasing their amount of bonds, and vice versa. However, Pfau challenged this approach and advised that it is actually more economical to increase the amount of stock in your portfolio as you age. I decided to test both theories.

The criticism that both Target Date Funds and Pfau's approach have faced is that they do not take into account the varying degrees of risk tolerance of different investors. An investor with a longer time horizon may prefer the tradeoff of lower returns for lower risk, and therefore may still prefer more bonds to stocks, even though we may expect the opposite. However, these modern funds offer better alternatives to the "one size fits all" approach that Bengen took with a constant 50 stocks-50 bonds allocation for all 30 years.

I have begun the 35-year period with varying amounts of stocks and bonds. Although Bengen only used a 30-year time horizon, studies show that retirees are living longer than in the past so it is necessary to account for the extra living time. For the first study testing Pfau's approach, I began with a 30 stocks-70 bonds allocation. After five years, I increase the allocation to 40 stocks-60 bonds, then 50 stocks-50 bonds after another 5 years, and so on until I am at 90 stocks- 10 bonds and hold that constant until the end of retirement. Because this portfolio gradually gains more stock as time goes on, we expect it will become riskier but it also will generate higher returns (or greater losses in times of economic downturn). Then to test the Target Date Funds, I started with a 90 stocks-10 bonds allocation, again increasing bonds this time to 80 stocks-20 bonds after 5 years, and so on until the portfolio is held constant at 10 stocks-90 bonds. This is the conventional approach that says that when you have a longer time horizon for your investment to grow, you should be more aggressive and choose a portfolio weighted heavier with stocks that allows for a greater growth potential. As you get older, you can't afford the risk of your portfolio having a bad year and losing 20% of its value, as is possible with stocks so you shift more towards bonds.

In order to account for the average return and standard deviation of a portfolio, I used the returns of the S&P 500 and T-bonds for the time period of 1926-2012 to calculate what the return of a portfolio would have been for that year with the respective weights of stocks and bonds. I then found the average of the returns and the average of the standard deviations for a portfolio made up of the respective amounts of stocks and bonds. It was also important to account for the average inflation from the years 1926-2012 by subtracting this percentage from the average return (see Appendix A). I held the withdrawal at a straight $50,000 or 5% of the initial portfolio value, under the assumption that a typical retiree will spend about the same

amount of money each year in order to maintain a certain standard of living, regardless of the

performance of the markets or their portfolio. Incorporating the mean, standard deviation, and a

randomly chosen percentile portfolio performance, I was able to generate the return. I then

simply subtracted out the $50,000 in living expenses from the balance of the investment and then

multiplied that number by the return to represent the growth return, or loss, from that year. By

creating a macro (see Appendix B), I was able to generate one thousand numbers that represent

the balance of the investment after 35 years, as either a surplus or a deficit.

Chapter 5

Results

It is very difficult to pinpoint an ideal portfolio allocation when we don't know what will happen with the markets in the future. During the period of 1926-2012 from which I used the returns, there were two periods of unusual returns. The years prior to 1946 made up the period of the Great Depression and World War II in which there was an extreme bear market. The markets crashed and many people who had money invested heavily in stocks saw their investments plummet. On the other hand, there was the period of the bull market in the 1990s when stocks were flourishing, and many people saw their investments grow rapidly. However, taking an average is the most accurate way to include the bear markets, the bull markets, and everything in between. The table below shows the failure rate for a study done based on Bengen's original portfolio allocation of 50 stocks- 50 bonds for all 35 years. The mean represents the average return and the standard deviation represents the risk associated with this portfolio allocation. As you can see, this type of portfolio runs short of funds on average 40.1% of the time.

Table 1: 50 Stock 50 Bond Allocation For All 35 Years

Allocation	Mean	Standard Deviation	Percentage Failure
50-50	.0593	4.22×10^{-17}	40.1%

The results of the simulations show that Wade Pfau has a very valid point when he advises retirees to invest their money more heavily in bonds initially, and then gradually increase the weight of stocks as time goes on. In the study that I conducted, beginning with a portfolio allocation of 30 stocks and 70 bonds and increasing stocks every 5 years, an investor is about half as likely to run out of money after 35 years than by using the Target Date process. On average, a retiree invested in 30 stocks- 70 bonds and then increasing the amount of stock every five years only ran out of money 31.7% of the time. That is an almost 70% success rate if you gradually increase your amount of stock. Even an investor who allocates their portfolio to 90 stocks- 10 bonds and holds that steady their entire retirement will only run out of money 26.7% of the time on average. As we would expect, the more exposure a portfolio has to stocks initially, the higher the return, as indicated by the mean in Table 2 below. It is interesting to note, however, that the standard deviation, which is representing risk in Table 2, actually decreases with more stock exposure. This defies the commonly accepted belief that with more stock exposure comes higher returns but also higher risk. That makes the option of starting with a high stock exposure from the start seem the most ideal, with the highest returns and lowest risk, and also the lowest failure rate of running out of money during retirement.

Table 2: Increasing Stock Exposure Every Five Years

Allocation (Stocks-Bonds)	Mean	Standard Deviation	Percentage Failure
30-70	.0654	.0319	31.7%
40-60	.0700	.0308	28.2%
50-50	.0738	.0266	28.1%
60-40	.0769	.0206	25.7%
70-30	.0793	.0136	26.2%
80-20	.0808	.0067	25.3%
90-10	.0815	1.41×10^{-16}	26.7%

Stocks will clearly offer better returns as it also presents a fair amount of risk. Investing your portfolio more heavily in bonds, especially right from the start, leaves one with a much larger chance of running short of funds. An investor who puts their investment in 90 bonds- 10 stock will run short 66.1% of the time which is definitely not a safe bet. If a retiree were to follow the Target Date Funds approach and invested in 30 bonds-70 stocks, gradually increasing the amount of bonds every 5 years, he would run out of money 30.8% of the time. This number is a higher failure rate than being invested in 90 stocks-10 bonds right from the start and maintaining that for the duration of retirement. However, a retiree with their portfolio weighted more heavily towards bonds enjoys the reduced risk that makes up for the reduction in return, which is indicated by the standard deviations in Table 3 below. As you can see, as you begin retirement more heavily weighted in bonds and then still increase your bond exposure every five years, the standard deviation decreases, as does the risk. However, this comes with a trade-off

because you can also see that the return, represented by the mean in Table 3, decreases as well with higher initial bond exposure. The simulation confirmed the belief that a portfolio weighted more heavily towards bonds will provide lower returns but also lower risks, as well as Pfau's belief that it is more beneficial to gradually increase your exposure to stocks as the time horizon decreases.

Table 3: Increasing Bond Exposure Every Five Years

Allocation (Bonds-Stocks)	Mean	Standard Deviation	Percentage Failure
30-70	.0530	.0206	30.8%
40-60	.0484	.0143	35.0%
50-50	.0445	.0087	37.9%
60-40	.0413	.0041	47.0%
70-30	.0389	.0012	55.8%
80-20	.0373	.0005	62.0%
90-10	.0365	1.41×10^{-17}	66.1%

This methodology shows that the more variation to a portfolio i.e. starting with the least amount of stocks and then increasing the amount every five years is the best approach. Bengen kept his portfolio at a 50 stocks- 50 bonds allocation for all 30 years that he ran the simulation, which, although straightforward and simple, is too basic for today's economy. Through the incorporation of more stocks as time goes on, an investment has potential for high growth so as to decrease the chances of running short on funds. My study, in which I varied the number of

stocks and bonds, allows for the more realistic and economic approach that an increasing number of investors are taking today.

There are certainly other variables that I could change if I wanted to explore the most ideal scenarios in order to reduce the chance of a deficit during retirement. First, I could change the duration of retirement to reflect the differences of life spans. I could use longer durations to account for the expanding lifespans of many people today, or I could do the opposite and use a reduced duration due to the increasing age of retirement. With Social Security decreasing, leading to an increased age of retirement, retirees are seeing a reduction in their number of years of retirement, allowing for more time to build upon their savings. This is actually helpful for retirees and could add a new dimension to a study. Further, I could change the withdrawal amount per year. I could either increase or decrease the $50,000 per year to account for differences in lifestyle, and I could also make the withdrawal rate each year a percentage of the balance of the investment. This approach could account for people who cut down on discretionary spending in times of economic downturn, and those who increase their consumption when they are economically well off. Some retirees may spend less money when their savings are dwindling such as during a bear market or may decide they only want to take a small percent each year. Then, there are others who see their savings growing due to favorable market returns and decide to take an extra vacation or trip that year, leading to higher rates of withdrawals. I could account for both of those by adjusting withdrawal rates. Finally, I could change the sources from which I calculated my returns each year using the S&P 500 and T-bonds and use a different source.

Chapter 6

Conclusion

While Bengen laid down the foundation of the safe withdrawal rate, it soon became clear that there were many flaws within his assumptions and methodologies, and therefore, issues with his conclusions. There is no exact number that can be used as a "safe withdrawal rate." Due to differences in lifestyles, risk aversion, and even varying market conditions, it is impossible to conclude that there is one rate for all retirees. The importance of the withdrawal rate is to first ensure that a retiree will not run out of funds before they die, but also that they are maximizing their standard of living by consuming the most amount of money possible each year of retirement. The safest withdrawal rate for each retiree should be investigated on a case-by-case basis. Through Target Date Funds, it is possible to tailor a portfolio allocation each year according to the preferences of the individual. It is imperative that retirees work to pinpoint their preferences and budget their funds in order to be financially successful.

Appendix A

**Return Rate and Inflation Rate Information for US Markets**

	S&P 500	T-Bonds	Inflation Rate
1926	11.62%	7.77%	-1.49%
1927	37.49%	8.93%	-2.08%
1928	43.61%	0.10%	-0.96%
1929	-8.41%	3.42%	0.20%
1930	-24.90%	4.66%	-6.03%
1931	-43.34%	-5.31%	-9.53%
1932	-8.19%	16.84%	-10.30%
1933	53.99%	-0.07%	0.51%
1934	-1.44%	10.02%	2.03%
1935	47.67%	4.98%	2.99%
1936	33.92%	7.51%	1.21%
1937	-35.03%	0.23%	3.10%
1938	31.12%	5.53%	-2.78%
1939	-0.41%	5.94%	-0.48%
1940	-9.79%	6.09%	0.96%
1941	-11.59%	0.93%	9.72%
1942	20.34%	3.22%	9.29%
1943	25.90%	2.08%	3.16%
1944	19.75%	2.82%	2.11%
1945	36.44%	10.74%	2.25%
1946	-8.07%	-0.11%	18.16%
1947	5.71%	-2.63%	9.01%
1948	5.50%	3.40%	2.71%
1949	18.79%	6.45%	-1.80%
1950	31.71%	0.06%	5.79%
1951	24.02%	-3.94%	5.88%
1952	18.37%	1.15%	0.88%
1953	-0.99%	3.63%	0.63%
1954	52.63%	7.18%	-0.50%
1955	31.56%	-1.30%	0.37%
1956	6.56%	-5.59%	2.86%
1957	-10.78%	7.45%	3.02%
1958	43.36%	-6.10%	1.76%
1959	11.95%	-2.26%	1.50%
1960	0.47%	13.77%	1.48%

1961	26.89%	0.97%	0.67%
1962	-8.73%	6.89%	1.22%
1963	22.80%	1.21%	1.65%
1964	16.48%	3.51%	1.19%
1965	12.45%	0.71%	1.92%
1966	-10.06%	3.65%	3.35%
1967	23.98%	-9.19%	3.04%
1968	11.06%	-0.26%	4.72%
1969	-8.50%	-5.07%	6.11%
1970	4.01%	12.11%	5.49%
1971	14.31%	13.23%	3.36%
1972	18.98%	5.68%	3.41%
1973	-14.66%	-1.11%	8.80%
1974	-26.47%	4.35%	12.20%
1975	37.20%	9.19%	7.01%
1976	23.84%	16.76%	4.81%
1977	-7.18%	-0.67%	6.77%
1978	6.56%	-1.16%	9.03%
1979	18.44%	-1.22%	13.31%
1980	32.42%	-3.95%	12.40%
1981	-4.91%	1.85%	8.94%
1982	21.41%	40.35%	3.87%
1983	22.51%	0.68%	3.80%
1984	6.27%	15.42%	3.95%
1985	32.16%	31.99%	3.71%
1986	18.47%	24.43%	0.75%
1987	5.23%	1.73%	4.41%
1988	16.81%	9.67%	4.42%
1989	31.49%	18.10%	4.64%
1990	-3.42%	6.17%	6.10%
1991	30.55%	19.26%	3.07%
1992	7.67%	8.05%	2.89%
1993	9.99%	18.23%	2.75%
1994	1.31%	-7.78%	2.67%
1995	36.97%	31.66%	2.54%
1996	23.07%	-0.92%	3.33%
1997	33.37%	15.87%	1.71%
1998	28.58%	13.52%	1.61%
1999	21.04%	-8.74%	2.62%
2000	-9.10%	20.27%	3.45%
2001	-11.89%	4.21%	1.60%
2002	-22.10%	16.79%	2.20%
2003	28.50%	2.70%	1.80%

2004	10.88%	7.70%	3.30%
2005	4.91%	6.61%	3.39%
2006	15.79%	1.74%	3.24%
2007	5.49%	9.81%	3.50%
2008	-37.10%	23.10%	0.00%
2009	26.50%	-12.90%	2.70%
2010	15.10%	9.40%	1.50%
2011	2.10%	29.90%	3.00%
2012	16.00%	3.56%	2.00%

Appendix B

Simulation Macro
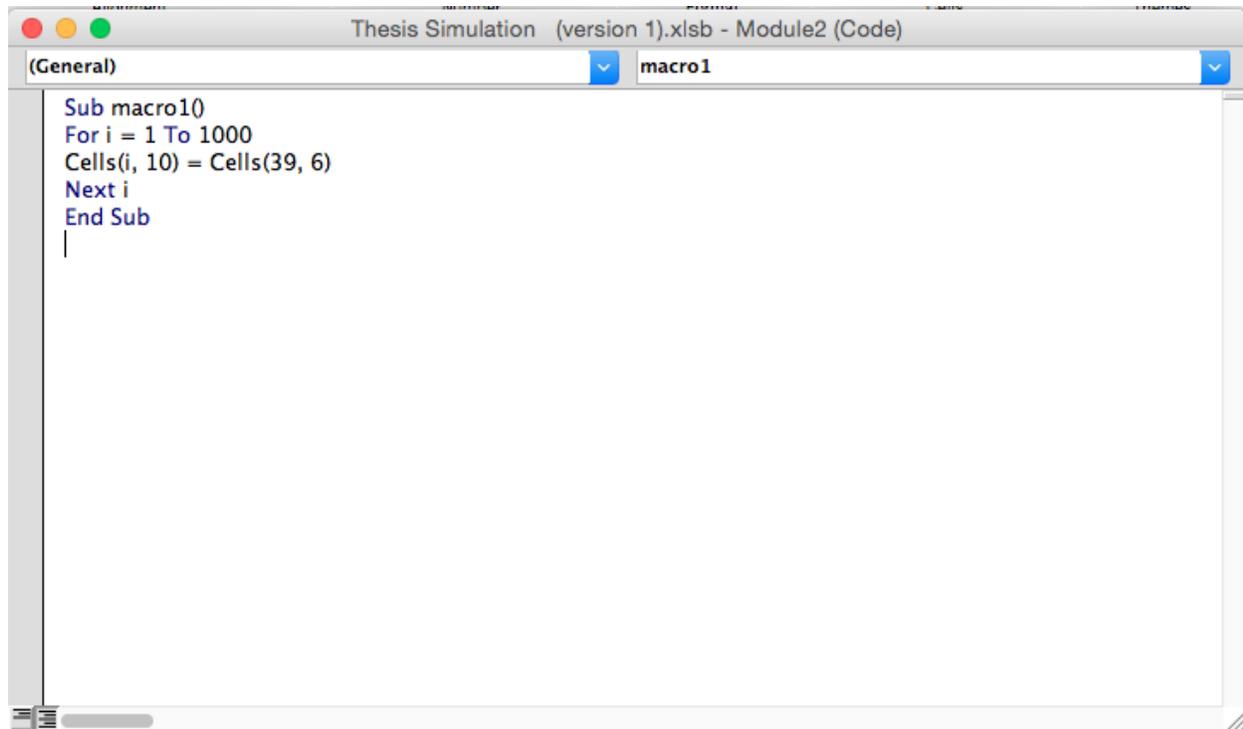

```vba
Sub macro1()
For i = 1 To 1000
Cells(i, 10) = Cells(39, 6)
Next i
End Sub
```

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EDUCATION

The Pennsylvania State University: Schreyer Honors College   **University Park, PA**
Smeal College of Business   *Graduation: May 2015*
Bachelor of Science: Finance

HONORS

Deans List   *7 of 7 Semesters*
National Society of Collegiate Scholars   *May 2012-Present*

RELEVANT EXPERIENCE

L'Oréal USA   **Berkeley Heights, NJ**
Compass Intern, Corporate Finance   *June 2014-August 2014*

Operated an integrated a multimillion dollar financial planning software called Compass, designed to standardize and centralize master data
Extracted and transformed Hyperion data through mapping and analysis into Compass-compatible formats
Analyzed and reconciled data across SAP and Compass to validate the accuracy of processes and reports generated for budgets and trends
Manipulated data from the two systems to create an Excel document that will be used for future validation, resulting in a 35% reduction in manual labor of validating each PNL line
Collaborated cross-functionally with Compass IT USA to resolve disputes in loaded data and to fix mapping errors

TD Bank Financial Group   **Cherry Hill, NJ**
Credit Risk Summer Analyst, Commercial Credit Department   *May 2013-August 2013*

Assisted loan officers underwriting commercial loans in a market with a portfolio aggregating over $200MM in assets
Performed analysis on cash flows, lease tracks, collateral, and accounts payable/receivable of over 30 businesses

Analyzed tax returns, financial statements, credit reports, and complete profiles of loan and deposit information to appraise current or prospective borrowers
Spread business and personal financial statements using Moody's Risk Analyst and Excel to assign risk rating
Combined business and individual cash flows to generate a global cash flow analysis for management approval

UBS   **New York, NY**
Unlock Your Potential   *August 2013*

Selected to be a part of a 50 member event to learn more about personal brand directly from industry experts
Defined a personal brand in preparation of the internship search process
Networked with women across multiple business line who shared their career experiences and insights

LEADERSHIP EXPERIENCE

Alpha Phi Sorority   **University Park, PA**
Executive Vice President   *December 2012- December 2013*

Elected by the chapter's 108 active members to oversee the financial and administrative operations of the chapter
Serve as Chairwoman of the Bylaws Committee and implemented a new Chapter point system which resulted in a 30% increase in overall philanthropy participation, per university records
Participate as a member of the Judiciary Board to develop a document containing the rules and regulations by which the Chapter will abide to comply with university standards
Oversee the development of the Housing Occupancy Plan, which assigns members their living arrangements