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THE IMPACT OF SAME-SEX MARRIAGE ON SOCIAL SECURITY'S FINANCES

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ABSTRACT

This research seeks to analyze the impact of the expansion of the legalization of same-sex marriage on the finances of Social Security. Using Census Bureau data, models were developed to first calculate projected Social Security benefits for individuals, and then project the percent change in the actuarial present value of Social Security payments to married couples by recognizing same-sex marriage. The addition of same-sex married couples into the pool of Social Security beneficiaries impacts the value of Social Security payments due to two provisions: the spousal benefit and the survivor benefit. Based on the assumptions and modeling techniques used in the completion of this thesis, the spousal benefit, which allows a married Social Security beneficiary to receive the maximum of his or her own benefit or half of his or her spouse's benefit, accounted for a 2.5% increase in annual Social Security marital benefit payments. The survivor benefit, which allows a married Social Security beneficiary to receive the maximum of his or her own benefit or 100% of his or her deceased spouse's benefit, accounted for a 2.9% increase in annual Social Security marital benefit payments. In total, this increase in marital benefit payments due to the recognition of same-sex marriage is projected to lead to a 0.4% increase in annual Social Security disbursements.

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Introduction

With current legislation and court cases throughout the United States expanding marital rights to same-sex couples occurring simultaneously with concerns about the finances of Social Security, it becomes a point of interest of how Social Security will be impacted by these new marriages. To understand how this impact might transpire, it is important to first analyze Social Security and the lesbian, gay, bisexual, and transgender (LGBT) communities. Then, it will be possible to create a model to project the effect of the expansion of same-sex marriage on the finances of Social Security by making informed assumptions that best align with current trends.

Chapter 1 reviews current literature on this topic. It begins with an exploration on the history, funding, and benefit payment mechanisms that help to form an understanding of Social Security. Specifically, Social Security will be described in terms of the spousal benefit, which allows a married Social Security beneficiary to receive the maximum of his or her own benefit or half of his or her spouse's benefit, and the survivor benefit, which allows a married Social Security beneficiary to receive the maximum of his or her own benefit or 100% of his or her deceased spouse's benefit. Next, trends within the LGBT community are outlined so that the marriage discussion can be framed in the context of the thesis. Finally, past studies on the relationship between same-sex marriage and Social Security will be analyzed.

Chapter 2 combines the information obtained through the literature review and describes the assumptions that are used in the model to address the central question. Furthermore, this chapter applies these assumptions and explains the model that has been developed. The remaining three chapters – Results, Discussion, and Conclusion – outline the findings of the researcher, explain the significance of the results, and provide insight into possible next steps and future research.

Chapter 1 : Literature Review

Social Security

Social Security was created during the Franklin D. Roosevelt administration by the passing of the Social Security Act of 1935. According to the preamble of the law, Social Security was established as:

> An act to provide for the general welfare by establishing a system of Federal old-age benefits, and by enabling the several States to make more adequate provision for aged persons, blind persons, dependent and crippled children, maternal and child welfare, public health, and the administration of their unemployment compensation laws; to establish a Social Security Board; to raise revenue; and for other purposes. (*The Social Security Act of 1935* 1)

Social Security, as an overall program, encompasses many federal benefits that are overseen by the Social Security Administration. What often comes to mind as "Social Security" in terms of the retirement income program is a subset called the Old Age, Survivors, and Disability Income Program (OASDI), as established under Title II of The Social Security Act. For the purposes of this thesis, "Social Security" and "OASDI" will be used to refer to the same program.

Social Security is funded by the taxes that both employers and employees pay throughout working years. According to the Social Security Administration, this funding process allows workers to obtain work "credits." How this works is that for each $1200 earned in a year, the worker receives one Social Security credit, with a maximum of four credits being granted per year. To be eligible for the Social Security retirement benefits, an individual needs to accrue forty credits. Provided a worker has obtained 40 credits, he or she can retire as early as age 62 to begin receiving benefits, but these benefits will come at a penalty of 5/9% for each month before full retirement. For 2014, the age for full retirement is given in Table 1. (Social Security Administration 8-10)

Table 1: Social Security full retirement age

Year of Birth	Full Retirement Age
1943-1954	66
1955	66 and 2 months
1956	66 and 4 months
1957	66 and 6 months
1958	66 and 8 months
1959	66 and 10 months
1960 or later	67

Spousal retirement benefits from Social Security impact dependent and survivor benefits as follows. During retirement years when both spouses are alive, a spouse can receive the benefit based on their wage history or, if greater, their spousal benefit, which is half of their spouse's benefit. For the survivor benefit, after a spouse dies, the living partner is able to receive the larger of his or her own benefit or the benefit of the deceased spouse (Baker 1). There are also stipulations that grant divorced partners access to similar benefits. For divorced partners, the following criteria have to be met: the marriage must have lasted at least ten years prior to the divorce, the divorce had to be at least two years before the benefit period, and the spouse seeking payment must be at least 62 years old, unmarried, and not eligible for an equal or higher benefit from his or her own wage history (Social Security Administration 8).

To illustrate how these two benefits work, take for example a married couple composed of Partner A and Partner B. Partner A's benefit is $1,300 per month and Partner B's benefit is $1,700 per month. If both A and B retire at full retirement age, A would receive:

$$\max(1300, 1700 \times 0.5) = \$1300,$$

and B would receive:

$$\max(1700, 1300 \times 0.5) = \$1700.$$

Because of the low disparity in their benefits, caused by too similar of a wage history, they both receive their own benefit, so they are unaffected by the spousal benefit. However, if B dies before A, then A's benefit will change from $1300 to:

$$\max(1300, 1700) = \$1700,$$

so the survivor benefit helps them, but only if B dies first. As seen in this example, the wage disparity has to be large in order for the spousal benefit to be activated. As an illustration, if one partner had an average lifetime earnings of $100,000, the spouse would need to earn under $29,750 for his or her average lifetime earnings in order to benefit from the spousal benefit because of the progressive calculation of Social Security benefits (Baker 1). A complete discussion on how this calculation was done, as well as further extensions of this principle, will be outlined in Chapter 2.

To get an idea of the scope of Social Security, the Social Security Administration (SSA) states, "In 2014, over 59 million Americans will receive almost $863 billion in Social Security benefits." This $863 billion represents the OASDI portion of the $1.3 trillion of expenditures that SSA oversees. This accounted for 37% of federal expenditures in 2013 (*2013 OASDI Trustees Report* 3). OASDI aims to replace around 40% of an individual's pre-retirement wages. When compared to their total income in retirement, "52% of married couples and 74% of unmarried persons receive 50% or more of their income from Social Security," and "22% of married couples and about 47% of unmarried persons rely on Social Security for 90% or more of their income" (*Social Security Administration*).

Each year, the OASDI Trustees, which is the board that was established by the Social Security Act of 1935 to oversee the OASDI trust funds, produce a report to publicly state the status of the program. According to the 2014 OASDI Trustees Report, since the inception of the program, the number of Social Security beneficiaries per 100 covered workers has been, and is projected to continue, increasing dramatically. This means that the proportion of workers to retirees is decreasing, so the pool of funds

collected will have to be spread among more beneficiaries. Another way to look at this, as outlined by the report, is to analyze the cost rate, which is approximately the ratio of total benefits to total earnings, which is heavily influenced by the ratio of beneficiaries to workers. The cost rate is the product of the number of beneficiaries and their average benefit, divided by the product of the number of covered workers and their average taxable earnings. To illustrate this in formula,

$$Cost\ Rate = \frac{\#\ of\ Beneficiaries\ \times\ Average\ Benefit}{\#\ of\ Covered\ Workers\ \times\ Average\ Taxable\ Earnings} \approx \frac{Total\ Outflows}{Total\ Inflows}.$$

Under the current projections, the cost rate will increase throughout time because the number of beneficiaries is growing faster than the number of covered workers, primarily due to our longer lifespans and high fertility rates in the baby boomer years. Cost rates can also be used to find the actuarial balance. Actuarial balance is the difference between the summarized income rate and summarized cost rate. As seen in Figure 1, since the cost rate is increasing more quickly than the income rate, the actuarial balance is being driven down, which means that Social Security is projected to have a negative actuarial balance, also known as an actuarial deficit, over the report's 75-year projection under low-cost, intermediate-cost, and high-cost valuations. Because of this, the OASDI Trustees project that the trust funds will be depleted by 2034 under intermediate-cost assumptions. The depletion dates for the low-cost and high-cost assumptions are 2059 and 2029, respectively (*2014 OASDI Trustees Report* 12).
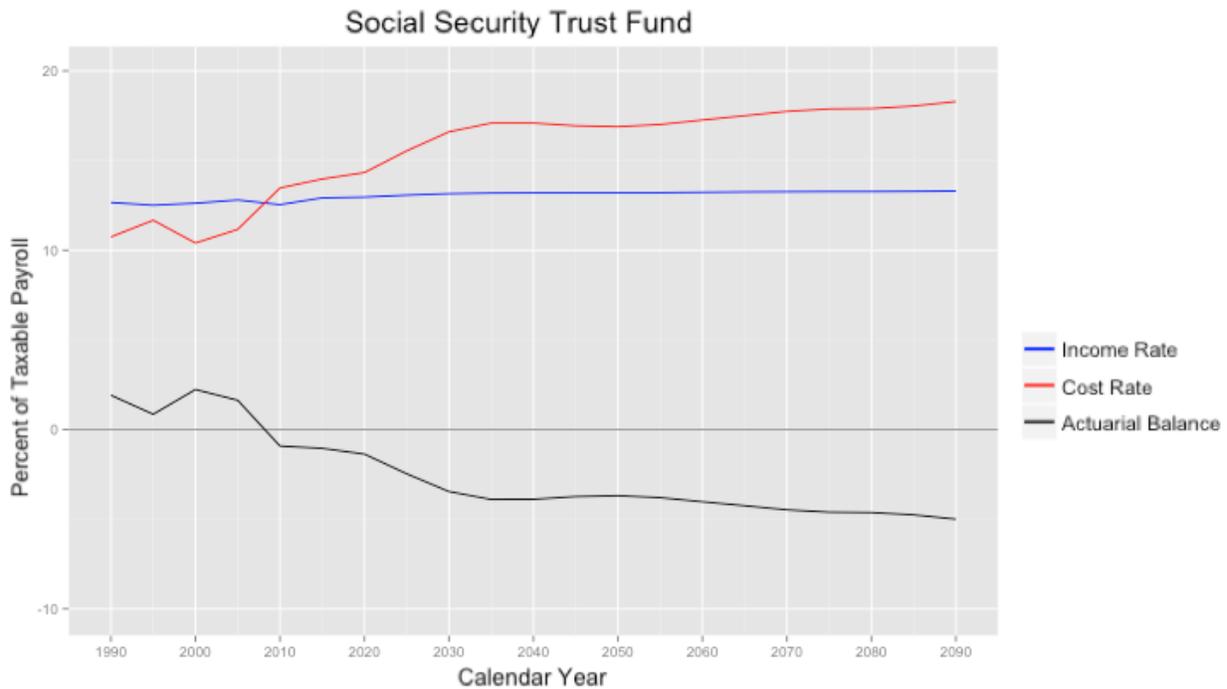
Figure 1: Illustration of the yearly income rate, cost rate, and actuarial balance as a percentage of taxable payroll

The Trustees recommend to lawmakers that there is a need to increase revenue, reduce program costs, or do both to maintain solvency. The 2014 OASDI Trustees Report adds that, through examination of data for mortality, fertility, marital status, immigration trends, and demographics from the 2010 Census, the long-range actuarial balances have decreased from -2.72 percent of taxable payroll in 2013 to -2.88 percent of taxable payroll in 2014 (*2014 OASDI Trustees Report* 18). The sources for the shift in actuarial balance can be seen in the table below:

Table 2: Sources of change in Social Security Trust Fund actuarial balance between 2013 and 2014

Source of Change	Percent of Taxable Payroll
2013 Actuarial Balance	**-2.72**
Legislation	-0.01
Valuation Period	-0.06
Demographic Data	0.04
Economic Data	-0.10
Disability Data	0.02
Programmatic Data	-0.05
2014 Actuarial Balance	**-2.88**

LGBT Community Demographics

In order to project the effect of same-sex marriage on Social Security's funding, it is vital to understand trends in the LGBT community. The first step in this process is determining how many LGBT individuals are in the United States. In a report titled "How many people are lesbian, gay, bisexual, and transgender?" Gary Gates, a Williams Distinguished Scholar at the Williams Institute, UCLA School of Law, comments that there are many challenges present in measuring the LGBT community. First, most surveys ask for individuals to self-identify, which can lead to differences in perceptions when dealing with gender and sexuality. Second, inconsistent reporting and formatting of questions has made it hard to gather congruent data. Finally, although public opinion of sexuality has shifted in recent years, people might feel pressured or stigmatized while completing these surveys, which could lead to underreporting (Gates 2).

In the analysis of nine different surveys related to gender and sexuality, the percentage of individuals in the United States who self-identified as LGBT ranged between 1.7% and 5.6%. According to Gates, the generally accepted number of self-identified LGBT adults in the United States is

3.5% of the population. Of American women, 3.4% self-identified as LGBT, with 2.2% identifying as

bisexual and 1.1% identifying as lesbian. Of American men, 3.6% self-identified as LGBT, with 1.4%

identifying as bisexual and 2.2% identifying as gay. As can be seen from these figures, women are much

more likely than men to identify as bisexual. For the LGBT community as a whole, approximately 60%

identify as lesbian or gay and approximately 40% identify as bisexual. For the whole population of the

United States, between 0.1% and 0.5% of adults identify as transgender. An interesting note is that, while

3.5% of respondents self-identify as LGBT, 8.2% of American adults reported engaging in same-sex

behavior, and 11% of American adults reported attraction to people of the same sex, so the number of

LGBT individuals could increase as time progresses and social norms continue to shift (Gates 3-7).

        As previously mentioned, public perception plays a large role in understanding trends in the

LGBT community and in shaping public policy regarding same-sex marriage. According to the Gallop

Poll's 2014 report, 55% of the general public now supports same-sex marriage, compared to only 27% of

Americans in 1996 (Jones and Saad 2). In comparison to the Pew Research Center's 2013 report, *A

Survey of LGBT Americans*, this figure is still far from 93% of LGBT adults that support legalizing same-

sex marriage. The study noted that 49% of LGBT respondents agreed that the best way to achieve

equality is by becoming part of mainstream culture through institutions like marriage, while 49% believed

that it is better to maintain a distinct culture and way of life while achieving equality. In determining

LGBT American's marital trends, 60% of LGBT respondents reported that they are married or intend to

marry one day, and 27% of unmarried LGBT respondents answered that they are unsure if they would

want to get married (*A Survey of LGBT Americans* 9-18, 71). Same-sex couples prefer marriage to other

statuses, with 30% getting married in the first year that same-sex marriage was legal in a state, while only

18% entered into a civil union or domestic partnership in that first year. In states with legal same-sex

marriage, 47% of resident same-sex couples have chosen to marry. Additionally, as time progresses after

same-sex marriage becomes legal in a state, more couples choose marriage. For example, after 5.75 years

of legality in Massachusetts, 68% of same-sex couples married, while after 1.25 years of legality in

Vermont, only 26% have married (Badgett 6-11). Badgett remarked, "…qualitative evidence and other studies suggest that the main reason for the greater demand of same-sex couples for marriage is that it comes with important symbolic meaning in our society" (12).

According to the 2010 Census preferred estimates, there are 646,464 same-sex couples in the United States. Of this group, 131,729 reported being married, while 514,735 reported being unmarried partners (*2010 Census and ACS Summary File Counts*).

Same-Sex Marriage and Social Security

According to the Congressional Budget Office (CBO), marital status is a factor in determining benefits and rights in 1,138 statutory provisions (Holtz-Eakin 1). As previously mentioned, Social Security is one such benefit that is determined on this basis. The CBO also reported that benefits paid to spouses and widows accounts for nearly 20% of Social Security's budget (Holtz-Eakin 6). The distinction between the different forms of legal recognition for same-sex relationships plays an important role in determining what benefits same-sex couples are entitled to. There are three forms of legal status: domestic partnership, civil union, and marriage. The specific definitions and rights granted under each status vary by state, or even by zip code. First, a domestic partnership generally offers the fewest benefits and is only recognized in the state or municipality in which it was granted. No federal benefits are available in a domestic partnership. Next, a civil union extends most or all of the state's rights of marriage, but is only recognized in the state in which it was granted, and it does not provide any federal benefits. Finally, marriage provides all state and federal benefits and is recognized anywhere in any state or country. However, same-sex marriages are only recognized in the states in which same-sex marriage is legal ("Civil Unions and Domestic Partnership Statutes" 1).

Accordingly, the only marital status that is impacted by Social Security's spousal and survivor benefits is marriage. As of January 2015, in 39 states, including the District of Columbia, a same-sex

couple that was married in a state that allows same-sex marriage and filed for Social Security while being domiciled in one of these 39 states can receive Social Security benefits (*GN 00210.100 Same-Sex Marriage – Benefits for Aged Spouses*). Each of these states has specific dates for when same-sex marriages were permitted in that state and the date for which they will recognize a marriage from another state for couples that are newly domiciled. These details are outlined in GN 00210.003 of the SSA's Program Operations Manual System. It is important to note that 25.8% of same-sex spouses live in a state where they wouldn't be able to apply for Social Security spousal benefits because SSA uses that state's definition of marriage. Additionally, 24.2% of all same-sex couples – married or unmarried – live in a state that would cause a similar lack of access to Social Security marital benefits (*2010 Census and ACS Summary File Counts*).

When looking at same-sex marriage and Social Security together, it is beneficial to look at the wage history of the LGBT community compared to the general population. There are a number of important characteristics of same-sex couples that affect their potential Social Security benefits. According to Naomi Goldberg, who is the Peter J. Cooper Public Policy Fellow at the Williams Institute, UCLA School of Law, same-sex married couples generally attain higher levels of education, which positively impacts earnings. Additionally, LGBT individuals often have longer employment histories. This is particularly prevalent for women in same-sex marriages. However, Goldberg explains, "There is a well-documented gay male 'penalty' and lesbian 'premium' in terms of earnings when compared to different sex-coupled men and women." While women in same-sex couples may exhibit a "premium" and a longer working history, the gender gap in wages can be amplified in a marriage with two women (Goldberg 3-4). As for specifics about wages for same-sex couples, the Pew Research Center study found that same-sex married couples earn an average of $107,000 per year, while opposite-sex married couples earned an average of $96,000 per year and opposite-sex unmarried couples earned an average of $65,000. The study also found that both spouses are employed in 58% of same-sex couples, while, for opposite-sex married couples and opposite-sex unmarried couples, the figure is 47.2% and 54.7%, respectively (*A

Survey of LGBT Americans 27). While this would suggest that same-sex couples would enjoy higher

Social Security benefits due to higher wages and better earning histories, for couples in which both

partners are over 65 years old, female same-sex marriages have $5412 less in Social Security income than

opposite-sex couples, and male same-sex marriages have $3060 less in Social Security income than

opposite-sex couples. When it comes to the survivor benefit, same-sex couples living in states in which

the marriage is not recognized are, on average, ineligible for more than $5700 annually in Social Security

benefits, according to calculations by The Williams Institute (Goldberg 6-9).

In comparing the impact of the spousal and survivor benefits for same-sex couples to those

received by opposite-sex couples, assuming legal marital status, research suggests that the spousal benefit

isn't as crucial for same-sex couples because the wage disparity is much less than in opposite-sex couples.

The survivor benefit, which is triggered when the higher wage-earner dies first, allowing the lower wage-

earner to collect the higher-wage earner's benefit instead of his or her own, would also have slightly less

impact for same-sex couples because same-sex couples are generally closer in age and have similar life

expectancies due to being the same gender. In contrast, for opposite-sex couples, husbands are, on

average, two to three years older, have shorter life expectancies than their wives, and earn more than their

wives (Holtz-Eakin 6).

In a 2004 CBO report analyzing the potential financial impact of same-sex marriage on a number

of different federal programs, it was estimated that an additional $250 million would be drawn out of

Social Security due to the expansion of same-sex marriages. Out of the approximately $90 billion in

spousal and survivor benefit payments in that year, this $250 million represents a 0.28% increase. This

number was projected to grow over time because, at the time of the study, the average same-sex couple

was 40 years old, so the majority of these couples would not yet be eligible for Social Security. Also,

since this study is ten years old, during a time when Massachusetts was the only state to allow same-sex

marriage, the number of eligible same-sex couples has increased dramatically (Holtz-Eakin 7). From this

study, it can be seen that the projected impact on Social Security's funding was minimal compared to the

immense expenditures of the program. According to this, the impact, even if it were doubled, could be met by a 0.005% increase in both the worker and employer's contribution to Social Security (Baker 2).

The 2014 OASDI Trustees Report also briefly discusses the expansion of same-sex marriage in regards to sources of change in the actuarial balance. Citing the repeal of the Defense of Marriage Act in June 2013, the Trustees projected that the expansion of benefits to same-sex married couples will decrease (worsen) the long-range actuarial balance by only 0.01 percent of taxable payroll. In this calculation, "The Trustees have assumed that Social Security will expand its guidelines to recognize all auxiliary beneficiaries for such marriages and that same-sex marriages will eventually be recognized in all States" (*2014 OASDI Trustees Report* 18).

Chapter 2 : Methods

By combining the information gathered from past research on LBGT community demographics with raw data from the U.S. Census Bureau, while using the 2004 CBO and 2014 Trustees Report estimates as guidance, it is possible to develop models to project the impact of the expansion of same-sex marriage on the financing of Social Security. This chapter outlines the sources of data and assumptions that are used in the projection, describes the process of determining Social Security benefits, and explains the modeling techniques used to project the spousal and survivor benefits for both opposite-sex couples and same-sex couples.

Demographic Data and Assumptions

In order to project the impact of same-sex marriage on Social Security funding, it is first necessary to find representative data for the U.S. population. The source of data used in this thesis is the 2013 American Community Survey Public Use Microdata Sample (ACS PUMS). The ACS PUMS is a representative sample of the 2013 American Community Survey. The ACS is a survey used by the Census Bureau to collect data every three years to track census data more regularly than once every decade. The ACS PUMS is broken into two separate categories: population records and housing unit records. These two categories are available for individual states or for the entire United States. In this thesis, the United States population records and housing records are used. The population records file contains over 3 million respondents and includes information such as income, age, sex, state of residency, etc. The housing records file groups each of the respondents from the population records file into individual housing units. The housing records file contains information such as household income, marital status, number of workers in workforce, etc. In the 2013 ACS PUMS, the housing records file also asks respondents to mark if they are in a same-sex marriage or same-sex partnership.

To use this data to model the central question, it is necessary to make demographic assumptions. The most important demographic assumptions focus on the LGBT community trends. As was noted in the prior chapter, this area is extremely dynamic and new, so exact answers are unavailable and even government estimates are unclear. In the last year alone, the number of states recognizing same-sex marriages has grown from nineteen to thirty-nine, and further federal cases are pending. Because of this, especially marked by the rapid, unilateral adoption of legal recognition of same-sex marriage throughout the country, this thesis assumes that all states will legalize same-sex marriage and all auxiliary government benefits connected to marital status will be granted to all same-sex married couples. This assumption is in line with the 2014 Trustees Report. Since the 2013 ACS PUMS is coded for same-sex marriages and same-sex partnerships, it is also possible to look at same-sex partners. Many of the households marked as same-sex partner households can be assumed to be in this status because of the absence or newness of legal same-sex marriage in the state in which is the couple is domiciled. Accordingly, it is assumed that sixty percent of same-sex partners will become married. This assumption is based on the 2013 Pew Research Poll noted in the prior chapter. In the model used in this thesis, same-sex married couples will include all households coded as same-sex married couple and a random sample of 60% of households coded as same-sex partners. A final assumption must be made about the projected percentage of the married population in the United States that are same-sex married couples. This additional assumption is necessary because only respondents with non-missing values are included in the calculations for the spousal and survivor benefits. However, the number of same-sex respondents with non-missing data is dramatically below estimates from all sources cited in Chapter 1. Accordingly, same-sex married couples will be fixed at 3% of all married couples.

Social Security Benefit Calculator

The first step in projecting the changes in outflows of Social Security payments is to determine how Social Security benefits are calculated. Unlike most insurance or pension programs, Social Security acts as a transfer program, where benefits are designed to redistribute retirement income so that lower wage-earners have a higher replacement ratio – the ratio of retirement income to pre-retirement income – than higher wage-earners. Because of this structure, the process used to calculate Social Security benefits functions differently than traditional measures. The process is as follows:

- Step 1: A worker's yearly career earnings are put into a table. These are the nominal earnings, so they are not yet adjusted for inflation or other factors.

- Step 2: An indexing factor is calculated for each year of the worker's career. The indexing factor is calculated by dividing the Average Wage Index (AWI) for the year in which the worker turns 60 years old by the AWI for each year in the worker's career. For instance, the indexing factor in 2000 for a worker who was born in 1950 is calculated by dividing the AWI in 2010 by the AWI in 2000.

- Step 3: For each year, the nominal salary is multiplied by the indexing factor for that year to index the nominal wage up to the year in which the worker reaches age 60. This new salary for each year is referred to as "indexed earnings."

- Step 4: The indexed earnings for each year are capped by the contribution and benefit base. These limits are adjusted each year. For 2015, the base is $118,500, so earnings above this amount are ignored.

- Step 5: The average of the thirty-five highest capped indexed earnings is found and divided by 12. This gives the "average indexed monthly earnings" (AIME). The "primary insurance amount" (PIA), which is the benefit an individual would receive if he or she begins receiving the benefit at the full retirement age, is then calculated by applying the PIA formula to the AIME. The PIA formula applies weights to the AIME,

breaking the AIME into three sections at two "bend" points. The weights used are 90% of the AIME below the first bend point, 32% of the AIME above the first bend point but below the second bend point, and 15% of the AIME above the second bend point. The bend points are determined based on the year in which the worker reaches age 62. In 2015, the two bend points are $826 and $4980. The PIA is then rounded down to the nearest dime. For a worker turning age 62 in 2015 with an AIME of $8000, the PIA is calculated as follows:

$$PIA = 0.9 \times \$826 + 0.32(\$4980 - \$826) + 0.15(\$8000 - \$4980) = \mathbf{\$2525.60}$$

- Step 6: The PIA is adjusted based on when the benefit commences. If the worker commences benefits before his or her full retirement age, the benefit is reduced by 5/9 of one percent for each month before full retirement. If the worker commences benefits after normal retirement age, the benefit is increased by 8% for every year of delay. In addition, the monthly benefit is increased by a cost-of-living adjustment (COLA) each year.

- Step 7: After the reduction or the COLA is applied, the final PIA is found by rounding down to the nearest dollar. In the case above, the final PIA would be $2525 if no reduction or COLA is made. This is their initial monthly Social Security benefit. It will increase by the COLA in future years too.

The process outlined above is the process that is used in this thesis to calculate the monthly benefits for each individual in the ACS PUMS, as can be seen in Appendix A. However, since each respondent's entire wage history isn't available, slight modifications are made in the calculation procedure. Since the ACS PUMS is from 2013, the income listed in the survey is used as the 2013 salary. To approximate the other years' wages – since thirty-five total years are needed – the 2013 salary is discounted/rolled-forward by the increase in the AWI for each year. For instance, since the AWI increased by 1.8% in 2013, the 2013 salary is increased by 1.8% to find the salary in 2014. It is also

assumed that all workers will retire at their full retirement age. Although many individuals elect to commence their Social Security benefit before their full retirement age, since this thesis only looks at the percent change in the present value of payments and not annual cash flow, picking an accepted and consistent age is the important consideration. The full retirement age assumption satisfies this need. Furthermore, since the thesis is using the ACS PUMS, which contains a representative sample of over three million respondents, it is safe to use these assumptions.

The Social Security benefit calculator was constructed using Excel and automated with a script written in VBA. All of the tables used to determine the bend points, contribution and benefit bases, average wage index, cost of living adjustments, and full retirement age were based on data from the Social Security Administration. For a detailed look at tables used in the calculator and for access to the macro-enabled Excel model, refer to Appendix A.

Spousal Benefit Determination

In the next two sections, the spousal benefit calculation and survivor benefit calculation will be discussed. The modeling used in determining these two calculations was done in R. While the next two sections will outline the motivation behind the steps taken throughout the coding in R, not every detail will be highlighted. Accordingly, the source code is provided in Appendix B.

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The impact of same-sex marriage on Social Security funding is realized in two forms: the spousal benefit and the survivor benefit. This section discusses the modeling techniques used to determine the impact of the spousal benefit.

In Chapter 1, it was explained that the spousal benefit is triggered when the disparity in wages between spouses is large enough that the PIA for one spouse is less than half of the PIA for the other spouse. The illustration provided in Chapter 1 stated that in order for the spousal benefit to be triggered

for a married couple with a spouse earning $100,000, the other spouse would have to be making $29,750 or less. Note that due to the progressive structure of Social Security as a transfer system, although the ratio of the two wages is 3.36, the ratio of their benefits is 2.00. Using the Excel benefit calculator, it is possible to verify these wages. From this model, an individual earning $100,000 in 2013 would have a PIA equal to $2551. According to this model, to have a PIA equal to half of $2551, or approximately $1275, an individual would need to earn $30,100 in 2013. Since the Excel benefit calculator uses AWI increases to calculate prior salaries instead of a salary scale or actual salaries, the numbers aren't exactly the same, but this still serves as a strong approximation, as the two salaries only differ by $350.

By extending this illustration, it is possible to calculate a line that describes the corresponding salaries that would trigger the spousal benefit. This line, which is calculated for all salaries up to $120,000 – since there is no sense going higher than the contribution and benefit base of $118,500 – then outlines the maximum salary that the lower wage-earner would need to have such that that the spousal benefit is still triggered. Any salary pair falling below this line triggers the benefit and any pair above the line does not. In the graph below, this spousal benefit trigger line is shown. Spouse 1 refers to the higher wage-earner and Spouse 2 refers to the lower wage-earner.
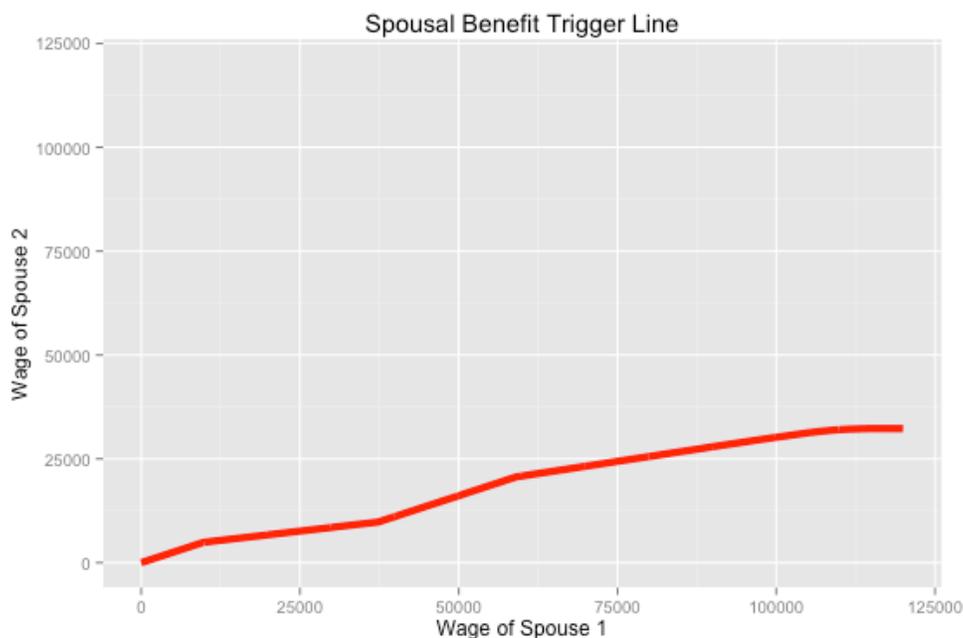
Figure 2: Illustration of the spousal benefit trigger line

Turning to the ACS PUMS data, it is possible to see how wages of married couples in the United

States compare to this line. Before doing so, it is necessary to clean and manipulate the data from the

ACS PUMS. First, households with individuals above the age of 65 are removed from the dataset

because only the working population with non-retirement salaries could safely be analyzed under this

methodology. Using the population records along with the housing unit records, it is then possible to find

the age and income of each spouse. In agreement with the earlier classification method, Spouse 1 is

assigned to the higher wage-earner and Spouse 2 is assigned to the lower wage-earner. Also, as before,

all salaries are capped at $120,000. By integrating the Excel benefit calculator into the R population

model, it is then possible to find the benefit for each spouse across all of the housing units. Also, by

using Spouse 1's salary, the corresponding spousal benefit trigger salary can be found. In doing so,

Spouse 2's salary can be compared to the trigger salary to see if the spousal benefit will come into play

for each married couple. Additionally, if the spousal benefit is triggered, the difference between Spouse

2's prior benefit and half of Spouse 1's benefit is taken to see the additional monthly dollar amount that

the couple receives because of the spousal benefit. A graphical representation of this is illustrated below

from a sample of one thousand married couples. Any points falling below the red line would trigger the spousal benefit.
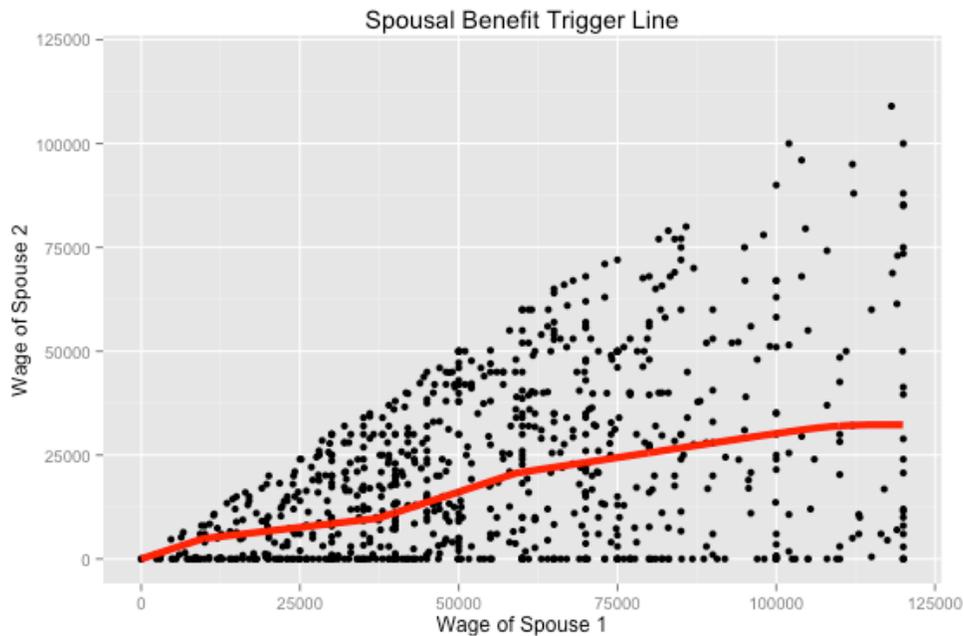

Figure 3: Spousal benefit trigger line plotted against a sample of 1000 married couples

Survivor Benefit Determination

A similar approach is taken to determine the impact of the survivor benefit. As discussed in Chapter 1, the survivor benefit is triggered when the higher wage-earning spouses dies before the lower wage-earning spouse. Upon the death of the higher wage-earner, the lower-wage earner receives his or her spouse's benefit instead of his or her own. Unlike the spousal benefit line shown above, which resembles a piecewise function with a slope generally around 1/3, the survivor benefit line has a slope of 1 for all salaries. For sake of comparison, the survivor benefit line is shown below:
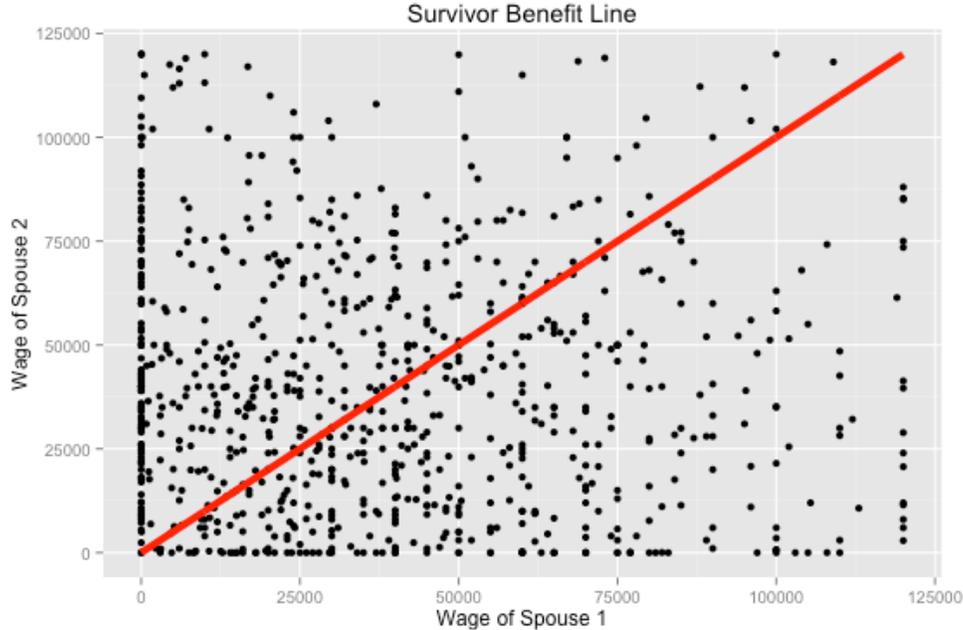
Figure 4: Survivor benefit trigger line plotted against a sample of 1000 married couples

In the plot above, the same married couples are shown, but for the purpose of this graph, Spouse 1 and Spouse 2 do not necessarily refer to the higher and lower wage-earner, respectively. It is shown differently here so that salaries can fall on either side of the line. In this illustration, the important factor to remember is that the survivor benefit is only triggered when the higher wage-earner dies first. Accordingly, any point that does not fall on the line has the potential to trigger the survivor benefit, but only if the lower wage-earner outlives his or her spouse.

The meaningful way to understand the impact of the survivor benefit is to calculate reversionary annuities for each married couple. A reversionary annuity is an annuity that is paid to a beneficiary after the death of the insured. In this instance, a reversionary annuity is an annuity that is paid to the lower wage-earner after the higher wage-earner dies. It is possible to find the expected present value of a reversionary annuity of $1 per year, payable at the beginning of the year, according to the formula:

$$\ddot{a}_{x|y} = \ddot{a}_y - \ddot{a}_{xy}$$

where:

$$\ddot{a}_y = \sum_{t=0}^{\infty} v^t \, {}_tp_y$$

is a single life annuity that pays \$1 per year at the beginning of the year to a life aged y while the

individual is still alive and:

$$\ddot{a}_{xy} = \sum_{t=0}^{\infty} v^t \, {}_tp_x \, {}_tp_y$$

is a joint life annuity that pays \$1 per year at the beginning of the year to lives aged x and y given that

both are still alive. In the context of this thesis, the reversionary annuity formula uses the higher wage-

earner as a life aged x and the lower wage-earner as a life aged y. Also, in the formulas above, ${}_tp_x$

represents the probability of a life aged x living at least t years and

$$v^t = \left(\frac{1}{1+i}\right)^t.$$

Based on the 2014 Trustees Report's long-range economic assumptions the interest rate used in

calculating the expected present value is 2.9%.

The mortality data used in calculating the reversionary annuities is also available through the

Social Security Administration. These mortality tables are period life tables running from 1900 to 2090

for ages 0 to 120. Since these are period life tables, each column represents the exact age of the

individual within each year in a given row. Because this isn't a static life table, and is available for males

and females with yearly mortality improvements, these tables allow for robust calculations. Based on

these mortality tables, the summations in the prior formulas only need to go up to age 120, since people

are not living beyond that age. It is computationally easier to use a recursion formula to calculate the

single life and joint life annuities that are used in the reversionary annuity formula starting at age 120 and

moving one year at a time to the younger ages, as follows:

$$\ddot{a}_y = 1 + v \times p_y \times \ddot{a}_{y+1}$$

$$\ddot{a}_{xy} = 1 + v \times p_x \times p_y \times \ddot{a}_{x+1:y+1}$$

with:

$$\ddot{a}_{120} = 1, \qquad \ddot{a}_{120:y} = \ddot{a}_{x:120} = 1.$$

Using the recursion formula, starting at age 120 when the single life and joint life annuity equal 1, each annuity at the prior age can be calculated. This allows the calculation to build off the prior value until reaching the desired age.

Returning to the reversionary annuity, this concept can be used to determine the present value of the expected amount of additional benefit that Spouse 2 will receive by being able to collect Spouse 1's benefit after Spouse 1 dies. In order to do so, the following formula can be used to approximate the actuarial present value of the additional monthly benefit:

$$PV\ additional\ benefit \approx 12 \times (Spouse\ 1\ Benefit - Spouse\ 2\ Benefit) \times \ddot{a}_{x|y}.$$

This is an approximation because the reversionary annuity is used to calculate the actuarial present value of annual payments, but, in this case, Social Security payments are made monthly. Twelve times the difference of the two spouses' monthly benefit represents the additional annual benefit that Spouse 2 will receive after Spouse 1 dies. Multiplying this by the reversionary annuity thus provides the actuarial present value of the survivor benefit payable to Spouse 2.

Chapter 3 : Results

From the original ACS PUMS data file comprised 1,476,313 housing units, 480,831 housing units contained married couples younger than age 65 with non-missing responses. Out of these housing units, 478,565 housing units contained heterosexual married couples, 2266 housing units contained same-sex married couples, and 896 housing units contained unmarried same-sex partners. Based on the data from these couples, along with the assumption of adjusting the number of same-sex married couples to be fixed at 3% of all married couples, the results are as follows.

First, the central question can be addressed by looking at the spousal benefit portion. An illustration of a random sample of 2000 same-sex married couples and 2000 heterosexual married couples can be seen below:
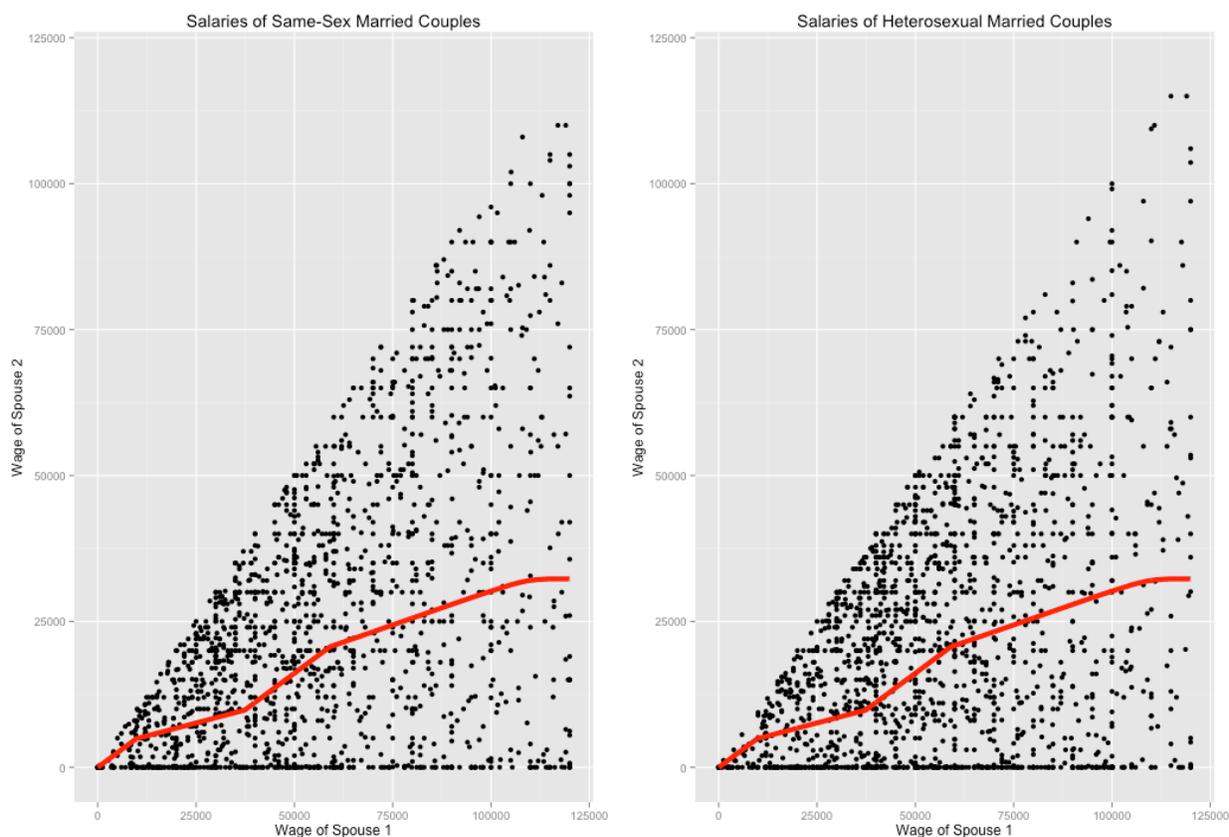

Figure 5: Illustration of the distribution of salaries for married couples

Figure 5 can be used to compare the spread of spousal incomes between same-sex married couples and heterosexual couples. The most important features to note are the amount of salary pairs lying along the axis where Spouse 2's salary equal $0, as well as the general deviation of the pairs away from the center slope where Spouse 1's salary equal Spouse 2's salary. While it is not abundantly clear from Figure 5 how the spread of incomes differ between the two groups, this can be answered analytically for all available housing units. These results are recorded in Table 3 below:

Table 3: Spousal benefit results for married couples and partners

	Heterosexual Married Couples	Heterosexual Partners	Same-Sex Married Couples	Same-Sex Partners
Percent to Get Spousal Benefit	44.7%	44.5%	40.0%	39.0%
Additional Monthly Benefit	$635.27	$454.92	$602.39	$474.52
Percent with One Wage-Earner	24.9%	20.1%	20.9%	13.6%

Table 3 provides the results of the spousal benefit analysis for heterosexual and same-sex married couples, as well as for heterosexual and same-sex partners. The first row – "Percent to Get Spousal Benefit" – contains the percent of couples within each housing unit that would profit from the spousal benefit because Spouse 2's income is sufficiently less than Spouse 1's income such that it triggers the spousal benefit. In other words, this is the percent of income pairs falling below the spousal benefit trigger line. The second row – "Additional Monthly Benefit" – contains the average dollar amount that couples who benefit from the spousal provision will receive per month. Accordingly, this dollar amount is the average difference between Spouse 2's new benefit (half of Spouse 1's benefit) and Spouse 2's original benefit for each of the couples falling into the "Percent Benefiting" category. The third row – "Percent with One Wage-Earner" – contains the percent of couples within each marital status that only have one spouse in the work force.

Similar results can be yielded for the survivor benefit portion. These results are recorded in Table 4 below:

	Heterosexual Married Couples	Same-Sex Married Couples
Average Age	46.7	47.1
Average Difference in Age	3.9	5.5
Percent with Same Age	14.6%	12.7%
Percent with Older Higher Wage-Earner	50.1%	48.7%

Table 4 provides the results of the survivor benefit analysis for heterosexual and same-sex married couples. The first row – "Average Age" – contains the average age of both spouses within all non-retired heterosexual married couples and all non-retired same-sex married couples. The second row – "Average Difference in Age" – contains the average absolute difference in age between the two non-retired spouses within the two categories. The third row – "Percent with Same Age" – contains the percent of married couples within the two categories that have the same age. The fourth row – "Percent with Older Higher Wage-Earner" – contains the percent of housing units in which the higher wage-earning spouse is the older spouse. In other words, this is the percent of couples in which Spouse 1 is older than Spouse 2.

These results are then used to find the overall impact of Social Security recognizing same-sex married couples by calculating the percent increase in the present value of the combined spousal benefit – found by the additional annual benefit collected by same-sex married couples – and survivor benefit – found by annualized reversionary annuities collected by same-sex married couples – fitted to our population with the assumption of 3% of married couples being same-sex married couples. In formulas, the percent increase is found according following equations:

$$Percent\ Increase = \frac{(Same - Sex\ Benefits + Heterosexual\ Benefits) - Heterosexual\ Benefits}{Heterosexual\ Benefits}$$

$$= \frac{Same - Sex\ Benefits}{Heterosexual\ Benefits}$$

More specifically, the percent increase due to the spousal benefit is:

$$100 \left[\frac{\sum_{i=1}^{m} 12 \max(0.5 * X_i\ Benefit - Y_i\ Benefit, 0)}{\sum_{j=1}^{n} 12 \max(0.5 * X_j\ Benefit - Y_j\ Benefit, 0)}\right] * \frac{3\%/97\%}{m/n}$$

where n is the number of heterosexual married couples, m is the number of same-sex married couples, X is the spouse with the higher salary (aka Spouse 1), and Y is the spouse with the lower salary (aka Spouse 2). Thus, m/n is the ratio of same-sex married couples to opposite-sex couples in the data, which is 0.4% of the ACS PUMS data. However, since it is assumed that the ratio should be 3% that will benefit from the marriage equality law changes, the results are adjusted up by a factor of approximately 6, which is that factor on the right hand side of the above formula. This yields for us the percent increase in benefits for the system. The numerator contains the summation of the spousal benefit over the same-sex married couple population and the denominator is the summation of the spousal benefit over the heterosexual married couple population. The formula for the percent increase due to the survivor benefit is:

$$100 \left[\frac{\sum_{i=1}^{m} 12(X_i\ Salary - Y_i\ Salary)\ddot{a}_{x_i|y_i}}{\sum_{j=1}^{n} 12(X_j\ Salary - Y_j\ Salary)\ddot{a}_{x_j|y_j}}\right] * \frac{3\%/97\%}{m/n}\ ,$$

where the same notation is used as in the spousal benefit formula. In both cases, the 0.03 represents the assumption that 3% of all married couples are same-sex married couples.

The percent increase in annual Social Security payments from the spousal benefit due to recognizing same-sex married couples is 2.5%. The percent increase in annual payments from the survivor benefit due to recognition of same-sex marriages is 2.9%. Together, the total increase in annual Social Security marital benefit payments due to legalizing same-sex marriage is 2.9%.

Chapter 4 : Discussion

As noted in the prior chapter, assuming that 3% of all married couples are same-sex married couples, the total increase in annual Social Security marital benefit payments due to legalizing same-sex marriage is 2.9%. Overall, based on the $672 billion in Social Security OASI – the portion of OASDI that only focuses on old age retirement and survivor benefits and not disability benefits – disbursements in 2013, with spousal and survivor benefits accounting for roughly 15% of OASI payments, the 2.9% increase in marital benefits due to the legalization of same-sex marriage is projected to lead to a $2.9 billion, or 0.4%, increase in annual Social Security OASI disbursements. It is beneficial to analyze the sources of this increase, and is possible to do so by referring to the results in Table 3 and Table 4.

In looking at the spousal benefit, all three results provide meaningful insight. First, as can be seen in row one, 44.7% of heterosexual couples benefit from the spousal provision, compared to 40.0% of same-sex married couples. Furthermore, the average additional monthly benefit for those benefiting from the spousal provision is $635.27 for heterosexual couples, compared to $602.39 for same-sex couples. This suggests that not only are fewer same-sex couples benefiting from the spousal provision, but also that those couples that are benefiting are, on average, receiving less of a benefit. This signifies that, in terms of the spousal benefit, same-sex couples require less money to be paid out from Social Security. One possible reason for this is seen in the percentage of couples with one wage-earner. As noted in Table 3, 24.9% of heterosexual married couples only have one wage-earner, compared to 20.9% of same-sex married couples.

Next, in analyzing the survivor benefit, further insight can be gained. In comparison to the spousal benefit, the survivor benefit isn't as apparent in terms of same-sex couples requiring less money to be paid out from Social Security than heterosexual couples. The average age of non-retired heterosexual and same-sex spouses – 46.7 and 47.1, respectively – are extremely similar. The average difference in age of non-retired same-sex married couples is 1.5 years higher than the average difference in age of non-retired heterosexual married couples, suggesting that there may be a longer period of time

during which the survivor benefit would be in effect for same-sex married couples. This is reflected in

the lower percentage of same-sex spouses having the same age as compared to heterosexual spouses.

However, this is possibly offset by the comparison of couples in which the higher wage-earner is older.

For heterosexual married couples, 50.1% of couples have the older spouse as the higher wage-earner,

compared to 48.71% of same-sex married couples.

     As noted in Chapter 3, overall, the spousal benefit accounted for a 2.5% increase in annual Social

Security marital benefit payments and the survivor benefit accounted for a 2.9% increase, leading to a

combined total increase of 2.9% in marital benefit payments due to recognizing same-sex marriages.

From this, the most important characteristic to note is that increasing the number of beneficiaries by 3%

led to an annual increase in expenditures of less than 3%, suggesting that same-sex married couples profit

less than heterosexual married couples from the marital benefits of Social Security. To further illustrate

this point, it is possible to look at the percent of total cost attributable to same-sex married couples. In

other words, what percent of Social Security payments would be paid to same-sex married couples if the

total number of married couples remained the same? This can be calculated according to a modified

version of the prior percent increase formulas, with the following equation:

$$100\left[\frac{SameSex\ Spousal + SameSex\ Survivor}{(SameSex\ Spousal + SameSex\ Survivor) + (Hetero\ Spousal + Hetero\ Survivor)}\right],$$

where:

$$SameSex\ Spousal = \frac{n}{m} * \frac{p}{1-p}\left(\sum_{i=1}^{m} 12\max(0.5 * X_i\ Benefit - Y_i\ Benefit, 0)\right)$$

$$SameSex\ Survivor = \frac{n}{m} * \frac{p}{1-p}\left(\sum_{i=1}^{m} 12(X_i\ Salary - Y_i\ Salary)\ddot{a}_{x_i|y_i}\right)$$

$$Hetero\ Spousal = \sum_{j=1}^{n} 12\max(0.5 * X_j\ Benefit - Y_j\ Benefit, 0)$$

$$Hetero\ Survivor = \sum_{j=1}^{n} 12(X_j\ Salary - Y_j\ Salary)\ddot{a}_{x_j|y_j}.$$

In these formulas, *p* represents the percent of all married couples that are same-sex married couples, while the other notation remains the same. Since the numerator is completely determined by a factor of *p* but the denominator contains an additional constant from the heterosexual married couples, there is exponential decay in ratio of the total percent of Social Security payments attributable to same-sex married couples to the percentage of all married couples that are same-sex married couples. Using this formula, if 3% of all married couples are same-sex married couples, the percent of payments attributable to same-sex married couples would be 2.8%. However, if instead it is assumed that 10% of all married couples are same-sex married couples, the percent of payments attributable to same-sex married couples would be 8.8%. Taking the aforementioned ratio of the total percent of Social Security payments attributable to same-sex married couples to the percentage of all married couples that are same-sex married couples, the ratio is 93.7% with the 3% assumption, compared to a ratio of 88.0% with the 10% assumption. Essentially, in the eyes of Social Security, the higher the proportion of married couples that are same-sex married couples (without, of course, increasing the total number of married couples), the better, since the economic and demographic characteristics of same-sex married couples require less money to be paid out from the marital provisions.

These results tend to agree with the prior research cited in Chapter 1. First, in understanding the demographic and economic differences between same-sex and heterosexual married couples that motivate the underlying change in Social Security payments, the findings from the 2013 Pew Research Center study, "A Survey of LGBT Americans," and the 2004 CBO projections serve as beneficial points of comparison. According to the Pew study, same-sex married couples have higher instances of multiple wage-earners than heterosexual married couples. The results of this thesis agree with this, finding that the percentage of households with one wage-earner is higher for heterosexual married couples than for same-sex married couples. The results of this thesis also align with the 2004 CBO statement that there is less disparity in wages amongst same-sex spouses than heterosexual spouses. This is seen in the lower percentage of same-sex spouses triggering the spousal benefit and the lower additional monthly benefit

for those same-sex spouses that do trigger the spousal benefit. A point of disagreement between the findings of this thesis and the projections from the 2004 CBO report is the difference in ages amongst spouses. The report cited that in heterosexual married couples, on average, the husband is two years older. Furthermore, the report stated that the difference in age amongst same-sex spouses is less than the difference in age amongst heterosexual spouses. However, the results of this thesis conclude that the average difference in age for heterosexual spouses is roughly four years, which is less than the roughly five year average difference in age for same-sex spouses. The 2004 CBO report didn't detail the calculation of average difference in age, but simply stated, "On average, such [same-sex] partners are the same age, and statistically they have the same life expectancy." It is possible that findings from the report were basic assumptions without data verification, so great concern shouldn't be assigned to the discrepancy between the report and the findings of this thesis.

Finally, in comparing the total percent change in annual Social Security disbursements to the 2004 CBO report and the 2014 OASDI Trustees Report, there is confidence in the accuracy of the findings of this thesis. The 2004 CBO report projected a 0.28% increase in annual Social Security payments due to the legalization of same-sex married. While this is less than the 0.428% increase projected in this thesis, the 2004 report is over a decade old, prior to the rapid expansion of legalization of same-sex marriage and before sufficient data and surveying methods were available. Additionally, these results are largely in agreement with the 2014 Trustees Report. The Trustees remarked that the legalization of same-sex marriage would lead to a "small but significant financial impact," commenting that the long-range OASDI actuarial balance would decrease by 0.01 percent of taxable payroll due to the expansion of benefits to same-sex married couples.

Chapter 5 : Conclusion

This research set out to analyze the impact of the expansion of legalized same-sex marriage on the long-term funding of Social Security. To answer this question, the 2013 American Community Survey was used to provide demographic and economic data for married couples in the United States. Models were developed to first calculate projected Social Security benefits for individuals, and then project the percent change in the actuarial present value of Social Security payments to married couples by recognizing same-sex marriage.

The addition of same-sex married couples into the pool of Social Security beneficiaries impacts the value of Social Security payments due to the spousal benefit and the survivor benefit. Based on the assumptions and modeling techniques used in the completion of this thesis, the spousal benefit, which allows a married Social Security beneficiary to receive the maximum of his or her own benefit or half of his or her spouse's benefit, accounted for a 2.5% increase in annual Social Security marital benefit payments. The survivor benefit, which allows a married Social Security beneficiary to receive the maximum of his or her own benefit or 100% of his or her deceased spouse's benefit, accounted for a 2.9% increase in annual Social Security marital benefit payments. Accordingly, by legalizing same-sex marriage, it is projected that there will be a 2.9% increase in annual Social Security marital benefit payments. In total, this increase in marital benefit payments due to the recognition of same-sex marriage is projected to lead to a 0.4% increase in annual Social Security disbursements.

This topic provides ample opportunities for further research. One important aspect of Social Security that wasn't projected in this thesis is Social Security benefits for children. As the number of recognized same-sex marriages increases, so will the number of children – particularly adopted children – in same-sex families. This could serve as an additional increase in Social Security payments, but it is important to keep in mind that this might not lead to a significant increase since the child's benefit would only increase if the adopted parents had more income than either of the biological parents. Research could also be conducted on all 1,138 federal benefits that are dependent on marital status. Although

Social Security is likely the largest and most pressing of these benefits, all of these expenditures could be impacted by the expansion of legalized same-sex marriage. Several of these marital benefits were analyzed in the 2004 CBO report, but after a decade of drastic change, it is important to update these findings.

Additionally, improvements can be made to the existing research design. Since the landscape of same-sex marriage is so dynamic at this point in time, it would be beneficial to simply repeat this same analysis each year with more complete data about which states recognize same-sex marriage, LGBT community demographics, etc. As of now, Social Security actuaries assume that same-sex couples marry at two-thirds the rate of heterosexual couples, but as society becomes more accepting of the LGBT community, it is possible that the same-sex marriage rate will approach the heterosexual marriage rate. Furthermore, as time passes, available census data should continue to improve. One challenge faced in this completion of this thesis was incomplete data that could not be used, particularly for same-sex married couples and same-sex partners. With improvements in surveying data from the Census Bureau and better understanding from individuals completing these surveys, the coding accuracy for LGBT individuals should continue to improve. Also, with the release of the next ACS PUMS and the 2020 census, newer data should provide more accuracy for LGBT community demographics.

Appendix A

Social Security Benefit Calculator Excel and VBA Model

The Excel model used to calculate Social Security benefits can be accessed at

http://1drv.ms/1Hyx4Uk.   By following this link, it is possible to download the Excel file. To calculate a

benefit amount, enter the birthdate, salary, and the year in which the salary is calculated. These are the

three highlighted cells at the top of Column B. The calculation will flow through and provide the final

PIA in Cell N14.

Because of the way the file is hosted, it no longer contains the macro used to calculate the spousal

benefit trigger line. To do so, create a macro with the VBA script below (make sure the main sheet is

called "Benefit Calculator" and the sheet that will hold the values for the spousal benefit trigger line is

called "Spouse Slope"):

```
Sub Macro1()
'
' Macro1 Macro
'
Dim n As Long

For n = 1 To 1200
    Range("B2").Select
    ActiveCell.FormulaR1C1 = 100 * n
    Range("B2").Select
    Selection.Copy
    Sheets("Spouse Slope").Select
    ActiveSheet.Cells(n + 2, 2).Select
    Selection.PasteSpecial Paste:=xlValues, Operation:=xlNone, SkipBlanks:= _
        False, Transpose:=False
    Sheets("Benefit Calculator").Select
    Range("N14").Select
    Application.CutCopyMode = False
    Selection.Copy
    Range("N16").Select
    Selection.PasteSpecial Paste:=xlValues, Operation:=xlNone, SkipBlanks:= _
        False, Transpose:=False
    Application.CutCopyMode = False
    Range("N14").Select
    Application.CutCopyMode = False
    Selection.Copy
```

```
    Sheets("Spouse Slope").Select
    ActiveSheet.Cells(n + 2, 5).Select
    Selection.PasteSpecial Paste:=xlValues, Operation:=xlNone, SkipBlanks:= _
        False, Transpose:=False
    Sheets("Benefit Calculator").Select
    Range("N14").GoalSeek Goal:=Range("O16"), ChangingCell:=Range("B2")
    Range("B2").Select
    Selection.Copy
    Sheets("Spouse Slope").Select
    ActiveSheet.Cells(n + 2, 3).Select
    Selection.PasteSpecial Paste:=xlValues, Operation:=xlNone, SkipBlanks:= _
        False, Transpose:=False
    Sheets("Benefit Calculator").Select
    Range("B9").Select
Next n

End Sub
```

Appendix B

R Code for Population Model

Below is the R code that is used to model the spousal and survivor benefit impacts. R was chosen

because the data files from the ACS PUMS are too large to use Excel. R also provided tremendous

computational power to clean and manipulate the data, produce aesthetically pleasing plots, calculate

intricate annuity values, summarize data, etc. After saving the output from the VBA script as

"Spousal_Benefit.csv," the only other files that are needed are the ACS PUMS files, which can be found

at http://tinyurl.com/m2mjdlj, the female period life table, which can be found at http://1drv.ms/1C3tu4k,

and the male period life table, which can be found at http://1drv.ms/1C3tGR7.

```
library("ggplot2")
library("plyr")

##### spousal benefit portion

#read in spousal benefit data
spousal <- read.csv("Spousal_Benefit.csv")
colnames(spousal) <- c("Spouse_1", "Spouse_2", "Benefit")
#add missing rows
spousal <- rbind(c(100,44,7),spousal)
spousal <- rbind(c(0,0,0),spousal)
#plot spousal data
ggplot(spousal, aes(Spouse_1, Spouse_2)) + geom_line(colour='red', size=2) + xlab("Wage of
Spouse 1") + ylab("Wage of Spouse 2") + ggtitle("Spousal Benefit Trigger Line") +
xlim(0,120000) + ylim(0,120000)

#read in data
pop_a <- read.csv("ss13pusa.csv")
pop_b <- read.csv("ss13pusb.csv")
house_a <- read.csv("ss13husa.csv")
house_b <- read.csv("ss13husb.csv")

#remove unnecessary columns
house_a <- house_a[,c(2,68,69,84,94,97)]
house_b <- house_b[,c(2,68,69,84,94,97)]
pop_a <- pop_a[,c(2,8,69,70,66,68,67)]
pop_b <- pop_b[,c(2,8,69,70,66,68,67)]

#merge household data and delete duplicate
house <- rbind(house_a, house_b)
rm(house_a)
rm(house_b)
#merge person data and delete duplicate
```

```
pop <- rbind(pop_a, pop_b)
pop_age <- pop[,c(1,2)]
pop_age$AGESP <- NA
res <- numeric(nrow(pop_age))
res <- rep(NA, nrow(pop_age))
test <- NULL
for (i in 1:nrow(pop_age)) {
  test[i] <- pop_age[i,1]==pop_age[i+1,1]
  if(test[i]) {
    res[i]=pop_age[i+1,2]
  }
}
pop$AGESP <- res
rm(pop_age)
rm(pop_a)
rm(pop_b)
#merge household and person data into one data frame
data <- merge(house, pop, by.x = "SERIALNO", by.y = "SERIALNO")
rm(house)
rm(pop)

#add total personal income column
data$INC <- (data$SSP + data$WAGP + data$SEMP + data$SSIP)
#remove people who are younger than 65
data <- data[data$AGEP < 65,]
#keep only first instance of each SERIALNO
data <- data[!duplicated(data$SERIALNO),]
#find spouse's income
data$SPOUSEINC <- (data$HINCP - data$INC)
#assign max to Spouse_1 and min to Spouse_2
data$Spouse_1 <- pmax(data$INC,data$SPOUSEINC)
data$Spouse_2 <- pmin(data$INC,data$SPOUSEINC)
#round to nearest hundred
data$Spouse_1_Round <- round(data$Spouse_1, -2)
data$Spouse_2_Round <- round(data$Spouse_2, -2)
#cap at $120,000
data$Spouse_1_Capped <- pmin(data$Spouse_1_Round,120000)
data$Spouse_2_Capped <- pmin(data$Spouse_2_Round,120000)

#do a lookup of Spouse1 salary to find corresponding trigger for Spouse 2
data_temp <- data[,c(1,20)]
colnames(data_temp) <- c("SERIALNO", "Spouse_1")
data_temp <- join(data_temp, spousal)
data$Spouse_2_Test <- data_temp[,3]
data$Spouse_2_Test_Round <- round(data$Spouse_2_Test, -2)
rm(data_temp)

#check if Spouse 2's income is less than the spousal benefit trigger
cond <- data$Spouse_2_Capped < data$Spouse_2_Test_Round
data$Spousal_Check <- ifelse(cond, 1, 0)

#find Spouse 1's benefit
data_temp <- data[,c(1,20)]
colnames(data_temp) <- c("SERIALNO", "Spouse_1")
data_temp <- join(data_temp, spousal)
data$Spouse_1_Beneft <- data_temp[,4]
rm(data_temp)

#find Spouse 2's benefit
data_temp <- data[,c(1,21,23)]
```

```
cond <- data$Spouse_2_Capped < data$Spouse_2_Test_Round
data_temp$Spouse_1 <- ifelse(cond, data_temp$Spouse_2_Test_Round, data_temp$Spouse_2_Capped)
data_temp <- join(data_temp, spousal)
data$Spouse_2_Beneft <- data_temp[,6]
rm(data_temp)

#find difference between Spouse 2's spousal benefit and Spouse 2's benefit w/o spousal benefit
data_temp <- data[,c(1,21)]
colnames(data_temp) <- c("SERIALNO", "Spouse_1")
data_temp <- join(data_temp, spousal)
data$Spouse_2_Beneft_Prior <- data_temp[,4]
data$Spouse_2_Diff <- data$Spouse_2_Beneft - data$Spouse_2_Beneft_Prior
rm(data_temp)

#assign Age_1 to higher wage-earner and Age_2 to lower wage-earner
data$Age_1 <- numeric(nrow(data))
data$Age_2 <- numeric(nrow(data))
cond <- data$INC > data$SPOUSEINC
data$Age_1 <- ifelse(cond, data$AGEP, data$AGESP)
cond <- data$INC < data$SPOUSEINC
data$Age_2 <- ifelse(cond, data$AGEP, data$AGESP)
#check for incorrect ages being assigned to spouses
cond <- data$Age_1 < 18
data$Age_1 <- ifelse(cond, NA, data$Age_1)
cond <- data$Age_2 < 18
data$Age_2 <- ifelse(cond, NA, data$Age_2)
#find absolute value of difference in age
data$Age_Diff <- abs(data$Age_1 - data$Age_2)
#identify if higher wage-earner is older
cond <- data$Age_1 > data$Age_2
data$Age_Check <- ifelse(cond, 1, 0)

# Multiple plot function
multiplot <- function(..., plotlist=NULL, file, cols=1, layout=NULL) {
  require(grid)

  # Make a list from the ... arguments and plotlist
  plots <- c(list(...), plotlist)

  numPlots = length(plots)

  # If layout is NULL, then use 'cols' to determine layout
  if (is.null(layout)) {
    # Make the panel
    # ncol: Number of columns of plots
    # nrow: Number of rows needed, calculated from # of cols
    layout <- matrix(seq(1, cols * ceiling(numPlots/cols)),
                     ncol = cols, nrow = ceiling(numPlots/cols))
  }

  if (numPlots==1) {
    print(plots[[1]])

  } else {
    # Set up the page
    grid.newpage()
    pushViewport(viewport(layout = grid.layout(nrow(layout), ncol(layout))))

    # Make each plot, in the correct location
    for (i in 1:numPlots) {
```

```
        # Get the i,j matrix positions of the regions that contain this subplot
        matchidx <- as.data.frame(which(layout == i, arr.ind = TRUE))

        print(plots[[i]], vp = viewport(layout.pos.row = matchidx$row,
                                        layout.pos.col = matchidx$col))
    }
  }
}


#separate same-sex couples from heterosexual couples
data_age <- data
data <- data[,1:28]
data_married <- na.omit(data[data$HHT==1,])
data_notSSMC <- data_married[data_married$SSMC==0,]
data_SSMC <- na.omit(data[data$SSMC!=0,])
data_PartnerSS <- na.omit(data[data$PARTNER==1 | data$PARTNER==3,])
data_PartnerNotSS <- na.omit(data[data$PARTNER==2 | data$PARTNER==4,])

#plot random sample of 1000 married couples
data_samp <- data_married[sample(nrow(data_married), size=1000),]
ggplot() + geom_point(data=data_samp, aes(x=Spouse_1, y=Spouse_2)) + geom_line(data=spousal,
aes(x=Spouse_1, y=Spouse_2), colour='red', size=2) + xlab("Wage of Spouse 1") + ylab("Wage of
Spouse 2") + ggtitle("Spousal Benefit Trigger Line") + xlim(0,120000) + ylim(0,120000)

#pull random sample of 2000 couples for hetero MC and SSMC
data_notSSMC_samp <- data_notSSMC[sample(nrow(data_notSSMC), size=2000),]
data_SSMC_samp <- data_SSMC[sample(nrow(data_SSMC), size=2000),]

#plot same-sex couples against heterosexual couples
SSMC <- ggplot() + geom_point(data=data_SSMC_samp, aes(x=Spouse_1, y=Spouse_2)) + xlab("Wage
of Spouse 1") + ylab("Wage of Spouse 2") + ggtitle("Salaries of Same-Sex Married Couples") +
xlim(0,120000) + ylim(0,120000) + geom_line(data=spousal, aes(x=Spouse_1, y=Spouse_2),
colour='red', size=2)
notSSMC <- ggplot() + geom_point(data=data_notSSMC_samp, aes(x=Spouse_1, y=Spouse_2)) +
xlab("Wage of Spouse 1") + ylab("Wage of Spouse 2") + ggtitle("Salaries of Heterosexual
Married Couples") + xlim(0,120000) + ylim(0,120000) + geom_smooth() + geom_line(data=spousal,
aes(x=Spouse_1, y=Spouse_2), colour='red', size=2)
multiplot(SSMC, notSSMC, cols=2)

#show percent benefiting from spousal benefit, additional monthly benefit, and WIF=1 for
hetero MC, hetero part, SSMC, SS Part
row1 <- c(
  round(mean(data_notSSMC$Spousal_Check)*100,2),
  round(mean(data_PartnerNotSS$Spousal_Check)*100,2),
  round(mean(data_SSMC$Spousal_Check)*100,2),
  round(mean(data_PartnerSS$Spousal_Check)*100,2)
  )
row2 <- c(
  round(sum(data_notSSMC$Spouse_2_Diff)/sum(data_notSSMC$Spousal_Check),2),
  round(sum(data_PartnerNotSS$Spouse_2_Diff)/sum(data_PartnerNotSS$Spousal_Check),2),
  round(sum(data_SSMC$Spouse_2_Diff)/sum(data_SSMC$Spousal_Check),2),
  round(sum(data_PartnerSS$Spouse_2_Diff)/sum(data_PartnerSS$Spousal_Check),2)
  )
row3 <- c(
  round(nrow(data_notSSMC[data_notSSMC$WIF==1,])/nrow(data_notSSMC)*100,2),

round(nrow(data_PartnerNotSS[data_PartnerNotSS$Spouse_2==0,])/nrow(data_PartnerNotSS)*100,2),
  round(nrow(data_SSMC[data_SSMC$WIF==1,])/nrow(data_SSMC)*100,2),
  round(nrow(data_PartnerSS[data_PartnerSS$Spouse_2==0,])/nrow(data_PartnerSS)*100,2)
```

```
  )
table_spouse <- matrix(c(row1, row2, row3), ncol=4, byrow=TRUE)
colnames(table_spouse) <- c("Heterosexual Married Couples", "Heterosexual Partners", "Same-Sex
Married Couples", "Same-Sex Partners")
rownames(table_spouse) <- c("Percent Benefiting", "Additional Monthly Benefit", "Percent With
One Wage-Earner")
table_spouse <- as.table(table_spouse)
table_spouse

##find percent change by adding in same sex couples
PartnerSS_samp <- data_PartnerSS[sample(nrow(data_PartnerSS), size=0.6*nrow(data_PartnerSS)),]
n=0.03/0.97 #assumption for percent of married couples that are SSMC
spouse_per <-
100*(nrow(data_notSSMC)*n/(nrow(data_SSMC)+nrow(PartnerSS_samp))*(12*sum(data_SSMC$Spouse_2_Di
ff) + 12*sum(PartnerSS_samp$Spouse_2_Diff)))/(12*sum(data_notSSMC$Spouse_2_Diff))
spouse_per


##### survivor benefit portion

#create survivor benefit line
survivor <- spousal[,c(1,1)]
colnames(survivor) <- c("Spouse_1", "Spouse_2")
#plot survivor data
ggplot() + geom_point(data=data_samp, aes(x=INC, y=SPOUSEINC)) + geom_line(data=survivor,
aes(x=Spouse_1, y=Spouse_2), colour='red', size=2) + xlab("Wage of Spouse 1") + ylab("Wage of
Spouse 2") + ggtitle("Survivor Benefit Line") + xlim(0,120000) + ylim(0,120000)

#load mortality tables (generational SSA)
mort_male <- read.csv("Mort_Male.csv")
colnames(mort_male) <- c("Calendar_Year", 1:120)
surv_male <- 1-mort_male
surv_male$Calendar_Year <- surv_male$Calendar_Year*(-1)+1
for (k in 1:119) {
  surv_male <- rbind(surv_male,surv_male[191,])
}
rm(mort_male)
mort_female <- read.csv("Mort_Female.csv")
colnames(mort_female) <- c("Calendar_Year", 1:120)
surv_female <- 1-mort_female
surv_female$Calendar_Year <- surv_female$Calendar_Year*(-1)+1
for (k in 1:119) {
  surv_female <- rbind(surv_female,surv_female[191,])
}
rm(mort_female)

i <- 0.029
v <- 1/(1+i)
rm(i)

#create blank matrix for male and female annuities
ann_male <- matrix(, nrow=191, ncol=121)
colnames(ann_male) <- c("Birth_Year", 1:120)
ann_female <- matrix(, nrow=191, ncol=121)
colnames(ann_female) <- c("Birth_Year", 1:120)
#fill in birth years
for (t in 1:191) {
  ann_male[t,1] = 1900+t-1
}
for (t in 1:191) {
```

```
    ann_female[t,1] = 1900+t-1
}


#create single life annuity matrix for males and for females
#this shows SLA for current age by birth year
for (t in 0:190){
  ann_male_vect <- NULL
  ann_male_vect[120] = 1
  for (k in 1:119) {
    ann_male_vect[120-k] = 1+v*surv_male[120-k+t,120-k+1]*ann_male_vect[120-k+1]
  }
  ann_female_vect <- NULL
  ann_female_vect[120] = 1
  for (k in 1:119) {
    ann_female_vect[120-k] = 1+v*surv_female[120-k+t,120-k+1]*ann_female_vect[120-k+1]
  }
  for (k in 1:119) {
    ann_male[t+1,k+1] = ann_male_vect[k]
  }
  for (k in 1:119) {
    ann_female[t+1,k+1] = ann_female_vect[k]
  }
}


#male-female joint life annuity with same age
ann_mf <- matrix(, nrow=191, ncol=121)
colnames(ann_mf) <- c("Birth_Year", 1:120)
for (t in 1:191) {
  ann_mf[t,1] = 1900+t-1
}
surv_mf <- surv_female * surv_male
surv_mf$Calendar_Year <- (surv_mf$Calendar_Year)^0.5
for (t in 0:190){
  ann_mf_vect <- NULL
  ann_mf_vect[120] = 1
  for (k in 1:119) {
    ann_mf_vect[120-k] = 1+v*surv_mf[120-k+t,120-k+1]*ann_mf_vect[120-k+1]
  }
  for (k in 1:119) {
    ann_mf[t+1,k+1] = ann_mf_vect[k]
  }
}


#male-male joint life annuity with same age
ann_mm <- matrix(, nrow=191, ncol=121)
colnames(ann_mm) <- c("Birth_Year", 1:120)
for (t in 1:191) {
  ann_mm[t,1] = 1900+t-1
}
surv_mm <- surv_male * surv_male
surv_mm$Calendar_Year <- (surv_mm$Calendar_Year)^0.5
for (t in 0:190){
  ann_mm_vect <- NULL
  ann_mm_vect[120] = 1
  for (k in 1:119) {
    ann_mm_vect[120-k] = 1+v*surv_mm[120-k+t,120-k+1]*ann_mm_vect[120-k+1]
  }
  for (k in 1:119) {
    ann_mm[t+1,k+1] = ann_mm_vect[k]
  }
```

```r
}

#female-female joint life annuity with same age
ann_ff <- matrix(, nrow=191, ncol=121)
colnames(ann_ff) <- c("Birth_Year", 1:120)
for (t in 1:191) {
  ann_ff[t,1] = 1900+t-1
}
surv_ff <- surv_female * surv_female
surv_ff$Calendar_Year <- (surv_ff$Calendar_Year)^0.5
for (t in 0:190){
  ann_ff_vect <- NULL
  ann_ff_vect[120] = 1
  for (k in 1:119) {
    ann_ff_vect[120-k] = 1+v*surv_ff[120-k+t,120-k+1]*ann_ff_vect[120-k+1]
  }
  for (k in 1:119) {
    ann_ff[t+1,k+1] = ann_ff_vect[k]
  }
}

#do analysis of age between different groups
#find birth year
data_age$Birth_Year_1 <- 2013 - data_age$Age_1
data_age$Birth_Year_2 <- 2013 - data_age$Age_2
#break out into different groups
age_married <- na.omit(data_age[data_age$HHT==1,])
age_notSSMC <- age_married[age_married$SSMC==0,]
age_SSMC <- na.omit(data_age[data_age$SSMC!=0,])

row1 <- c(
  round(mean((age_notSSMC$Age_1+age_notSSMC$Age_2)/2),2),
  round(mean((age_SSMC$Age_1+age_SSMC$Age_2)/2),2)
)
row2 <- c(
  round(mean(age_notSSMC$Age_Diff),2),
  round(mean(age_SSMC$Age_Diff),2)
)
row3 <- c(
  round(nrow(age_notSSMC[age_notSSMC$Age_Dif==0,])/nrow(age_notSSMC)*100,2),
  round(nrow(age_SSMC[age_SSMC$Age_Dif==0,])/nrow(age_SSMC)*100,2)
)
row4 <- c(
  round(nrow(age_notSSMC[age_notSSMC$Age_Check==1,])/nrow(age_notSSMC)*100,2),
  round(nrow(age_SSMC[age_SSMC$Age_Check==1,])/nrow(age_SSMC)*100,2)
)
table_surv <- matrix(c(row1, row2, row3, row4), ncol=2, byrow=TRUE)
colnames(table_surv) <- c("Heterosexual Married Couples", "Same-Sex Married Couples")
rownames(table_surv) <- c("Average Age", "Average Difference in Age", "Percent with Same Age",
"Percent with Higher Earner As Older")
table_surv <- as.table(table_surv)
table_surv

#assign annuity amounts to SSMC
age_SSMC$Sex_1 <- age_SSMC$SEX
age_SSMC$Sex_2 <- age_SSMC$SEX
for (x in 1:nrow(age_SSMC)) {
  if (age_SSMC$Sex_1[x]==1) {
    age_SSMC$SLA_1[x]=ann_male[age_SSMC$Birth_Year_1[x]-1900+1,age_SSMC$Age_1[x]]
  } else {
```

```
      age_SSMC$SLA_1[x]=ann_female[age_SSMC$Birth_Year_1[x]-1900+1,age_SSMC$Age_1[x]]
    }
}


#assign annuity amounts to notSSMC
age_notSSMC$Sex_1 <- numeric(nrow(age_notSSMC))
age_notSSMC$Sex_2 <- numeric(nrow(age_notSSMC))
cond <- age_notSSMC$INC > age_notSSMC$SPOUSEINC
age_notSSMC$Sex_1 <- ifelse(cond, age_notSSMC$SEX, age_notSSMC$SEX-10)
cond <- age_notSSMC$INC < age_notSSMC$SPOUSEINC
age_notSSMC$Sex_2 <- ifelse(cond, age_notSSMC$SEX, age_notSSMC$SEX-10)
for (i in 1:nrow(age_notSSMC)) {
  if (age_notSSMC$Sex_1[i]==-8) {
    age_notSSMC$Sex_1[i]=1
  } else {
    if (age_notSSMC$Sex_1[i]==-9) {
      age_notSSMC$Sex_1[i]=2
    } else {
      age_notSSMC$Sex_1=age_notSSMC$Sex_1
    }
  }
}
for (i in 1:nrow(age_notSSMC)) {
  if (age_notSSMC$Sex_2[i]==-8) {
    age_notSSMC$Sex_2[i]=1
  } else {
    if (age_notSSMC$Sex_2[i]==-9) {
      age_notSSMC$Sex_2[i]=2
    } else {
      age_notSSMC$Sex_2=age_notSSMC$Sex_2
    }
  }
}
for (x in 1:nrow(age_notSSMC)) {
  if (age_notSSMC$Sex_1[x]==1) {
    age_notSSMC$SLA_1[x]=ann_male[age_notSSMC$Birth_Year_1[x]-1900+1,age_notSSMC$Age_1[x]]
  } else {
    age_notSSMC$SLA_1[x]=ann_female[age_notSSMC$Birth_Year_1[x]-1900+1,age_notSSMC$Age_1[x]]
  }
}

#find joint-life annuity for each SSMC
for (x in 1:nrow(age_SSMC)) {
  ann_vect <- NULL
  ann_vect[1] = 1
  if (age_SSMC$Sex_1[x]==1) {
    for (t in 1:(120-max(age_SSMC$Age_1[x],age_SSMC$Age_2[x]))) {
      ann_vect[t+1] = 1+v*surv_male[114+age_SSMC$Age_1[x]-t+1,min(122-t,122+age_SSMC$Age_1[x]-
age_SSMC$Age_2[x]-t)]*surv_male[114+age_SSMC$Age_2[x]-t+1,min(122-t,122-
age_SSMC$Age_1[x]+age_SSMC$Age_2[x]-t)]*ann_vect[t]
      age_SSMC$JLA_1[x]=ann_vect[length(ann_vect)]
    }
  } else {
    for (t in 1:(120-max(age_SSMC$Age_1[x],age_SSMC$Age_2[x]))) {
      ann_vect[t+1] = 1+v*surv_female[114+age_SSMC$Age_1[x]-t+1,min(122-
t,122+age_SSMC$Age_1[x]-age_SSMC$Age_2[x]-t)]*surv_female[114+age_SSMC$Age_2[x]-t+1,min(122-
t,122-age_SSMC$Age_1[x]+age_SSMC$Age_2[x]-t)]*ann_vect[t]
      age_SSMC$JLA_1[x]=ann_vect[length(ann_vect)]
    }
  }
```

```
}

#find joint-life annuity for each hetero MC
for (x in 1:nrow(age_notSSMC)) {
  ann_vect <- NULL
  ann_vect[1] = 1
  if (age_notSSMC$Sex_1[x]==1) {
    for (t in 1:(120-max(age_notSSMC$Age_1[x],age_notSSMC$Age_2[x]))) {
      ann_vect[t+1] = 1+v*surv_male[114+age_notSSMC$Age_1[x]-t+1,min(122-
t,122+age_notSSMC$Age_1[x]-age_notSSMC$Age_2[x]-t)]*surv_female[114+age_notSSMC$Age_2[x]-
t+1,min(122-t,122-age_notSSMC$Age_1[x]+age_notSSMC$Age_2[x]-t)]*ann_vect[t]
      age_notSSMC$JLA_1[x]=ann_vect[length(ann_vect)]
    }
  } else {
    for (t in 1:(120-max(age_notSSMC$Age_1[x],age_notSSMC$Age_2[x]))) {
      ann_vect[t+1] = 1+v*surv_female[114+age_notSSMC$Age_1[x]-t+1,min(122-
t,122+age_notSSMC$Age_1[x]-age_notSSMC$Age_2[x]-t)]*surv_male[114+age_notSSMC$Age_2[x]-
t+1,min(122-t,122-age_notSSMC$Age_1[x]+age_notSSMC$Age_2[x]-t)]*ann_vect[t]
      age_notSSMC$JLA_1[x]=ann_vect[length(ann_vect)]
    }
  }
}

#find reversionary annuity for SSMC
age_SSMC$Rev <- age_SSMC$SLA_1 - age_SSMC$JLA_1
age_SSMC$Surv <- 12*(age_SSMC$Spouse_1_Beneft - age_SSMC$Spouse_2_Beneft)*age_SSMC$Rev

#find reversionary annuity for hetero-MC
age_notSSMC$Rev <- age_notSSMC$SLA_1 - age_notSSMC$JLA_1
age_notSSMC$Surv <- 12*(age_notSSMC$Spouse_1_Beneft -
age_notSSMC$Spouse_2_Beneft)*age_notSSMC$Rev

#find percent change by adding in same sex couples
n=0.03/0.97 #assumption for percent of married couples that are SSMC
surv_per <-
100*(nrow(age_notSSMC)*n/nrow(age_SSMC)*sum(age_SSMC$Surv))/(sum(age_notSSMC$Surv))
surv_per

####combine spousal and survivor to find total change
n=0.03/0.97 #assumption for percent of married couples that are SSMC
total_per <-
100*(nrow(age_notSSMC)*n/nrow(age_SSMC)*sum(age_SSMC$Surv)+nrow(data_notSSMC)*n/(nrow(data_SSM
C)+nrow(PartnerSS_samp))*(12*sum(data_SSMC$Spouse_2_Diff) +
12*sum(PartnerSS_samp$Spouse_2_Diff)))/(sum(age_notSSMC$Surv)+12*sum(data_notSSMC$Spouse_2_Dif
f))
total_per

n=0.03/0.97
frac <-
100*(nrow(age_notSSMC)*n/nrow(age_SSMC)*sum(age_SSMC$Surv)+nrow(data_notSSMC)*n/(nrow(data_SSM
C)+nrow(PartnerSS_samp))*(12*sum(data_SSMC$Spouse_2_Diff) +
12*sum(PartnerSS_samp$Spouse_2_Diff)))/(nrow(age_notSSMC)*n/nrow(age_SSMC)*sum(age_SSMC$Surv)+
sum(age_notSSMC$Surv)+nrow(data_notSSMC)*n/(nrow(data_SSMC)+nrow(PartnerSS_samp))*(12*sum(data
_SSMC$Spouse_2_Diff) +
12*sum(PartnerSS_samp$Spouse_2_Diff))+12*sum(data_notSSMC$Spouse_2_Diff))
frac/n
n=0.1/0.9
frac <-
100*(nrow(age_notSSMC)*n/nrow(age_SSMC)*sum(age_SSMC$Surv)+nrow(data_notSSMC)*n/(nrow(data_SSM
C)+nrow(PartnerSS_samp))*(12*sum(data_SSMC$Spouse_2_Diff) +
```

```
12*sum(PartnerSS_samp$Spouse_2_Diff)))/(nrow(age_notSSMC)*n/nrow(age_SSMC)*sum(age_SSMC$Surv)+
sum(age_notSSMC$Surv)+nrow(data_notSSMC)*n/(nrow(data_SSMC)+nrow(PartnerSS_samp))*(12*sum(data
_SSMC$Spouse_2_Diff) +
12*sum(PartnerSS_samp$Spouse_2_Diff))+12*sum(data_notSSMC$Spouse_2_Diff))
frac/n

####final results
table_spouse
table_surv
spouse_per
surv_per
total_per
```

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ACADEMIC VITA

Eric Stoltz
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EDUCATION

The Pennsylvania State University, Schreyer Honors College, Smeal College of Business
Expected: May 2015
> Bachelor of Science, Risk Management: Actuarial Science Option
> Minors: Statistics and Spanish

ACTUARIAL EXAMS

Passed: Exam P, Exam FM, Exam MFE, Exam MLC

WORK EXPERIENCE

Aon Hewitt   **Chicago, IL**
Retirement Actuarial Intern   *June 2014-August 2014*
- o Worked with nine different client teams to consult on pension and post-retiree benefit obligations
- o Completed valuations and expense allocations for qualified, SERP, and international pension plans
- o Participated in special projects including: pre-65 retiree exchange feasibility analysis; TV lump sum window data work; benefit projections under plan restructuring; and quantitative comparison of employee benefit programs

Contribution Health, Inc.   **York, PA**
Actuarial Analyst   *June 2013-August 2013*
- o Analyzed employer and employee costs under the Employer Mandate of the PPACA
- o Produced reports for clients detailing strategic analyses from "Pay or Play" modeling
- o Performed cost analysis on renewal rates for small business consortiums
- o Developed actuarial models to execute scenario modeling for large employer health care costs under PPACA

LEADERSHIP AND RELATED EXPERIENCE

Actuarial Science Club   **University Park, PA**
President   *February 2014-March 2015*
- o Serve as main representative of club and as contact for members, officers, and adviser
- o Assist in organization of company information sessions, professional workshops, and exam study sessions
- o Delegate club operations to different members of the executive team
- o Instruct as Teaching Assistant for R M 411 and as review session leader for second actuarial exam (Exam FM)

Food for Thought- Penn State Chapter   **University Park, PA**
President, Founder   *February 2012-April 2014*
- o Founded local chapter of non-profit organization Food for Thought (registered 501(c)3)
- o Guided strategy and execution on all programming and fundraising with a goal of raising $6000
- o Directed the Executive Board and led general body meetings of 20 members

Sapphire Leadership Program   **University Park, PA**
Vice President of Corporate Relations   *January 2013-January 2014*
- o Active in development of program, and in restructuring and organization of corporate events
- o Served as point-of-contact for all companies that interact with and recruit form the Sapphire Leadership Program
- o Student Representative on the Executive Insights Committee with Smeal College of Business directors