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FINANCIAL GROUP

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To: House Business & Labor Committee Members

Thank you for listening to my testimony in support of SB 142 regarding repeal of unisex actuarial tables for auto and life insurance. I promised to provide more information to Representative Reinhart and the Committee on actuarial assumptions in Unisex rates. This Honors Thesis by Anju Gupta at Ball State University in April 1989 is an actuarial view of the discussion from 20 years ago that is very insightful to why Montanans have such high life and auto insurance rates.

In the Opinion on page 23 it states:

"*Frequently, proponents of unisex ratings use the argument that gender is a characteristic which can not be changed: therefore, a person should not be penalized for his or her gender. However, if unisex rating were to become mandated, this situation of penalizing an individual on the basis of gender would not only still exist, but it would become magnified. Under the current system using gender-based tables, the risk borne by each person due to his or her gender is fairly allocated. If unisex rating became the law, each person would be bearing his or her own risk as well as subsidizing the risk of an equally situated person of the opposite sex.*"

This sums up so much of my testimony in support of this bill. Montana women have the highest life insurance rates in the nation because the magnification of unisex rates. Montana men get the lowest annuity payouts in the national also due to this magnification.

Montana households also get to pay the extra cost for the creating, funding, marketing and justifying unisex actuarial tables.

Sincerely,

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Unisex Rating in Insurance

An Honors Thesis (ID 499)

by

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Introduction

When the Equal Rights Amendment missed ratification by three states in 1982 (Gest, 1985:40), the fight for equal rights for men and women did not end. Various feminists groups, including the National Organization of Women (NOW), continue to lobby for equal rights for women in many different areas. Recently, the fight for equal rights has reached the insurance industry.

In order to calculate premiums on insurance policies, companies use sex-distinct tables. NOW and other feminist groups argue that the use of these tables discriminates against women. To insure the equal treatment of men and women, NOW maintains that these sex-distinct tables should be abolished and a unisex table should be used. The insurance industry, however, argues gender is a primary risk factor in setting rates (Dennon, 1988:1), and if important risk factors are eliminated, overpricing and underpricing will occur (Carroll, 1988:56).

In the course of this paper, I will attempt to present both supporting and opposing views of this argument as fairly as possible. However, the main point of this paper is to present an actuarial view of the argument. I will outline a brief history of the unisex debate, and then I will present both views of the issue. Then, I will try to explain the actuarial viewpoint of the issue of using gender as a basis of ratemaking for insurance products.

What Does Unisex Rating Mean?

When actuaries design tables for pricing insurance products, they use actual data from past experience. They group lives according to the risks each life represents. The risks which they use for classification have been found to allocate cost fairly according to the degree of risk which the insurer bears. These risks include such characteristics as the age of the insured, the gender of the insured, whether the insured smokes or not, and many others.

The use of unisex tables would eliminate gender as a risk classification. Rather than establish separate male and female tables, actuaries would design a table based on a group blended by gender. One method of blending would involve adding the percentage of male business

times male lives to the percentage of female business times female lives. For example, if approximately seventy percent of an insurance company's business came from males and the other thirty percent from females, the blended group at age x would consist of seventy percent of the male lives at age x plus thirty percent of the female lives at age x.

Once this blended group has been established, the actuaries would calculate, using the same methods as they would with sex-distinct rates, the mortality tables. From these mortality tables, the net single premiums, annuity values, and premiums would be calculated.

Using sex-distinct tables produces different premium rates for males and females. However, premiums for females are not higher on all insurance products. While men pay higher premiums for equal life insurance coverage than do women, annuities used in pension programs charge women more than men.

Unisex legislation would mandate the use of unisex mortality tables in the annuity and premium calculations. However, the issue is not about the use of unisex tables; the issue is about the validity of gender as a risk classification.

History

Over the past years, there has been a great deal of legislation which addresses the issue of equality among men and women. Some of this legislation has been directed at the insurance industry. The Supreme Court made two landmark decisions, *City of Los Angeles Water and Power vs. Manhart* and *Arizona Governing Committee vs. Norris*, which addressed the issue of sex-distinction in pensions. On the state level, there have been several states which enacted legislation requiring the use of unisex tables for either auto insurance or all lines of insurance.

Title VII of the the Civil Rights Act of 1964 was used to cite in allegations of discrimination in both the *Manhart* and *Norris* cases. Each of the titles in the Civil Rights Act of 1964 prohibits discrimination in particular areas, and Title VII prohibits discrimination in the area of employment (Cary and Peratis, 1978:53). Congress expressly declared that no employer "shall discriminate against any individual on the basis of 'race, color, religion, *sex*, or national origin'" (Cary and Peratis, 1978:30).

In 1978, the case of the *City of Los Angeles Water and Power vs. Manhart* came before the Supreme Court. In this case, the employees of the Los Angeles Department of Water and Power sued the Department for requiring female employees to make larger monthly contributions to a

pension plan than their male counterparts in order to receive the same monthly benefit (Cary and Peratis, 1978:71-72). The use of gender-based tables in computing benefit amounts for a mandatory defined benefit plan was found to be in violation of the Civil Rights Act of 1964 (Kurlowickz and Damiani, 1987:30).

In 1983, the case of *Arizona Governing Committee vs. Norris* was brought before the Supreme Court. In this case, Nathalie Norris, an employee of the State of Arizona, sued her employer for violating the Civil Rights Act of 1964 by administering a pension plan which computed benefits using a sex-distinct table. The Supreme Court ruled in favor of Norris, requiring plan sponsors to only use unisex tables when computing benefits. Prior to the Supreme Court decision, a female employee would receive a lower monthly pension benefit than her male counterpart (Gibson et al, 1983:1).

Since a large majority of insurance regulation is conducted on the state level, many of the significant cases in which unisex legislation has passed occur in the states. However, in 1983, Republican Senator Bob Packwood of Oregon introduced a bill at the federal level, that was eventually defeated, which would have prohibited the use of gender-based tables in all lines of insurance (Dennon, 1988:1). Several states have enacted legislation which requires the use of unisex tables, and still others are considering it.

There are several states which require the use of unisex tables in setting rates on automobile insurance. As early as 1974, the use of unisex tables for auto insurance became effective in the state of Hawaii. In 1975, North Carolina followed with legislation requiring unisex auto insurance. Unisex auto insurance is required in the state of Michigan, effective since 1981. A regulation requiring the use of unisex auto rates was scheduled to take effect in September, 1986 in Pennsylvania; however, the state legislature passed a bill nullifying the regulation before it could take effect (Dennon, 1988:2).

In 1983, Montana became the first state to enact legislation requiring the use of unisex tables for all lines of insurance. This law went into effect in October, 1985 (Youngman, 1987:1). The state legislature voted to repeal the law in 1987; however, Governor Ted Schwinden vetoed the repeal on the basis of constitutional guarantee against discrimination (Dennon, 1988:2).

The State of Massachusetts recently became the second state to require the use of unisex tables for all lines of insurance. The state is the first to move to unisex rating as a result of a regulation, rather than legislation (McGhee, 1988:6). The regulation was promulgated on September 18, 1987 and became effective September 1, 1988 (Benjamin, 1988:4).

There are other states which are currently investigating the idea of unisex rating. During the 1988 Iowa state legislative session, a study committee on the elimination of discriminatory insurance practices was established. In Minnesota, a special eleven-member task force has been established by Minnesota Insurance Commissioner Michael Hatch to study the issue (Jones, 1988:1). William E. Kingsley, an American Council of Life Insurance (ACLI) executive vice-president, remarked that the ACLI expects a big push for unisex rating in the insurance industry. Since the defeat of the federal bill for unisex rating, there has been increased interest in unisex rating bills among state legislators (Arndt, 1987:3).

Support for Unisex Rating

Support for unisex rating comes from several different directions. The most prominent area of support is feminist organizations, such as the National Organization of Women (NOW) as well as others. The American Civil Liberties Union (ACLU) also actively supports unisex legislation. Although most insurance companies have opposed unisex rating, some have supported it. Most notably, John Hancock Financial Services has both supported unisex rating and worked to help enact unisex legislation (Hathaway, 1988:54).

Proponents of unisex rating have used many arguments to support their cause; however, the most common argument used is that the use of sex-distinct tables in insurance is unfairly discriminatory. Although gender has been found to be a good predictor of risk, some feel it should not be used to set rate differentials because, as gender is a characteristic that cannot be changed, the individual should not be punished for it (Dennon, 1988:25). While insurers continue to support the use of gender as a reliable and significant cost factor, proponents maintain that gender-based insurance is offensive to basic civil rights principles (Zimmerman, 1986:24). Gender has been found to be a socially unacceptable method of grouping people for business purposes (Bennett, 1986:106). According to the Senate Commerce Committee in 1982, "...treating men and women equally in insurance is not so much a matter of statistics as of 'simple justice'" (Dennon,1988:25).

Marcia Youngman, the Non-Gender Insurance Project Director for the Women's Lobbyist Fund of Montana, is a strong supporter of unisex rating. In her testimony to the Massachusetts Division of Insurance, Ms. Youngman stated that her group supported the unisex legislation for economic reasons as well as for civil rights reasons (Youngman,1987:1). Ms. Youngman discussed the effects of unisex legislation in Montana, including higher

rates due to factors unrelated to the law such as illegal political ratemaking and poor rate adjustment processes (Youngman, 1987:1-4). The Women's Lobbyist Fund of Montana conducted a rate study to discover the impacts of the unisex law on various types of insurance. The results of this study showed that while some rates went up and some went down, "...the rate picture is generally much fairer than before,..." (Youngman, 1987:5).

Ms. Youngman also stated in her testimony that the industry uses gender-related statistics inconsistently, in ways that have not treated women fairly. She feels actuarial data is used in several areas in a way which minimizes benefits to women. Ms. Youngman summarized her feelings by stating, "It is in the best interest of companies as well as consumers to rate people according to performance and lifestyle factors that allow companies to reward people for safe and healthy behaviors and thus attract low-risk customers, rather than according to the uncontrollable factor of gender" (Youngman, 1987:7).

The ACLU supports unisex rating on the basis of the fundamental policy that "...certain protected characteristics--race, color, religion, sex, marital status and national origin--should not be taken into account in setting insurance rates..." (Ellis, 1988:2). In her statement on the behalf of the ACLU before the Iowa Study Committee on the Elimination of Discriminatory Insurance Practices, Deborah A. Ellis stated that insurance is one of the few areas in this country in which intentional sex discrimination is permitted and defended (Ellis, 1988:4). She also made the point that insurance companies do not use either race or religion as a basis of risk classification; therefore, the same policy should apply to gender (Ellis, 1988:6). Ms. Ellis attacked the industry's claim that sex distinctions are based on actuarial science, saying that the only "science" involved was the taking of a group average (Ellis, 1988:11). As Ms. Ellis stated, "The fact of the matter is that all actuarial groupings are inevitably entirely arbitrary, or based upon social value judgments, or, in the worst case, are merely reflections of social stereotypes and prejudice" (Ellis, 1988:12).

In actuarial tables, women as a group live longer than men; however, individual women do not always live as long as actuarial tables predict (Erickson, 1988:1). Proponents of unisex rating use this argument frequently to support their views. As Jenny A. Erickson, Assistant Legislative Counsel at John Hancock Financial Services, stated to the Iowa Study Committee on the Elimination of Discriminatory Insurance Practices, divergent perspectives on the same important essence of insurance loss prediction make debate difficult (Erickson, 1988:1) However, as Ms. Erickson stated, "The issue is no longer an actuarial one, it's a social one" (Erickson, 1988:2). In a poll conducted among their clients, John Hancock Financial Services found that gender-based rates were offensive to customers, who viewed the issue as one of fairness and unfairness. The

company supports unisex rating as a good social policy whose time has come (Hathaway, 1988:54-55).

Opposition to Unisex Rating

While there is strong support for unisex rating, there is also a great deal of opposition directed towards the issue. The majority of this opposition comes from the insurance industry sector. The American Council of Life Insurance (ACLI), various companies, and specific actuaries have come out in strong opposition of unisex legislation. The main argument used by the opponents is that, under a system using unisex rates, one sex subsidizes the other on almost all lines of business. Other arguments used include the fact that experience has shown that males have higher mortality rates than females and the fact that gender-based rates are actuarially sound.

Insurance companies use gender as a primary risk for setting rates in several lines of insurance. The industry defends this practice, saying gender allocates cost fairly according to the degree of risk which the insurer bears (Dennon, 1988:1). While a growing number of insurance customers feel this system is unfair, William E. Kingsley of the ACLI suggest that there is a basic lack of understanding of risk-based rating (Arndt, 1987:3). Barbara Lautzenheiser, a practicing actuary for over twenty-seven years, argues that gender is valid as a risk classification, and, if it is eliminated, a subsidy would occur as insureds with different expected losses were placed in the same class (Lautzenheiser, 1988:1).

William F. Carroll, president of the Life Insurance Association of Massachusetts, says that gender is a significant risk factor in mortality rates, and that if it is ignored, overpricing and underpricing will result (Carroll, 1988:56). As Joseph S. Diamond indicated in an editorial in the National Underwriter, "'equal treatment' doesn't necessarily mean the same treatment; ...it really means fair and equitable treatment for all" (Diamond, 1988:18). Fairness in insurance means pricing each person according to the risk he or she represents (Carroll, 1988:56).

In a study done in connection with her doctoral thesis, Deborah Lee Wingard studied both the biological and behavioral factors which affect the sex differential in mortality rates. While most studies explore the behavioral factors which account for mortality differences between the two sexes, they do note that the male death rate is higher even in prenatal life, when behavioral factors could have little effect (Wingard, 1980:1). Ms. Wingard discovered in her study that women have lower death rates than

men in almost every country, at almost every age, and for most causes of death, indicating better overall fitness among women (Wingard, 1980:11).

As Ms. Lautzenheiser indicated in her testimony before the Iowa Study Committee on the Elimination of Discriminatory Insurance Practices, the risk classification plans and variables used to distinguish among different classes are based on actual data collected by the insurer (Lautzenheiser, 1988:1). Actuaries have carefully analyzed this data and constructed tables reflecting the differences. While some object to this practice because it treats women as a class rather than individuals, the industry defends the practice because there are limitations within actuarial science; the future cannot be predicted on each individual basis.

Proponents of unisex rating frequently accuse the industry of loading female policies with higher expense costs than male policies. Ms. Lautzenheiser says that mortality costs, which are lower for women, are the only differences in costs between the two sexes (Lautzenheiser, 1988:5). Competition within the industry automatically demands that prices fairly reflect costs (Lautzenheiser, 1988:1). If women's rates are higher than men's rates, even under a unisex system, it is not due to a conspiracy by the insurance industry, but rather due to actuarially sound rates (Lautzenheiser, 1988:13).

Actuarial Section

Given a group of lives starting at age x and the survivor experience in the following years, actuaries can design mortality tables. Using these tables, the actuaries can then calculate net single premiums, annuity values, and premium values. These calculations are made using the same formulas, regardless of what data was used to construct the mortality tables.

Construction of Mortality Tables:

When designing mortality.tables, the actuary starts with the raw data on a group of lives starting at age 0. (This can be done starting at any age x.)

Let l_0 = the number of lives in the original group.

Let l_x = the number of lives in the group at age x.

The original group, l_0, will reduce at each age by the number of deaths in the previous year.

$$\text{Let } d_x = \text{the number of deaths in the year } x$$

$$= l_x - l_{x+1}.$$

To make the terminology less cumbersome,

let (x) = a person aged x.

The probability that a person aged x will survive to age x+1 equals the number of lives at age x+1 divided by the number of lives at age x.

$$\text{Let } {}_np_x = \text{the probability that (x) survives n years}$$

$$= \frac{\text{the number of lives at age } x+n}{\text{the number of lives at age } x}.$$

$$p_x = \frac{\text{the number of lives at age } x+1}{\text{the number of lives at age } x}$$

$$= \frac{l_{x+1}}{l_x}.$$

Following the basic laws of probability, the probability of a person aged x dying before age x+1 equals one minus the probability of a person aged x surviving to age x+1.

$$\text{Let } q_x = \text{the probability that (x) dies before age } x+1$$

$$= 1 - p_x$$

$$= 1 - \frac{l_{x+1}}{l_x}.$$

From this formula the probability of dying within one year is calculated for each age x, from zero to ninety-nine, or the last year of survivorship. These probabilities then constitute the mortality table.

To illustrate the calculations performed when designing a mortality table, the data on the blended group of lives will be used. However, the same formulas and steps were used to calculate the mortality tables for the male and female groups of lives. The data used in these calculations is from

the actual experience of the Principal Mutual Life Insurance Company, located in Des Moines, Iowa.

Given data on males and females for age zero through age ninety-nine, a blended group is established, assuming that eighty percent of the total business was male and twenty percent of the total business was female. The original number of lives, starting at age zero, is

$$l_0 = 501883 .$$

To construct the mortality table, the probability of dying within one year is calculated for each age x. For example, for a person aged forty-four,

$$p_{44} = \frac{l_{45}}{l_{44}} = \frac{461435}{466085} = 0.99582$$

$$q_{44} = 1 - p_{44} = 1 - 0.99852 = 0.00418.$$

In the mortality tables, the probabilities of dying within one year, or the q_x's, are multiplied by one thousand, which produces $1000q_x$'s. In calculations involving q_x, the factor of one thousand is removed by division; therefore, this factor does not affect the calculations, but it does make reading the table easier.

Net Single Premiums:

Once the mortality table has been established, the net single premiums can be calculated.

Let b_t = the benefit payment for a life insurance.

The benefit function, b_t, is usually defined as the face value on the insurance policy and, therefore, is a constant value. However, it can also be a function with a value that changes over time.

Let v^t = the discount function for time of policy issue.

$b_t \times v^t$ = the present value of the benefit payment at the time of policy issue.

The discount function is used to discount the future benefit payment back to the time of policy issue.

The net single premium represents the expected present value of the benefit payment at the time the policy is issued. For a whole life insurance policy for a person aged x, the net single premium equals the present value of the benefit payment times the mortality function at age x, summed over the span of life.

Let A_x = the net single premium for whole life insurance for a person aged x

$$A_x = \sum_{k=0}^{\infty} b_{k+1} v^{k+1} {}_k p_x q_{x+k} .$$

Summing over such a long period of time can become difficult. Therefore, actuaries have developed commutation functions. These functions can be used to calculate net single premiums in terms of stored intermediate values. The commutation functions are defined in Actuarial Mathematics as follows:

$$D_x = v^x l_x$$

$$C_x = D_x v q_x$$

$$M_x = \sum_{k=0}^{\infty} C_{x+k} \quad \text{(Bowers et al, 1986:112).}$$

Using these definitions of commutation functions, the net single premium for a whole life insurance policy can be calculated.

$$A_x = b_t \times \frac{M_x}{D_x} .$$

Frequently, net single premiums are calculated so that the benefit is payable at the moment of death. In order to calculate these types of net single premiums, continuous values are integrated over the span of life rather than whole values being summed. That is,

$\bar{A}_x$ = the net single premium for whole life insurance, benefit payable at the moment of death

$$\bar{A}_x = \int_0^\infty b_t v^t {}_tp_x \mu_{x+t} dt \text{ , where } \mu_x \text{ is the force of mortality,}$$

while A_x is the net single premium for whole life insurance, benefit payable at the end of the year in which the death occurs. However, the net single premium with the benefit payable at the moment of death can be obtained using the net single premium with the benefit payable at the end of the year in which the death occurs. In order to make this calculation, several measurements of the interest rate will be used.

Let i = the interest rate used to discount the benefit back to the time of policy issue.

Let $v^t = (1 + i)^{-t}$.

Let $\delta = \ln(1 + i)$.

Assuming a uniform distribution of deaths, it has been shown that

$$\bar{A}_x = \frac{i}{\delta} A_x \quad \text{(Bowers et al, 1986:104).}$$

Using commutation functions,

$$\bar{A}_x = b_t \times \frac{i}{\delta} \frac{M_x}{D_x}.$$

To illustrate the necessary steps in the calculation of the whole life net single premium, the blended mortality table is used, although the same formulas are used to calculate the whole life net single premiums for males and females. Let the face value on a whole life insurance policy for a person aged forty-four be one. The assumed interest rate in the calculations will be seven percent. The net single premium for the whole life policy with benefits payable at the moment of death is

$$\bar{A}_{44} = \int_0^\infty v^t {}_tp_{44} \mu_{44+t} dt.$$

Using commutation functions,

$$\bar{A}_{44} = \frac{i}{\delta} \frac{M_{44}}{D_{44}}$$

$$\bar{A}_{44} = \frac{0.07}{\ln(1.07)} \times \frac{3972.30}{23745.37}$$

$$= 0.17308 .$$

The whole life net single premium for a male aged forty-four is

$$\bar{A}_{44} = 0.18086,$$

and the whole life net single premium for a female aged forty-four is

$$\bar{A}_{44} = 0.14190.$$

The significant differences between these three values will be discussed in the section on premiums.

Term insurance can also be used to illustrate premium differences for males and females. To calculate the net single premium for a term policy, benefit payable at the moment of death, the actuary follows the same basic steps as for a whole life policy. Once again there is a benefit function, b_t, and a discount function, v^t. However, rather than integrating from zero to infinity, the integration is from zero to n-1, with n being the duration of the term policy. To calculate the net single premium for a n-year term policy, benefit payable at the moment of death for a person aged x,

let $A^1_{x:\overline{n}|}$ = the net single premium for n-year term insurance for a person aged x

$$= \sum_{k=0}^{n-1} b_{k+1} v^{k+1} {}_kp_x q_{x+k} .$$

Commutation functions can be used to calculate this. The net single premium for a n-year term policy, benefit payable at the end of the year in which the death occurs is, in terms of commutation functions,

$$A^1_{x:\overline{n}|} = b_t \frac{(M_x - M_{x+n})}{D_x} .$$

The net single premium for a n-year term policy with benefit payable at the

moment of death is

$$\bar{A}^{1}_{x:\overline{n}|} = \int_0^n b_t v^t {}_tp_x \mu_{x+t} dt .$$

Under the uniform distribution of deaths,

$$\bar{A}^{1}_{x:\overline{n}|} = \frac{i}{\delta} A^{1}_{x:\overline{n}|}$$

$$= b_t \times \frac{i}{\delta} \frac{(M_x - M_{x+n})}{D_x} .$$

Using the mortality rates from the blended table, the net single premium for a ten-year term policy for a person aged thirty-five, with a benefit of one payable at the moment of death is

$$\bar{A}^{1}_{35:\overline{10}|} = \int_0^{10} v^t {}_tp_{35} \mu_{35+t} dt .$$

Using commutation functions,

$$\bar{A}^{1}_{35:\overline{10}|} = \frac{i}{\delta} \frac{(M_{35} - M_{45})}{D_{35}}$$

$$= \frac{0.07}{\ln(1.07)} \times \frac{(4770.96 - 3879.45)}{44796.45}$$

$$= 0.02059 .$$

The net single premium on a ten-year term policy is calculated for males and females using the same formulas. These calculations produce

$$\bar{A}^{1}_{35:\overline{10}|} = 0.02146$$

for a male aged thirty-five and, for a female aged thirty-five,

$$\bar{A}^{1}_{35:\overline{10}|} = 0.01708.$$

The differences between these three values will be investigated in the premium calculations.

Annuities:

Annuity values can also be calculated using the newly-constructed mortality table.

Let v^t = the discount function for the time of policy issue.

This discount function is the same as that used for calculating net single premiums. There are two types of annuities: an annuity-immediate, which pays at the end of the year, and an annuity-due, which pays at the beginning of the year.

Let $\ddot{a}_x$ = the actuarial present value of a whole life annuity-due of one for a person aged x

$$= \sum_{k=0}^{\infty} v^k {}_kp_x .$$

Commutation functions can be used to calculate this actuarial present value. A new commutation function, N_x, is introduced.

$$\text{Let } N_x = \sum_{u=x}^{\infty} D_u .$$

Using this definition for the commutation function , it can be shown that

$$\ddot{a}_x = \frac{N_x}{D_x}$$ (Bowers et al, 1986:140).

Given a person aged forty-four, the actuarial present value of a whole life annuity-due of one can be calculated. To illustrate the necessary steps, the blended mortality table will be used.

$$\ddot{a}_{44} = \sum_{k=0}^{\infty} v^k {}_kp_{44} .$$

Using commutation functions,

$$\ddot{a}_{44} = \frac{N_{44}}{D_{44}}$$

$$\ddot{a}_{44} = \frac{302245.45}{23745.37}$$

$$= 12.73 .$$

The actuarial present value of the same annuity for a male aged forty-four is

$$\ddot{a}_{44} = 12.61.$$

For a female aged forty-four, the actuarial present value of a whole life annuity-due is

$$\ddot{a}_{44} = 13.19.$$

The effect of these differences in values can be seen in the premium calculations. Therefore, they will be investigated further in the section regarding premiums.

The actuarial present value of a n-year temporary life annuity-due can be calculated as well. The discount function remains the same as with a whole life annuity-due.

Let $\ddot{a}_{x:\overline{n}|}$ = the actuarial present value of a n-year temporary life annuity-due of one for a person aged x

$$= \sum_{k=0}^{n-1} v^k {}_kp_x .$$

This actuarial present value can be calculated using commutation functions.

$$\ddot{a}_{x:\overline{n}|} = \frac{N_x - N_{x+n}}{D_x} .$$

To calculate the actuarial present value for a ten-year temporary annuity-due of one for a person aged thirty-five, using the blended mortality table,

$$\ddot{a}_{35:\overline{10}|} = \sum_{k=0}^{9} v^k {}_kp_{35} .$$

Using commutation functions,

$$\ddot{a}_{35:\overline{10}|} = \frac{N_{35} - N_{45}}{D_{35}}$$

$$= \frac{611818.28 - 278500.08}{44796.45}$$

$$= 7.44.$$

The same formulas are used to calculate the actuarial present values of a temporary annuity-due for a male and for a female. For a male aged thirty-five, the actuarial present value of a ten-year temporary annuity-due is

$$\ddot{a}_{35:\overline{10}|} = 7.44.$$

The actuarial present value for a similar annuity-due for a female aged thirty-five is

$$\ddot{a}_{35:\overline{10}|} = 7.45.$$

The significance of these values and their effect on the premiums will be investigated later.

Calculations can also be made for annuities payable on monthly, quarterly, or semi-annual basis. These are referred to as annuities which are payable on a *m*thly basis. The actuarial present value of an annuity of this type can be calculated using the actuarial present value of an annuity-due. Several measurements of interest rate will be used.

i = interest rate.

Let $d = \frac{i}{1+i}$.

Let $i^{(m)} = m[(1+i)^{1/m} - 1]$.

Let $d^{(m)} = m[1 - (1+i)^{-1/m}]$.

As shown in <u>Actuarial Mathematics</u>,

$$\alpha(m) = \frac{id}{i^{(m)}d^{(m)}}$$

$$\beta(m) = \frac{i - i^{(m)}}{i^{(m)}d^{(m)}}$$ (Bowers et al, 1986:137-138).

Using these definitions,

let $\ddot{a}_x^{(m)} = \alpha(m)\ddot{a}_x - \beta(m)$.

Commutation functions can then be used to calculate this value.

$$\ddot{a}_x^{(m)} = \alpha(m)\frac{N_x}{D_x} - \beta(m)$$.

To illustrate the calculation of the actuarial present value of an annuity-due of one with *m*thly payments, the blended mortality table will be used. For a person aged fifty-five, the actuarial present value of a whole life annuity-due with monthly payments is

$$\ddot{a}_{55}^{(12)} = \alpha(12)\ddot{a}_{55} - \beta(12).$$

Using an interest rate of seven percent,

$$i = 0.07$$

$$d = \frac{0.07}{1.07} = 0.06542056$$

$$i^{(12)} = 12[(1.07)^{1/12} - 1] = 0.06784974$$

$$d^{(12)} = 12[1 - (1.07)^{-1/12}] = 0.06746827$$

$$\alpha(12) = \frac{(0.07)(0.06542056)}{(0.06784974)(0.06746827)} = 1.00037888$$

$$\beta(12) = \frac{0.07 - 0.06784974}{(0.06784974)(0.06746827)} = 0.46972346$$.

Therefore,

$$\ddot{a}_{55}^{(12)} = 1.00037888\ddot{a}_{55} - 0.46972346 .$$

Using commutation functions,

$$\ddot{a}_{55}^{(12)} = 1.00037888\frac{N_{55}}{D_{55}} - 0.46972346$$

$$= 1.00037888\,\frac{116006.44}{10513.42} - 0.46972346$$

$$= 10.57\,.$$

The same formulas can be used to calculate the actuarial present value of a whole life annuity-due with monthly payments for a male aged fifty-five. The result is

$$\ddot{a}_{55}^{(12)} = 10.37.$$

The actuarial present value of a similar annuity-due for a female aged fifty-five is

$$\ddot{a}_{55}^{(12)} = 11.34.$$

These values have an impact on pension benefits and will be discussed further in that section.

Net Annual Premiums:

After the net single premiums and actuarial present values of annuities have been calculated, the net annual premiums can be calculated.

Let $P(\bar{A}_x)$ = the net annual payment, semi-continuous premium for a whole life insurance for a person aged x.

Assuming the equivalence principle,

$$P(\bar{A}_x) = \frac{\bar{A}_x}{\ddot{a}_x}\,.$$

When premiums are calculated using separate male and female tables, a significant difference can be seen between the two values. For example, the net annual premium on a sixty thousand dollar whole life policy for a female aged forty-four is

$$P(\bar{A}_{44}) = \frac{\$60{,}000\ \bar{A}_{44}}{\ddot{a}_{44}}$$

$$= \frac{\$60{,}000\ (0.1419)}{(13.19)}$$

$$= \$654.54\,.$$

However, the net annual premium on a sixty thousand dollar whole life policy for a male aged forty-four is

$$P(\bar{A}_{44}) = \frac{\$60{,}000\ \bar{A}_{44}}{\ddot{a}_{44}}$$

$$= \frac{\$60{,}000\ (0.18086)}{(12.61)}$$

$$= \$860.32\,.$$

The difference between the two values is significant. The actual dollar difference of over two hundred dollars indicates that this policy is over thirty percent more expensive for men than for women. This difference is not affected at all by any factors other than actual life experience.

Using a blended table to calculate the net annual premium on a sixty thousand dollar whole life policy for a person aged forty-four produces

$$P(\bar{A}_{44}) = \frac{\$60{,}000\ \bar{A}_{44}}{\ddot{a}_{44}}$$

$$= \frac{\$60{,}000\ (0.17308)}{(12.73)}$$

$$= \$815.85\,.$$

If this blended table were used, the premium for females would increase by almost twenty-five percent while the premium for males would decrease by approximately five percent.

Those opposed to unisex insurance use these figures to support their argument that, under gender-neutral rule, the female risks would be subsidizing the male risks by paying higher rates. The difference between the life experience of males and females is not a small, insignificant

percentage; by blending these two groups, the female group is being penalized unfairly while the male group is being given an advantage.

Term insurance is another insurance product in which male and female premiums are significantly different. To calculate the net annual premium for term insurance,

let $P(\bar{A}^{1}_{x:\overline{n}|})$ = the net annual payment, semi-continuous premium for a n-year term life insurance for a person aged x.

Assuming the equivalence principle,

$$P(\bar{A}^{1}_{x:\overline{n}|}) = \frac{\bar{A}^{1}_{x:\overline{n}|}}{\ddot{a}_{x:\overline{n}|}} .$$

There are significant differences in the premiums for males and females for term insurance as well as for whole life insurance. For example, the net annual premium on a twenty thousand dollar ten-year term policy for a female aged thirty-five is

$$P(\bar{A}^{1}_{35:\overline{10}|}) = \frac{\$20{,}000\ \bar{A}^{1}_{35:\overline{10}|}}{\ddot{a}_{35:\overline{10}|}}$$

$$= \frac{\$20{,}000\ (0.01708)}{(7.45)}$$

$$= \$45.84 .$$

The net annual premium on a twenty thousand dollar ten-year term policy for a male aged thirty-five is

$$P(\bar{A}^{1}_{35:\overline{10}|}) = \frac{\$20{,}000\ \bar{A}^{1}_{35:\overline{10}|}}{\ddot{a}_{35:\overline{10}|}}$$

$$= \frac{\$20{,}000\ (0.02146)}{(7.44)}$$

$$= \$57.71 .$$

The male and female premiums once again show a remarkable difference. The premium for a male is almost twenty-six percent higher than that for a female. This difference is affected by nothing other than actual life experience.

Using the blended table which would be mandated under unisex legislation, the net annual premium for a twenty thousand dollar ten-year term policy for a person aged thirty-five is

$$P(\bar{A}^{1}_{35:\overline{10}|}) = \frac{\$20{,}000\ \bar{A}^{1}_{35:\overline{10}|}}{\ddot{a}_{35:\overline{10}|}}$$

$$= \frac{\$20{,}000\ (0.02059)}{(7.44)}$$

$$= \$55.34\,.$$

As in the case of whole life insurance, use of a blended table would overcharge females and undercharge males. The net annual premium for this policy for females would increase by over twenty percent and the premium for males would decrease by approximately four percent when an unisex table is used. Although the differences between the male, female and blended premiums for term insurance are not as large as for whole life, the differences are still there. These values continue to support the arguments of those opposing unisex insurance.

Pension Benefits:

Unisex legislation is already in effect in the area of pensions. In the case of *City of Los Angeles Water and Power vs. Manhart*, the Supreme Court outlawed the practice of requiring men and women to contribute different amounts to a pension plan in order to obtain the same coverage. Then, in the case of *Arizona Governing Committee vs. Norris* in 1983, the Supreme Court mandated the use of unisex tables in the calculation of pension benefits.

Before investigating the effects of using unisex tables for pension plans, the pension benefit must be calculated. As most pensions pay benefits on a monthly benefit,

let $\ddot{a}_x^{(12)}$ = the actuarial present value of the whole life annuity-due used to calculate monthly pension benefits for a person aged x.

Let B = the total value of the pension upon retirement.

Let $B_x^{(12)}$ = the monthly pension benefit for a person aged x.

The monthly pension benefit is simply the total value of the pension divided by the whole life annuity-due payable monthly, for an entire year.

$$B_x^{(12)} = \frac{B}{12\ddot{a}_x^{(12)}}.$$

The monthly benefit on a forty thousand dollar pension for a male aged fifty-five is

$$B_{55}^{(12)} = \frac{\$40,000}{12\ddot{a}_{55}^{(12)}}.$$

$$= \frac{\$40,000}{12(10.37)}$$

$$= \$321.34.$$

The monthly benefit on a forty thousand dollar pension for a female aged fifty-five is

$$B_{55}^{(12)} = \frac{\$40,000}{12\ddot{a}_{55}^{(12)}}$$

$$= \frac{\$40,000}{12(11.34)}$$

$$= \$294.06.$$

There is a significant difference between the male and female benefits. In the case of the pension, the female benefit is over nine percent smaller than the male benefit. Using the blended table,

$$B_{55}^{(12)} = \frac{\$40,000}{12\ddot{a}_{55}^{(12)}}$$

$$= \frac{\$40,000}{12(10.57)}$$

$$= \$315.40.$$

While using a unisex table improves the benefit to females by seven percent, it decreases the benefit to males by almost two percent.

As in the case of life insurance, the use of the unisex table is penalizing one group unfairly and giving the other group an advantage. However, in the case of the pension benefit, the male group is being penalized and the female group is being given an advantage.

Opinion

The actuarial calculations in this paper strongly support the arguments of those who oppose unisex rating. In life insurance, premiums for males decrease using a unisex table while premiums for females increase using the unisex table. In the case of pensions, the benefits for females increase using unisex annuities and the benefits for males decrease using unisex annuities.

This situation indicates that one gender subsidizes the other under unisex rating. Although females receive higher pension benefits when unisex rates are used, it could be considered unfair that males receive lower pension benefits. In the case of life insurance, many females may be upset to find that their premiums will rise drastically under unisex rating while premiums for males drop.

Frequently, proponents of unisex rating use the argument that gender is a characteristic which cannot be changed; therefore, a person should not be penalized for his or her gender. However, if unisex rating were to become mandated, this situation of penalizing an individual on the basis of gender would not only still exist, but it would become magnified. Under the current system using gender-based tables, the risk borne by each person due to his or her gender is fairly allocated. If unisex rating became the law, each person would be bearing his or her own risk as well as subsidizing the risk of an equally situated person of the opposite sex.

The system of unisex rating will not provide equality for all. Instead, it will discriminate unfairly against large segments of people in almost all lines of insurance. No unfair discrimination against women is taking place in the insurance industry. However, unisex rating would mandate unfair discrimination against both sexes. By saying unisex rating is right, proponents are saying it is fair to overcharge half of the insureds and undercharge the other half.

As the fight for unisex rating continues, the question arises about what the consumers know. However, there seems to be very little action on the part of unisex proponents to educate the consumers about the issue. They will be the ones directly affected by unisex rating, and they should be the ones to decide.

The fight for unisex rating may continue forever. Although they do not want unisex rating to go into effect, many companies view it as inevitable. If the mandating of unisex tables is inevitable, then the legislation should be federal rather than from the state. If unisex rating represents equality for the citizens of one state, it should represent equality for the citizens of the entire country.

Actuarially, unisex rating is not logical. It defers the risk one individual represents to another individual. Different groups will be overcharged while others are undercharged. However, if unisex rating represents equality, then this situation will exist. Whether supporting or opposing the unisex rating in insurance, it is obvious that in this case equality does have a price.

Age	v^x	Male l_x	Male $1000q_x$
0	1.00000000	371097	2.63
1	0.93457944	370121	1.03
2	0.87343873	369740	0.99
3	0.81629788	369374	0.97
4	0.76289618	369016	0.93
5	0.71298618	368673	0.88
6	0.66634222	368349	0.83
7	0.62274974	368043	0.78
8	0.58200910	367756	0.75
9	0.54393374	367480	0.74
10	0.50834929	367208	0.75
11	0.47509280	366933	0.81
12	0.44401196	366636	0.92
13	0.41496445	366299	1.07
14	0.38781724	365907	1.24
15	0.36244602	365453	1.42
16	0.33873460	364934	1.59
17	0.31657439	364354	1.72
18	0.29586392	363727	1.82
19	0.27650833	363065	1.88
20	0.25841900	362382	1.90
21	0.24151309	361693	1.90
22	0.22571317	361006	1.88
23	0.21094688	360327	1.84
24	0.19714662	359664	1.80
25	0.18424918	359017	1.75
26	0.17219549	358389	1.72
27	0.16093037	357773	1.71
28	0.15040221	357161	1.70
29	0.14056282	356554	1.72
30	0.13136712	355941	1.75
31	0.12277301	355318	1.80
32	0.11474113	354678	1.87
33	0.10723470	354015	1.95
34	0.10021934	353325	2.05
35	0.09366294	352601	2.17
36	0.08753546	351836	2.32
37	0.08180884	351020	2.49
38	0.07645686	350146	2.68
39	0.07145501	349208	2.90
40	0.06678038	348195	3.15
41	0.06241157	347098	3.42
42	0.05832857	345911	3.71
43	0.05451268	344628	4.03
44	0.05094643	343239	4.37
45	0.04761349	341739	4.73
46	0.04449859	340123	5.12
47	0.04158747	338382	5.53
48	0.03886679	336511	5.97
49	0.03632410	334502	6.46