SELECTION EFFECTS IN THE UNITED KINGDOM
INDIVIDUAL ANNUITIES MARKET

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ABSTRACT

This paper explores adverse selection in the voluntary and compulsory individual annuity markets in the United Kingdom. Two empirical regularities support standard models of adverse selection. First, annuitants are longer-lived than non-annuitants. These mortality differences are more pronounced in the voluntary than in the compulsory annuity market. We estimate that the amount of adverse selection in the compulsory market is about one half of that in the voluntary market. Second, the pricing of different types of annuity products within each annuity market is consistent with individuals selecting products based, in part, on private information about their mortality prospects.

The aging of populations in many developed nations has generated substantial interest in the way households finance consumption in their retirement years. Annuities, insurance products that provide a payment stream for as long as the insured individual is alive, offer one way to spread an accumulated stock of resources over a retirement period of uncertain length. Theoretical research beginning with Yaari (1965) suggests substantial utility gains from annuitization in the presence of stochastic length of life.

Public policy discussions have also generated substantial current interest in the operation of annuity markets. The decline in long-term interest rates in the United Kingdom since the early 1990s has coincided with a decline in annuity payouts, relative to annuity premia. This has sparked a debate, summarized in studies by McDonald (1999) and Orszag (2000), about the desirability of mandatory annuitization in defined contribution pension programs and about the terms on which annuitization should be required if it is mandated at all.

Annuity markets have attracted even broader attention as part of the global debate on social security reform. There are proposals in many nations to replace or supplement existing defined-benefit social security programs with defined contribution systems in which individuals would accumulate assets in individual accounts. In such systems, it is not clear how individuals would draw down their asset balances during retirement. Some proposals call for mandatory annuitization of account balances at retirement. Others would allow individuals to draw down their account balances in more flexible ways, either by choosing to purchase annuity products from private insurance firms or possibly by taking lump-sum distributions. The relative attractiveness of these various options depends critically on whether reasonably priced individual annuities are available in the private annuity market.

Most empirical research on annuities markets, with the notable exceptions of James and Vittas (1999) and Murthi, et al. (1999a,b), has focused on the United States. Friedman and Warshawsky (1988; 1990), Warshawsky (1988), and Mitchell, et al. (1999) emphasize the limited size of the US individual annuity market and the difference between premium charges and the expected present discounted value of annuity payments for a typical individual. This difference is partly due to adverse selection. Individuals

who choose to purchase annuities in private markets tend to live longer than those who do not buy annuities.

This paper presents new evidence on the nature and extent of adverse selection in the UK annuity market. This market, which is larger and more developed than the comparable markets in most other developed nations, provides an attractive research setting for two reasons. First, there is both a compulsory private annuity market for individuals in various pension schemes, and a voluntary private annuity market for those who wish to annuitize some of their non-pension savings. We can therefore compare selection effects in these two markets. Second, the rich array of annuity products in the UK market makes it possible to study selection both across product types and into the annuity market.

This paper is divided into six sections. The first describes the various margins along which selection can operate in an annuity market. Section two describes the institutional structure of the UK annuity market. The third section describes the framework that we use to examine the pricing of annuities and the data on mortality rates, discount factors, and annuity prices that form the basis of our empirical analysis.

Section four presents evidence of selection into annuity markets. We present both direct evidence of mortality differences among compulsory annuitants, voluntary annuitants, and those in the population at large, as well as indirect evidence based on annuity pricing. The evidence suggests substantially greater selection into the voluntary than into the compulsory market.

The fifth section presents evidence of selection effects across different types of annuities within both the voluntary and the compulsory annuity markets. The results are consistent with shorter-lived annuitants selecting products that make payments to the estate in the event of an early death. Additionally, longer-lived individuals appear to choose annuities with payouts that are back-loaded relative to the annuities chosen by shorter-lived individuals. The last section summarizes our major findings and discusses their implications.

1. Adverse Selection in Annuity Markets: Theoretical Overview

An annuity pays a specified amount to its policyholder for as long as he or she is alive. It thereby insures the annuitant against the risk of outliving his or her resources. From the perspective of an insurance company, a high-cost annuitant is one who is likely to live longer than average. As in other insurance markets, there may be asymmetric information between the insurer and the insured. Individuals may have private information about their life expectancy, for example based on their parents' mortality or their own health, which the insurance company does not have. Given the prices offered by an insurance company, individuals may then use their private information to choose whether or not to buy an annuity. They may also use this information to select which type of policy to purchase, conditional on purchase.

1.1 Selection Into and Within Annuity Markets

Longer-lived individuals have greater incentives to purchase annuities (at a given price) than shorter-lived individuals do, since an annuity's value is increasing in the length of time that an individual expects to be alive to receive annuity payments. Longer-lived individuals also have greater incentives to purchase certain types of annuities, since the value of some features of annuity contracts are also increasing in life expectancy. We investigate two such features.

First, we consider the time profile of annuity payouts. Annuities that promise an escalating nominal payout stream, or, in an economy with a positive inflation rate, a constant real payout stream, provide payments that are backloaded relative to those from a fixed nominal annuity. A backloaded annuity should therefore be more appealing to a person with a longer life expectancy than to a person with a shorter life expectancy because more of the backloaded annuity's payments occur in later years. This should lead longer-lived individuals to select into annuities with more backloaded payments.

Second, some annuities offer a guarantee period. If an annuity is guaranteed for a fixed number of years and the annuitant dies within this time period, then payments will be made to the annuitants' estate until the end of the guarantee period. The guarantee feature should be more attractive to someone who believes that he is likely to die soon than to someone who expects a long life. Within the set of annuity

buyers, one might therefore expect a negative correlation between longevity and the decision to select an annuity with a guarantee period.

Such adverse selection can occur only if there is asymmetric information. If the insurance company knew as much about each annuitant's expected longevity as the annuitant did, it could sell policies with individual-specific prices. Assuming perfect competition in the annuity market, and ignoring the cost of customizing policies, insurance companies could offer each individual a personalized menu of annuity products that generated the same expected return from the firm's perspective.

When annuity buyers know more about their mortality prospects than the insurance company does, the nature of market equilibrium is different. Insurance companies can still offer menus of different products, with different prices, but now each potential annuitant acts as a price taker. Annuity providers price their products so that on average, the return to the various annuity products will be the same. This return will depend, however, on the set of individuals who choose to purchase each type of annuity. In pricing a more backloaded annuity, for example, an insurance company will consider the average mortality experience of the set of annuitants who are likely to purchase this type of annuity. A potential annuitant with private information that he is likely to be long-lived will therefore have a greater incentive to purchase a backloaded annuity than one with more payouts in the near term.

1.2 Active vs. Passive Selection

Models of insurance market equilibrium tend to emphasize selection effects based on private information. This selection can take two forms. In one, which we label "active selection," individuals make annuity purchase decisions based in part on their knowledge of their prospective mortality. In the other, which we call "passive selection," demand for annuities is correlated with another factor, for example individual wealth, which is in turn correlated with prospective mortality. Unlike active selection, passive selection does not require that individuals have information about their prospective mortality.[1]

Passive selection in the annuity market could arise from the well-known negative relationship between socio-economic status and mortality.[2] We present some evidence on the contribution of active

and passive selection effects to the mortality differences among voluntary annuitants, compulsory annuitants, and the population at large. It is important to note that active and passive selection can have similar welfare implications. In the UK market, most firms do not collect any information on the annuitant beyond age and gender. Since the insurance company does not observe socio-economic status, then an individual of low socio-economic status who decides to purchase an annuity may not be able to obtain a policy with the high payout that his low socio-economic status should dictate.

2. The Structure of Annuity Markets in the United Kingdom

There are two annuity markets in the United Kingdom: a compulsory one, and a voluntary one. Individuals with defined contribution private pensions, which provide retirees with a lump sum at retirement that depends upon previous plan contributions, face compulsory annuitization requirements. These rules require the retiree to use at least part of the lump sum available at retirement to purchase an annuity. Annuities purchased in accordance with these requirements are "compulsory annuities." Voluntary annuities, in contrast, are purchased using non-pension wealth.

Defined contribution pension plans are available both through employers, in which case they are called occupational defined contribution plans, and through personal pension schemes. One reason for compulsory annuitization laws for defined contribution plans is that these plans may substitute for the State Earnings-Related Pension Scheme (SERPS), which serves as a second-tier system on top of the state flat rate pension. Since its inception in 1978, individuals have been able to "contract out" of SERPS if they have a defined benefit pension scheme with a minimum benefit level. The 1986 Social Security Act allowed individuals to contract out of SERPS into defined contribution pension plans as well, as long as these plans collected a specified minimum level of contributions. Individuals can therefore choose between retirement annuity coverage provided through SERPS, and coverage provided through a compulsory annuity purchased with the assets in a defined contribution plan. Even when defined contribution pension plans are not substitutes for SERPS, compulsory annuitization laws apply.

The compulsory annuity market is much larger than the voluntary market. The Association of British Insurers (1999) reports that in 1998, annual annuity payments to annuitants in the compulsory market totalled £5.4 billion. Annual payments to voluntary annuitants in 1998 were only £0.8 billion. The total amount paid to purchase new immediate annuities in 1998 was £6 billion, with voluntary annuities accounting for less than six percent of this total.

2.1 Adverse Selection Into Annuity Markets

There is greater scope for adverse selection into the voluntary than into the compulsory annuity market, since participants in the former have a choice of whether or not to annuitize their resources. Yet the institutional structure of the compulsory market permits some scope for selection. First, individuals choose to be in the compulsory annuity market when they choose a defined contribution occupational or personal pension plan. This choice may be influenced by the attractiveness of the compulsory annuity that the individual will eventually have to purchase.

Second, annuitants in the compulsory annuity market have some discretion in the amount that they annuitize and in timing their annuitization that may result in adverse selection.[3] For example, compulsory annuitants may take a tax-free lump sum in lieu of annuitizing some portion of their accumulated fund, although the amount of this lump sum is limited. A potential annuitant may also delay the purchase of their annuity after retirement until age 75 provided that he or she draws an income from the pension fund that is between 35% and 100% of the amount that would be obtained from a single life, nominal annuity. Shorter-lived individuals may find both these options more appealing than those who expect to be longer-lived.

2.2 Adverse Selection within Annuity Markets by Product Choice

In addition to selection into an annuity market, there may also be selection across different annuity products within an annuity market. Both compulsory and voluntary annuitants face a wide range of annuity choices, although compulsory annuitants may not choose an annuity guarantee period of more than ten years. We limit our study to annuities whose payment profile is specified at the time of purchase, as opposed to variable (or "unit-linked") annuities whose payout is linked to the performance of an

underlying pool of investment assets. We focus on single life annuities, which involve only one

purchaser, rather than joint and survivor life annuities purchased by couples. Our empirical work

considers selection by guarantee period and by time profile of payments. A large number of firms in both

the compulsory and the voluntary market offer annuities with no guarantee period, as well as products

with five-year and ten-year guarantee periods.

The UK annuity market also offers a rich variety of time profiles of annuity payments.

Individuals may purchase a nominal annuity, which pays a constant nominal payout each period, or an

escalating annuity whose nominal payout rises annually by a fixed percentage. Escalation rates of one,

three, and five percent per year are commonly available. Annuitants may also purchase an "inflation-

indexed" or real annuity whose nominal payout is adjusted each year by the percentage change in the

Retail Price Index (RPI). There are no floors or ceilings on the adjustments to the annuity payment that

can occur with RPI-linked products. In addition to insurance against outliving one's resources, an

inflation-indexed annuity also provides insurance against fluctuations in the aggregate price level.

We examine the pricing of nominal annuities, real annuities, and annuities that escalate (in

nominal terms) at five percent per year. Data from the term structure of both index-linked and nominal

government bonds suggests that long-term expected inflation in the UNITED KINGDOM is well below

five percent per year. Annuities with payouts that rise at five percent per year are therefore expected to

offer a rising real payout stream.

While real and escalating annuities are widely available, Murthi, et al. (1999a) report that the vast

majority of single premium, non-variable annuities are nominal annuities. Escalating annuities comprise

less than five percent of the annuities sold, and real annuities only about two percent.[4] Nevertheless, we

do know that these annuities are widely available. We have identified at least eleven insurance

companies that offer inflation-indexed products in the compulsory market, and three that inflation-

indexed products in the voluntary market.[5]

3. Evaluating the Money's Worth of Various Annuity Products

We present two types of evidence that bear on selection into and within annuity markets. First, we present direct evidence on mortality differences between compulsory annuitants, voluntary annuitants and the general UK population. We are not aware of any annuitant mortality tables that are product-specific. In Finkelstein and Poterba (2000), however, we use data from individual annuity purchases to show that there are mortality differentials across the individuals who buy different products.

Second, we examine the pricing of different annuity policies.[6] The price of an annuity is measured as the difference between the actuarially fair payout, and the actual payout, from the annuity. A standard approach to quantifying this difference, described in Mitchell, et al. (1999), is to calculate the expected present discounted value (EPDV) of annuity payments and to compare this with the annuity premium paid. The ratio of EPDV to the annuity premium is the "money's worth."

The money's worth serves two purposes. First, it can be used to infer mortality differences across different groups of annuitants. We compare money's worth estimates for different annuity products. If administrative costs, profit rates, and other similar factors are constant across the markets for different annuity products, then the difference in money's worth values calculated with a given mortality table should reflect differences in adverse selection. If product A has a lower money's worth than product B when evaluated with a given mortality table, we infer that A is purchased by individuals who are "more adversely selected" than those who purchase B.

Second, provided an annuitant mortality table is available, the money's worth ratio can be used to evaluate a given annuity both from the perspective of a typical buyer of that annuity, and from the perspective of a typical individual in the population at large. The former provides a measure of the return received by individuals who purchase annuities. The latter asks the counterfactual question, "What would the return on an annuity be from the standpoint of a typical individual in the UK population?" This question can be asked separately for annuities offered in the voluntary and the compulsory markets. Of course, as our mortality data suggest, the typical annuitant is not selected randomly from the UK

population. Nevertheless, money's worth calculations based on population mortality tables can provide a quantitative measure of the extent of this selection in various annuity markets.

We use the difference between a given annuity's money's worth calculated using the population mortality table, and the same annuity's money's worth calculated using the product-specific mortality table, as a yardstick for measuring adverse selection. While money's worth calculations using the population mortality table do not describe the return on annuities for any set of current annuity buyers, they do provide insight on the attractiveness of annuities for individuals who face the average mortality rates of the population at large.

3.1. The Basic Framework

The EPDV of monthly, single life, annuity payments for various products are given below:

$$EPDV_{NOM} = \sum_{t=1}^{T} \frac{A_{NOM} * S_t}{\Pi_{j=1}^{t}(1+i_j)}. \tag{1}$$

$$EPDV_{REAL} = \sum_{t=1}^{T} \frac{A_{REAL} * S_t}{\Pi_{j=1}^{t}(1+r_j)}. \tag{2}$$

$$EPDV_{5\%ESC} = \sum_{t=1}^{T} \frac{A_{5\%ESC} * (1.05)^{t/12} * S_t}{\Pi_{j=1}^{t}(1+i_j)}. \tag{3}$$

$$EPDV_{Nom,5yrguarantee} = \sum_{t=1}^{60} \frac{A_{NOM}}{\Pi_{j=1}^{t}(1+i_j)} + \sum_{t=61}^{T} \frac{A_{NOM} * S_t}{\Pi_{j=1}^{t}(1+i_j)}. \tag{4}$$

In these expressions A denotes the monthly payout of the specified product, and S_t denotes the probability that the annuitant survives until period t. The payouts A_{NOM} and $A_{5\%ESC}$ are nominal payouts, while A_{REAL} is a real payout. Escalating and inflation-linked payouts are typically adjusted every twelve months. We use two sets of interest rates: i_j denotes the expected one-month nominal interest rate and

r_j denotes the expected one-month real interest rate in time period j. The EPDV for the five year guaranteed annuity recognizes that this annuity pays out for the first 60 months regardless of the annuitant's survival.

Money's worth, the EPDV/Premium ratio would be unity if the annuity were actuarially fair. Values below one can be attributed to a variety of factors, including adverse selection, administrative costs, and taxes on the insurance companies offering annuities. Even when the money's worth ratio is less than unity, buying an annuity can still increase the utility for a risk averse individual with an unknown lifetime. Mitchell, et al. (1999) present numerical simulations that illustrate this.

If the EPDV is calculated using the population mortality table, but annuitants are longer lived than average and insurance companies set annuity payouts accordingly, then the EPDV will fall below the premium cost of the annuity. Calculations of EPDV using annuitant mortality tables should result in money's worth values closer to unity than calculations using the population mortality table. Even using an annuitant mortality table, however, the money's worth may not be unity because of the other costs noted above.

3.2. Mortality and Interest Rates

Equations (1)-(4) indicate that calculating the EPDV of an annuity requires information on the term structure of real and nominal interest rates, the probability that an annuitant will survive to various ages, and the annuity payments for different products. For the term structure, we use the zero coupon yield curve of nominal and index-linked Treasury securities. With respect to interest rates, we have data on semi-annual yields for maturities up to 25 years. We convert these to monthly spot rates, assume that the spot rate for 25 years forward applies at all dates beyond the 25-year horizon, and use interest rate data for the week in which our data on annuity prices was collected.[7] We follow a number of earlier studies in using riskless interest rates to discount annuity payouts.[8] If we used a term structure corresponding to risky interest rates, the money's worth of the various annuity products would be lower than our calculations suggest.

We use five different cohort mortality tables which describe the mortality experience of a given birth cohort as it reaches different ages. All of these tables are published separately for men and women. First, we use the Government Actuary's Department's (GAD) official mortality tables for the UK

population. We use the most recent (1996) population period tables and the GAD's age and gender specific projections of mortality improvements to form cohort mortality tables for 1998.

We also use four mortality tables that reflect the mortality experience and projected mortality improvements of voluntary and compulsory annuitants. These data, compiled by the Institute of Actuaries' Continuous Mortality Investigation Bureau, are based on the empirical mortality experience of annuitants and the Institute of Actuaries' (1999b) age and gender specific mortality improvement projections. These tables correspond to the mortality experience of voluntary annuitants and of a group of pensioners whose mortality experience we use as a proxy for that of compulsory annuitants.

For each annuity market, we use information from two different sets of annuitant mortality tables. One estimates annuitant mortality curves by weighting the mortality experience of annuitant equally. The other estimates the mortality experience of annuitants by weighting each annuity buyer by the amount of their annuity purchase. The Institute of Actuaries refers to these, respectively, as "lives-weighted" and "amounts-weighted" mortality tables. Those who buy larger annuities tend to live longer than those who buy smaller annuities. We use these different mortality tables to explore the relative roles of active and passive selection in annuity markets.

We use the most recent available information on annuitant mortality. The voluntary annuitant tables are based on the mortality experience of individuals in the voluntary market between 1991 and 1994.[9] The table that we use for compulsory annuitants, the PF/PF '92 series published by the Institute of Actuaries (1999a), is based on the mortality experience of "life office pensioners" (individuals in insured occupational pension schemes) between 1991 and 1994. Whether life office pensioners are representative of compulsory annuitants is not clear. The compulsory annuity market is comprised of individuals in occupational defined contribution plans as well as those with personal pensions. The Association of British Insurers (1999) reports that in 1998, two-thirds of these payments went to individuals who had participated in occupational defined contribution plans, while one-third were to individuals who had personal pensions or Section 226 retirement annuities. In contrast, the vast majority

of life office pensioners are in defined benefit pension schemes. Life office pensioners are also likely to

be disproportionately from small firms, as larger firms are more likely to self-insure.

In spite of these differences, the same sort of selection effects, such as the opportunity to defer

annuitization and to draw down some of their account balance in the form of a lump sum payout rather

than an annuity, are likely to operate for both defined contribution life office pensioners and other

compulsory annuitants. Moreover, the fact that individuals can transfer money from both defined benefit

and defined contribution occupational pensions to personal pensions may homogenize the defined benefit

pensioners and the defined contribution pensioners. Ultimately, in the absence of better information, we

apply the life office pensioner mortality table to the compulsory annuity market.[10]

3.3 Annuity Prices

The final input that we need for the calculations in equations (1)-(4) is data on the payments

offered by different annuity products. We contacted several annuity brokers who supply potential annuity

buyers with information on the rates offered on various annuity products by different life insurance

companies. The brokers provide rates that vary by age, gender, type of product (nominal, real or

escalating), market type (compulsory or voluntary), premium amount, frequency of payments, guarantee

period, and degree of survivor benefits. Conversations with several annuity providers indicated that there

are no other characteristics of an annuitant that would be used in setting the annuity rate, although some

companies offer special rates to individuals likely to be in poor health, such as smokers. The set of firms

identified by these different brokers is similar. Moreover, we confirmed that our pricing data set, from

the annuity broker "Moneyfacts," lists rates for all of the top annuity providers. Annuity premiums are

not regulated, and there are no restrictions on how they can vary by age, gender, or product type.

Table 1 presents summary statistics on the average initial annual payments for different annuity

products that are available in the compulsory and the voluntary annuity markets. The table shows that

initial payments are higher for annuities with nominal payouts than for those with real payouts, and higher

for real products than for escalating products. The table also indicates that average payments for all

products are higher in the compulsory than in the voluntary market, which is consistent with greater

adverse selection in the voluntary market. Average payments are also higher for men than for women, reflecting the greater life expectancy for women and the correspondingly longer time over which the insurer expects to make annuity payments. The average payments shown in Table 1 mask substantial variation across firms in the rates offered for a given product-market-gender-age-cell.

The set of insurance companies offering a given annuity product differs across products, so differences in money's worth values across markets or across products within a market could be driven simply by differences in the set of firms offering different products.[11] In some of our subsequent calculations, to ensure comparability, we limit our attention to the prices of products offered by insurers who are active in all relevant annuity markets.

4.   Evidence of Selection into Annuity Markets

We consider two types of evidence for the degree of adverse selection in the annuity market. The first involves comparison of mortality rates for individuals in different annuity markets, and in the population at large. The second considers the relative prices charged in different annuity markets. This section presents both types of evidence, and then considers the role of active versus passive selection in generating our findings.

4.1 Annuitant Mortality Tables

The Institute of Actuaries' mortality tables for voluntary and compulsory annuitants provide direct evidence of mortality differences among these two groups and the general population. Fig. 1 shows the probability that a 65-year-old man will survive to various ages if he faces the mortality rates for the population at large, those for compulsory annuitants, and those for voluntary annuitants. The average 65-year-old male compulsory annuitant has a higher survival probability at all ages than an individual who faces the mortality rates for the population at large. The average 65 year old male voluntary annuitant has a still higher survival probability at all ages. To illustrate this, consider the probability of surviving from age 65 to age 82. For the average 65-year-old man, this probability is 41%. For the average 65-year-old

male compulsory annuitant it is 48%, and for the average 65-year-old voluntary annuitant, this probability is 56%. Mortality rates for women show a similar pattern.

It is interesting to consider the extent to which these mortality differences are driven by socio-economic, or passive, selection rather than active selection. Data on mortality rates for individuals in six social classes based on occupation suggest that mortality rates are lower for those in higher status occupations.[12] These patterns are relevant for the annuity market because annuitants as a group are of higher socio-economic status than non-annuitants along several dimensions. Banks and Emmerson (1999) illustrate this using data from the Family Resources Survey. While they caution that strong conclusions are difficult in light of their limited sample size, they find that individuals who have purchased an annuity tend to have more education, more financial assets, and are more likely to own their home than those without an annuity. The evidence on differences between voluntary and compulsory annuitants is less clear. For example, the median household income of voluntary annuitants is higher than that of compulsory annuitants (£301.5 per week, versus £283.5 per week). The proportion of compulsory annuitants in the highest financial assets category (£20,000 and above), however, is virtually identical (58.7%) to the proportion of voluntary annuitants in this category (61.0%). These results suggest that passive selection may contribute to mortality differences between the compulsory and voluntary markets.[13]

We can also compare mortality tables weighted by lives and by amounts to consider the role of socio-economic factors in explaining mortality differences. Fig. 2 shows the cumulative survival probabilities for a 65 year old male in the voluntary and in the compulsory market, using aggregate mortality tables that weight annuitants both by lives and by amounts. The figure illustrates that, in both markets, the survival probability is higher when mortality is weighted by amounts rather than by lives. This presumably reflects the fact that wealthier individuals (who have higher survival probabilities) purchase larger annuities than less wealthy individuals. The figure also indicates that the differences in the survival probabilities based on weighting by lives and by amounts are more pronounced in the compulsory market than in the voluntary market.

4.2 Money's Worth in Compulsory and Voluntary Markets

Table 2 presents money's worth values computed using mortality tables for both the population at large and for the annuity purchasers in each market.[14] We present results for a sample of firms that offer both nominal and escalating annuities in both the compulsory and the voluntary market. The table suggests several conclusions. First, money's worth values almost always decline with age. This pattern is consistent with the amount of private information about mortality risk rising as an individual ages. Second, there is no clear pattern of relative money's worth values for men and for women. Since insurance companies price annuities conditional on gender, the similarity of the money's worth values for men and women suggests that degree of private mortality information is similar for men and women.

Third, the average compulsory annuitant receives a money's worth for a compulsory annuity product that is similar to that which an average voluntary annuitant receives for a voluntary annuity product. We focus on comparisons that use mortality tables weighted by lives; it is possible to do a parallel calculation using amount-weighted mortality tables. The comparison of columns two and four shows that for a 65 year old male voluntary annuitant, a nominal annuity has a money's worth of 0.988, while for a 65 year old female buying a voluntary nominal annuity, the money's worth is 0.939.   In the compulsory market, the comparable money's worth values are 0.962 (men) and 0.945 (women).   These money's worth calculations using annuity-market-specific mortality tables indicate that differences in the money's worth values between the compulsory and voluntary markets when the two are evaluated using a common mortality table, such as the population mortality table, are largely the result of mortality differences between the two groups of annuitants.

Fourth, Table 2 allows us to compare the money's worth for a typical annuitant with that for a typical individual in the population, if such an individual were to purchase an annuity. In the voluntary annuity market, the money's worth ratio of a nominal annuity for a 65-year-old man facing the population average mortality rate is 0.865. Poterba and Warshawsky (2000) present comparable calculations for nominal annuities offered in the United States and find a money's worth ratio of 0.850. The data in Table 2 show that for the UK annuity market, the difference between the money's worth results using population

and annuitant mortality are more dramatic in the voluntary annuity market than in the compulsory market. A 65 year old male annuitant who faces the voluntary annuitant lives-weighted mortality table receives a 14.2% higher money's worth on a nominal product, and a 20.9% higher money's worth on an escalating product, than a 65 year old male who faces the mortality risk for the population at large.

The first two columns of Table 2 suggest that in the compulsory market, a 65 year old male who faces the average lives-weighted compulsory annuitant mortality rates receives a 6.9% higher money's worth on a nominal product (0.962/0.900 = 1.069) and a 10.0% higher money's worth on an escalating product (0.944/0.858 = 1.100) than a 65 year old male with the average mortality prospects for the population at large. The difference between the value of the compulsory annuity to a typical compulsory annuitant and the value of this product for a typical member of the population increases slightly with age and is smaller for women than for men. This pattern also emerges in the voluntary market.

Table 3 uses the estimates of the money's worth values in Table 2 to summarize the degree of adverse selection in the compulsory market relative to that in the voluntary market. The measure we report is the ratio of the difference in money's worth for a typical annuitant and a typical individual, calculated for the compulsory market relative to the voluntary market. The results show that, on average, the amount of adverse selection in the compulsory market is only half of that in the voluntary market. This is true for both nominal and escalating annuity products.

Another way to make comparisons like those in Table 3 is to ask what portion of the cost of the annuity for a typical individual from the UK population, measured as the deviation of money's worth from one, is attributable to mortality differences between the general population and the annuitant population.[15] In the voluntary market, about 90% of the divergence between the present discounted value of the annuity payouts computed using the male population mortality table, and unity, is attributable to differences between the mortality experience of voluntary annuitants and the population at large. In the compulsory market, only about 55% of this divergence for men is attributable to mortality differences. In both the voluntary and compulsory markets, the share of this divergence that is due to mortality differences is lower for women than for men.

4.3 Selection by Size of Policy

Our discussion of Table 2 thus far has focused on money's worth calculations that use lives-weighted mortality tables for annuitants. The table also shows, in columns three and six, that the money's worth computed using a mortality table that weights the mortality risk of each annuitant by the amount of annuity premium paid by that annuitant is even higher than the money's worth computed using a lives-weighted mortality table. This is clear from a comparison of columns two and three, and columns five and six, of Table 2. In the voluntary market, for example, the "lives-weighted" mortality table implies a money's worth of 0.988 for a 65-year-old man purchasing a nominal annuity, while the "amounts-weighted" mortality table yields a money's worth of 0.999. For a 65-year-old woman, the analogous values are 0.939 and 0.960. These patterns imply that the mortality risk for annuitants who buy larger annuity policies is lower than that for annuitants who purchase smaller annuities. This is consistent with active selection, with individuals with longer life expectancies purchasing larger annuities, as well as with "passive selection" based on wealth and socio-economic status. Since mortality risk is inversely related to socio-economic status, this could explain the differential mortality rates in the "lives" versus "amounts" weighted annuitant mortality tables.

If either active or passive selection occurs in the annuity market, then at a given annuity price, longer-lived individuals could choose to annuitize more of their wealth. This implies that money's worth calculated from a common mortality table should decrease with premium size. In the presence of fixed costs for each annuity policy, such as the administrative cost of setting up an annuity, however, it could still be possible for the average cost of insurance, which corresponds to the money's worth values that we report, to rise as a function of policy size. Moreover, even if these fixed cost considerations did not dominate size-related selection effects, insurers might not be able to offer less attractive terms on annuities with larger premiums than on annuities with smaller premiums. If large annuities cost more per unit of payout than smaller annuities, annuity buyers could always purchase several smaller annuities rather than one large one.[16]

Table 4 compares the money's worth of nominal, compulsory annuity products with £10,000, £50,000 and £100,000 premia.[17] (Results are similar for real and escalating annuities.) There is a consistent pattern across ages for both men and women. The money's worth is higher for annuities with £50,000 and £100,000 premia than for those with £10,000 premia, although it is slightly lower for policies with £100,000 premia than £50,000 premia.   The difference between the money's worth values for these large policies is small, however, compared to the difference between these policies and smaller policies. These results could be explained if the administrative cost savings from £50,000 and £100,000 premia outweigh any selection effects associated with larger policies. These findings are consistent with Cawley and Philipson's (1999) finding of "bulk discounts" in the US life insurance market.

5. Selection Among Product Types Within Annuity Markets

The foregoing calculations suggest that there is more adverse selection into the voluntary market than into the compulsory market. We now turn to selection across product type within an annuity market. We consider two characteristics along which selection may occur: the length of the guarantee period and the tilt of the annuity payment profile. We compare the money's worth of annuities with different guarantee periods and of annuities with different payment profiles. All of the calculations we report use population mortality tables, but similar findings emerge when annuitant mortality tables are used instead.

Table 5 compares the money's worth of annuities that offer no guarantee period, a five year guarantee period and a ten year guarantee period. The table shows that money's worth increases systematically with the length of the guarantee period. This is consistent with individuals having private information about their mortality, and shorter-lived individuals self-selecting into annuities with longer guarantee periods than longer-lived individuals. This pattern holds across all ages and for both men and women. It appears in both the compulsory and the voluntary market.

Table 6 compares the money's worth of nominal, real and escalating annuities in the compulsory market and in the voluntary market for the set of insurance companies that offer all three products in each market.[18] In both markets, across all ages and for both men and women, there is a consistent pattern of

lower money's worth values for escalating annuities than for nominal annuities, and lower values still for real annuities. Our theory of selection among annuities with different payout profiles is consistent with the finding that the money's worth of escalating annuities is lower than that of nominal annuities and that the money's worth of real annuities is lower than that of nominal annuities. But if selection among product types is based on the time-profile of annuity payments, with longer-lived potential annuitants choosing policies with more backloaded payouts, we would also expect that the money's worth of 5% escalating annuities would be below that of real annuities. However, the results in Table 6 do not support this prediction.

There are several possible explanations for this inconsistency. First, there may be a mismatch between the underlying investment portfolio and the liabilities of annuity companies that is larger for index-linked than for other annuities. Insurance companies appear to back their inflation-indexed annuities with inflation-indexed government bonds, and their nominal annuities with nominal corporate and government bonds. The absence of index-linked <u>corporate</u> bonds that pay a higher yield than similar government bonds may mean that insurance companies earn a lower return on the assets that they use to back inflation-indexed annuities.[19] This could translate into lower money's worth for these products.

Second, the brief lags in the adjustment of the price of index-linked bonds in the United Kingdom to changes in the price level require insurers to bear some inflation risk when they offer inflation-linked products. They may charge for this risk by offering less attractive terms on inflation-indexed annuities.

Third, it is possible that risk averse individuals are willing to pay a higher risk premium for a real product than for a nominal or an escalating product since the former provides inflation insurance in addition to longevity insurance. If insurance companies have some market power, the higher risk premium that they are able to charge for real annuities could explain the lower money's worth for real versus escalating annuities.

6. Conclusions

Our findings provide new evidence on the functioning of private annuity markets. The rich structure of the UK annuity market, with both a range of different policy types and a substantial pool of compulsory as well as voluntary annuity buyers, provides a valuable opportunity to explore issues that cannot be studied in many other annuity markets. Our analysis suggests several conclusions.

First, from the standpoint of an average person in the population, the amount of selection in the voluntary annuity market is substantial. Adverse selection explains roughly ninety percent of the difference between the actual payouts associated with voluntary annuities and the payouts that would be available if these products offered payouts that equated the premium cost and the expected value of future payouts for a randomly chosen person in the population. Adverse selection appears greater in the UK voluntary annuity market than in some other annuity markets. Brown, et al. (2000), for example, find that roughly half of the cost of purchasing an annuity in the US annuity market can be attributed to adverse selection.

Second, our results suggest that adverse selection in compulsory annuity markets is substantially less important than adverse selection in voluntary annuity markets. We estimate that the amount of adverse selection in the compulsory annuity market is only half of that in the voluntary annuity market.

Third, we investigate the role of socio-economic factors in explaining mortality differences among voluntary annuitants, compulsory annuitants, and the general population. The available evidence suggests that socio-economic differences may play an important role in explaining mortality patterns. The relative role of active selection, based on private knowledge of mortality risk, and passive selection, based on individual attributes that are correlated with mortality risk, is not relevant to assessing the efficiency costs of current selection. However, active and passive selection effects may have very different implications for the *future* operation of annuity markets. Socio-economic factors can *in principle* be observed by the insurance company. If companies collected such information and priced policies accordingly, passive selection effects could be ameliorated. Indeed, quite recently, there has been some stratification in the annuities market, with some firms now offering discounted annuity prices for

smokers and those from high-mortality regions, but these firms represent a very small share of the annuity market.[20] While such stratification may reduce selection effects, it may also limit the extent to which individuals can insure longevity risk in the annuity market.

One reason that annuity companies do not collect information on socio-economic status, despite the fact that it is a strong predictor of mortality, may be the costs of acquiring and verifying it. Another may be that the purchase price of the annuity provides indirect evidence of the buyer's socio-economic status, although there is mixed evidence on the value of this information. The factors that affect insurance company decisions about what information to collect about annuitants warrant further exploration.

Fourth, our results highlight the scope for selection across different product types, even in a compulsory annuity market. We find that money's worth increases with the length of the guarantee period. We also find that the money's worth for an annuity product with a rising nominal payout stream or an inflation-index payout stream is lower than that for a level nominal product. These results, in both the voluntary and compulsory market, suggest the presence of adverse selection within each annuity markets.   We explore this type of selection further in Finkelstein and Poterba (2000).

Our results on the operation of annuity markets have implications for two broad issues. One is the general analysis of insurance markets. The extent to which models of adverse selection, such as that developed by Rothschild and Stiglitz (1976), explain the functioning of actual insurance markets is an open question. Chiappori and Salanie (2000) find little evidence of adverse selection in the French auto insurance market, while Cutler and Reber (1998) report clear evidence of selection effects in the health insurance market. These studies also reference a number of earlier investigations of adverse selection in various insurance markets. Our findings support the potential importance of adverse selection, and they also suggest that selection can operate on several margins within an insurance market.

A second broad issue that our findings inform concerns the design of publicly-mandated retirement saving systems. With a defined contribution system, such as the systems being suggested in social security reform debates in many nations, the government must decide whether to require annuitization upon retirement. Our analysis suggests that voluntary annuity markets exhibit adverse

selection, and that even a relatively flexible mandatory annuitization system can substantially reduce this cost.

References

Abel, A.B. (1986). 'Capital accumulation and uncertain lifetimes with adverse selection.' *Econometrica*, vol. 54, no. 5, (September), pp. 1079-1097.

Association of British Insurers. (1999). *Insurance Statistics Year Book: 1986-1998*. London: Association of British Insurers.

Attanasio, O. and Emmerson, C. (1999). *Differential Mortality*. Institute for Fiscal Studies.

Attanasio, O. and Hoynes, H. (2000). 'Differential mortality and wealth accumulation.' *Journal of Human Resources*, vol. 35, no. 1, pp. 1-29.

Banks, J. and Emmerson, C. (1999). *UK Annuitants.* Institute for Fiscal Studies, Briefing Note No. 5. http://www.ifs.org.uk/publications/briefnotes.shtml

Blake, D. (1995). *Pension Schemes and Pension Funds in the United Kingdom.* Oxford: Clarendon Press.

Brown, J.R., Mitchell, O.S. and Poterba, J.M. (2000). 'The role of real annuities and indexed bonds in an individual accounts retirement program.' In *Risk Aspects of Social Security Reform* (eds. J. Campbell and M. Feldstein), pp. 321-360. Chicago: University of Chicago Press.

Brown, J.R. and Poterba, J.M. (2000). 'Joint life annuities and annuity demand by married couples.' *Journal of Risk and Insurance*, vol. 67, no. 4, (December), pp.527-554.

Brugiavini, A. (1993). 'Uncertainty resolution and the timing of annuity purchases.' *Journal of Public Economics*, vol. 50, no. 1, pp. 31-62.

Budd, A. and Campbell, N. (1998). 'The roles of the public and private sectors in the U.K. pension system.' In *Privatizing Social Security* (ed. M. Feldstein), pp.99-127. Chicago: University of Chicago Press.

Cawley, J. and Philipson, T. (1999). 'An empirical examination of information barriers to trade in insurance.' *American Economic Review*, vol. 84, no. 4, pp. 827-846.

Chiappori, P. and Salanie, B. (2000). 'Testing for asymmetric information in insurance markets.' *Journal of Political Economy*, vol. 108 (February), pp. 56-78.

Cutler, D. and Reber, S. (1998). 'Paying for health insurance: The tradeoff between competition and adverse selection.' *Quarterly Journal of Economics*, vol. 108 (May), pp. 433-466.

Disney, R, Johnson, P. and Stears, G. (1998). 'Asset wealth and asset decumulation among households in the retirement survey.' *Fiscal Studies*, vol. 19, no. 2, pp. 153-174.

Finkelstein, A. and Poterba, J.M. (2000). 'Adverse selection in insurance markets: Policyholder evidence from the U.K. annuity market.' *NBER Working Paper* 8045.

Friedman, B. and Warshawsky, M. (1988). 'Annuity prices and saving behavior in the United States.' In *Pensions in the U.S. Economy* (eds. Z. Bodie, J. Shoven, and D. Wise), pp.53-77. Chicago: University of Chicago Press.

Friedman, B. and Warshawsky, M. (1990). 'The cost of annuities: Implications for saving behavior and bequests.' *Quarterly Journal of Economics*, vol. 105, no. 1, (February), pp. 135-154.

Hamermesh, D. (1985). 'Expectations, life expectancy, and economic behavior.' *Quarterly Journal of Economics*, vol. 100, no. 2, (May), pp. 389-408.

Hurd, M. and McGarry, K. (1997).'The predictive validity of subjective probabilities of survival.' *NBER Working Paper* 6193.

Institute of Actuaries and Faculty of Actuaries, Continuous Mortality Investigation Committee. (1999a). *Continuous Mortality Investigation Reports*, Number 16.

Institute of Actuaries and Faculty of Actuaries, Continuous Mortality Investigation Committee. (1999b). Continuous Mortality Investigation Reports, Number 17.

James, E. and Vittas, D. (1999). *Annuities Markets in Comparative Perspective*. Working Paper, World Bank, Washington D.C.

McDonald, O. (1999). *Income in Retirement: Are Annuities the Answer?* London: Association of Unit Trusts and Investment Funds.

Mitchell, O.S., Poterba, J.M., Warshawsky, M. and Brown, J.R. (1999). 'New evidence on the money's worth of individual annuities.' *American Economic Review*, vol. 89, no. 5, pp. 1299-1318.

Murthi, M., Orszag, J.M. and Orszag, P. (1999a). 'The charge ratio on individual accounts: Lessons from the U.K. experience.' Birkbeck College, University of London Working Paper 99-2.

Murthi, M., Orszag, J.M. and Orszag, P. (1999b). 'The value for money of annuities in the U.K.: Theory, experience, and policy.' Birkbeck College, University of London Working Paper.

Office for National Statistics. (1997). *Health Inequalities.* London: The Stationary Office Limited.

Office for National Statistics. (1998).*Living in Britain: Results from the 1996 General Household Survey.* London: The Stationary Office Limited.

Orszag, J.M. (2000). *Annuities: The Problems*. Birkbeck College, University of London Working Paper.

Poterba, J.M. and Warshawsky, M. (2000). 'The costs of annuitizing retirement payouts from individual accounts.' In *Administrative Aspects of Social Security Reform* (ed. J. Shoven). Chicago: University of Chicago Press.

Rothschild, M. and Stiglitz, J. (1976). 'An essay on the economics of imperfect information.' *Quarterly Journal of Economics*, vol. 90, no. 4, (November), pp. 629-649.

Warshawsky, M. (1988). 'Private annuity markets in the United States: 1919-1984.' *Journal of Risk and Insurance*, vol. 55, no. 3, pp. 518-528.

Yaari, M. (1965). 'Uncertain lifetime, life insurance, and the theory of the consumer.' *Review of Economic Studies*, vol. 32, no 2, pp. 137-150.

Table 1: Average Annual Annuity Payments for Annuities with £10,000 Purchase Price

	Compulsory Market			Voluntary Market		
	Nominal	Real	5% Escalating	Nominal	Real	5% Escalating
Male 65	879.7	658.6	550.2	844.4	636.7	522.9
Male 70	1036.1	813.0	703.7	992.8	780.3	670.4
Male 75	1252.5	1031.5	915.9	1198.5	980.3	871.3
Female 65	768.5	553.6	445.4	727.6	533.7	420.3
Female 70	885.2	671.1	560.8	843.5	650.3	532.1
Female 75	1056.4	839.2	727.9	1007.9	817.0	690.0

Notes: Data are provided from Moneyfacts for November 6, 1998. All products are single premium immediate annuities with no guarantee period. Compulsory annuity rates are based on a product that pays monthly in advance; voluntary annuity rates are quoted based on products that pay monthly in arrears.

Table 2: The Effect of Different Mortality Tables on the Money's Worth of Compulsory and Voluntary Annuities

	Compulsory Market			Voluntary Market		
Annuity Type	Population Table	Compulsory Annuitant Table ("Lives")	Compulsory Annuitant Table ("Amounts")	Population Table	Voluntary Annuitant Table ("Lives")	Voluntary Annuitant Table ("Amounts")
			NOMINAL ANNUITIES			
Male, 65 Year Old	0.900	0.962	1.020	0.865	0.988	0.999
Male, 70 Year Old	0.872	0.945	1.005	0.837	0.986	1.00
Male, 75 Year Old	0.839	0.921	0.976	0.808	0.980	0.996
Female, 65 Year Old	0.904	0.945	0.976	0.853	0.939	0.960
Female, 70 Year Old	0.877	0.933	0.972	0.833	0.942	0.961
Female, 75 Year Old	0.859	0.923	0.971	0.819	0.937	0.950
			5% ESCALATING ANNUITIES			
Male, 65 Year Old	0.858	0.944	1.021	0.804	0.972	0.990
Male, 70 Year Old	0.829	0.924	0.999	0.786	0.977	0.997
Male, 75 Year Old	0.796	0.898	0.964	0.760	0.967	0.989
Female, 65 Year Old	0.859	0.920	0.972	0.793	0.911	0.935
Female, 70 Year Old	0.829	0.908	0.968	0.776	0.915	0.937
Female, 75 Year Old	0.813	0.899	0.968	0.768	0.911	0.924

Notes: Money's Worth calculations are based on average payments in sample of 9 firms that offer compulsory and voluntary nominal and 5% escalating products. See text for further discussion.

Table 3: Degree of Adverse Selection in Compulsory Annuity Market Compared to Degree of Adverse Selection in Voluntary Annuity Market

	Nominal annuity	5% escalating annuity
65 year old man	50.4 %	51.2 %
65 year old woman	47.7	51.7
70 year old man	49.0	49.7
70 year old woman	51.4	56.8
75 year old man	47.7	49.3
75 year old woman	54.2	60.1

Notes: Each entry corresponds to $(MW_{\text{compulsory annuitant table, compulsory market}} - MW_{\text{population mortality table, compulsory market}}) / (MW_{\text{voluntary annuitant table, voluntary market}} - MW_{\text{population mortality table, voluntary market}})$. The money's worth calculations that underlie these calculations are reported in Table 2.

Table 4: Comparison of Money's Worth Values for Compulsory Products with Different Initial Premium Amounts.

Premium Amount	£10,000	£50,000	£100,000
Male 60	0.907	0.922	0.921
Male 65	0.897	0.910	0.908
Male 70	0.886	0.892	0.889
Female 60	0.914	0.930	0.928
Female 65	0.898	0.912	0.907
Female 70	0.882	0.892	0.886

Notes: Data are provided by Annuity Direct for August 21, 1998. All products are nominal annuities with a five year guarantee period. Products are paid monthly in arrears. Calculations are based on average annuity payouts for the fourteen firms in the sample, and are based on population mortality tables.

Table 5: Comparison of Money's Worth Values for Products with Different Guarantee Periods

Annuity Product	Compulsory Market			Voluntary Market		
	No guarantee period	5 year guarantee	10 year guarantee	No guarantee period	5 year guarantee	10 year guarantee
Male 65	0.902	0.907	0.916	0.862	0.865	0.872
Male 70	0.877	0.887	0.908	0.833	0.844	0.864
Male 75	0.849	0.871	0.908	0.803	0.828	0.867
Female 65	0.904	0.908	0.915	0.854	0.857	0.864
Female 70	0.879	0.887	0.908	0.833	0.841	0.856
Female 75	0.865	0.877	0.901	0.819	0.833	0.859

Notes: Money's worth calculations for both the compulsory and voluntary market are based on population mortality tables and on average payments for the 16 firms that offer compulsory (nominal) 0, 5, and 10 year guarantees and on the 11 firms that offer voluntary (nominal) 0, 5, and 10 year guarantees.

Table 6: Comparison of Money's Worth Values for Products Available in the Voluntary and Compulsory Annuity Markets

Annuity Product	Compulsory			Voluntary		
	Nominal	Real	5% Escalating	Nominal	Real	5% Escalating
Male 65	0.900	0.825	0.856	0.865	0.792	0.807
Male 70	0.877	0.808	0.836	0.836	0.769	0.786
Male 75	0.854	0.792	0.819	0.804	0.745	0.759
Female 65	0.903	0.820	0.851	0.864	0.786	0.809
Female 70	0.880	0.803	0.829	0.844	0.773	0.793
Female 75	0.869	0.798	0.823	0.833	0.770	0.787

Notes: Money's worth calculations are based on population mortality tables and on average payments for the 11 firms that offer all 3 products in the compulsory market and the 3 firms that offer all 3 products in the voluntary market.

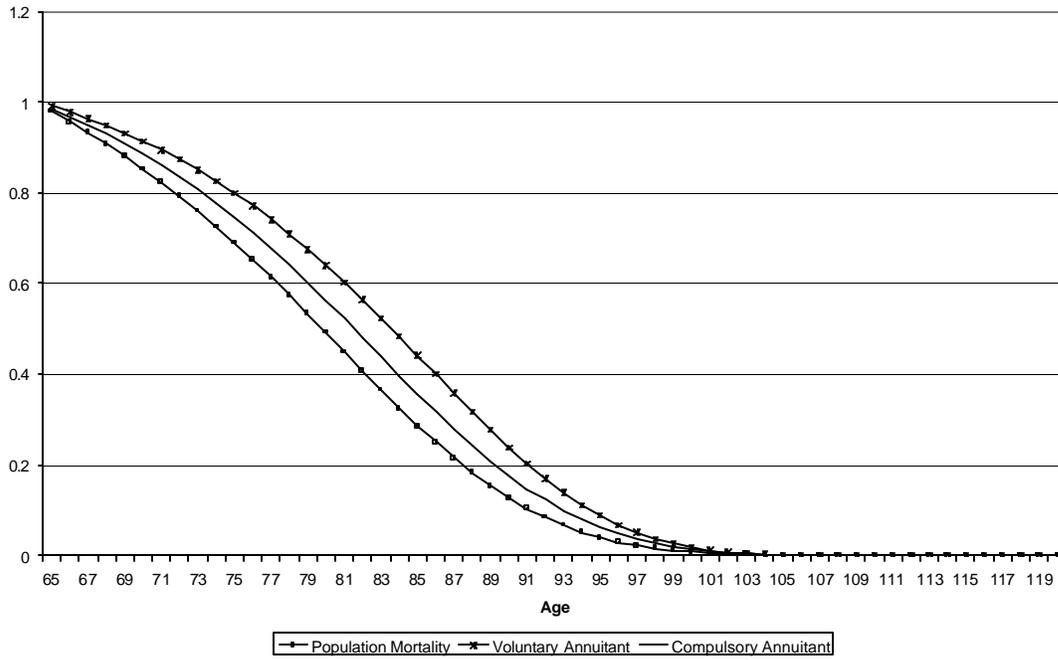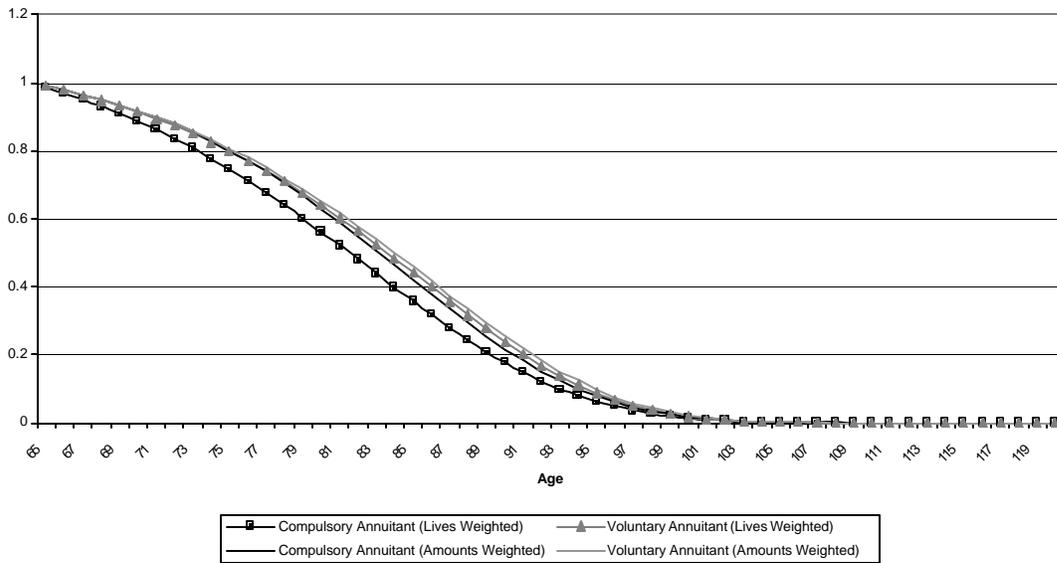**Fig. 1: Cumulative Survival Probabilities for 65 year old male cohort in 1998**

Fig. 2: Cumulative Survival Probabilities for 65 year old male cohort in 1998

[1] Cawley and Philipson (1999) find that the mortality rate among US life insurance purchasers is lower than that among non-purchasers. While this is inconsistent with the notion that those with higher mortality buy life insurance, it could be explained by passive selection, with higher wealth (and lower mortality) individuals buying more insurance. Hurd and McGarry (1997) and Hamermesh (1985) present direct evidence on how individuals form views of their prospective mortality rates and their relationship to aggregate mortality rates.

[2] This has been documented recently by Attanasio and Hoynes (2000), Attanasio and Emmerson (1999), Disney, Johnson, and Stears (1998), and the Office of National Statistics (1997).

[3] We focus on the rules that apply to the current generation of annuity buyers, but note that somewhat different rules apply to accumulated balances that are due to contracting out of SERPS. Budd and Campbell (1998) note that those contracting out of SERPS tend to be young and they are therefore unlikely to be current annuitants.

[4] This estimate, courtesy of Michael Orszag, is based on sales data for two large insurance companies and from an annuity broker who sells annuities provided by many different companies.

[5] The availability of indexed bonds since the early 1980s has enabled insurance companies to hedge the inflation risk associated with inflation-indexed annuity products. Brown, et al. (2000) note that various types of inflation-indexed annuity products have been available in the United States since the introduction of inflation-indexed bonds in 1998, but that the market for such products is still extremely small.

[6] We consider the pricing of both compulsory and voluntary annuities, while Murthi, Orszag, and Orszag (1999b) focus on pricing in just the compulsory market. Their study also presents time series evidence on the pricing of annuities throughout the 1990s, while our analysis focuses on annuity prices in 1998.

[7] We have two sets of data on annuity prices. One, which underlies the calculations in section four, is from November 6, 1998 and for this we use a November 5, 1998 term structure. The other, which is the basis for the calculations in section five, is from August 21, 1998 and for this we use an August 26, 1998 term structure.

[8] Murthi, Orszag, and Orszag (1999b) report comparable results using interest rates on risky corporate bonds as well as on government bonds. While the money's worth falls when it is evaluated using a higher discount rate, the patterns across different annuity products are not affected.

[9] This is the IM/IF '92 series for Immediate (Voluntary) annuities published in Institute of Actuaries (1999b). The tables we use include a one-year select period to account for the fact that in the year immediately following the purchase of an annuity, a voluntary annuitant experiences lighter mortality than other voluntary annuitants of the same age who had purchased their annuity more than a year ago.

[10] The Institute of Actuaries' Continuous Mortality Investigation Bureau has recently published retirement annuitant tables, but the insurance companies that write annuities are apparently not using these tables.

[11] In 1998, 17 firms offered nominal annuities in the compulsory annuity market, while 13 offered such products in the voluntary market. The number of firms offering inflation-linked annuities in these markets were 11 and 3, respectively, and the number offering nominal annuities with a 5 percent escalating clause were 17 and 10, respectively. The 11 firms offering real annuities in the compulsory market are a subset of the 17 offering nominal or escalating annuities. The same 17 firms offer nominal and escalating compulsory products. The 13 firms offering nominal voluntary annuities are not a subset of the 17 offering nominal compulsory annuities. The three firms offering real voluntary annuities also offer real compulsory products and escalating voluntary annuities. The 10 firms offering escalating voluntary products are a subset of the 13 offering nominal voluntary annuities.

[12] These data are reported in the Office of National Statistics (1997).

[13] One reason that voluntary and compulsory annuitants may be similar is the overlap in the two pools of annuitants. Because defined contribution plan participants can withdraw some portion of their accumulation in the form of a lump sum, those who want to fully annuitize may make such withdrawals and then use the proceeds to purchase a voluntary annuity. There is a tax incentive for pursuing this strategy, since compulsory annuity payments are treated as taxable income whereas only the portion of the voluntary annuity payments that is considered above the "return to capital" is subject to income taxation. The tax benefits of this strategy must be weighed against the higher annuity prices in the voluntary rather than the compulsory market.

[14] Table 2 is restricted to a sample of 9 firms that offer compulsory and voluntary nominal and 5% escalating products. The basic patterns are not sensitive to this restriction, which we impose so that our comparison across markets is not affected by changes in the composition of the sample of firms in a given market.

[15] For each market, we calculate $100*(MW_{annuitant\ table} - MW_{population\ table})/(1 - MW_{population\ table})$.

[16] To condition rates on the quantity of insurance purchased, insurers must be able to monitor the total amount of insurance that each buyer purchases. In insurance markets where payment occurs when an event (such as death) occurs, the insurance company can stipulate that the contract is valid only if the insured has not purchased other insurance, and investigate compliance upon submission of a claim. Abel (1986) and Brugiavini (1993) note that this

is difficult in annuity markets, and would require continuous monitoring, since payment occurs *until* an event (death) occurs.

[17]Moneyfacts, the annuity broker that supplied the data used earlier in this paper, only provides pricing information on annuities with initial premium of £10,000. The pricing data used in Table 4 are therefore drawn from a different annuity broker than the pricing data used in all other tables. The annuity broker which supplied the data used in Table 4, Annuity Direct, provides pricing information for different premium sizes in the compulsory but not in the voluntary market. All but one of the fourteen firms in the Annuity Direct database for nominal compulsory products is also in the Moneyfacts database. Annuity Direct does not, however, provide information on rates for 75 year olds. All Annuity Direct products offer a five-year guarantee.

[18] There are eleven such companies in the compulsory market and three in the voluntary market. The pattern of results in the compulsory market is not affected if we limit our sample to the three out of the eleven firms that offer all three products in both markets.

[19]It is also possible that a smaller total market size for inflation-indexed annuities leads insurers to charge higher markups to cover their fixed costs of offering and administering these products.

[20]One firm, MGM Assurance, offers annuities that are priced on the basis of occupational status and geographical location. In 1997, it accounted for only 0.2% of the annuity market for non-linked, single premium annuities.