

ADVERSE SELECTION IN TERM LIFE INSURANCE PURCHASING DUE TO THE BRCA1/2 GENETIC TEST AND ELASTIC DEMAND

Krupa S. Viswanathan
Jean Lemaire
Kate Withers
Katrina Armstrong
Agnieszka Baumritter
John C. Hershey
Mark V. Pauly
David A. Asch

ABSTRACT

Consumer groups fear that the use of genetic testing information in insurance underwriting might lead to the creation of an underclass of individuals who cannot obtain insurance; thus, these groups want to ban insurance companies from accessing genetic test results. Insurers contend that such a ban might lead to adverse selection that could threaten their financial solvency. To investigate the potential effect of adverse selection in a term life insurance market, a discrete-time, discrete-state, Markov chain is used to track the evolution of twelve closed cohorts of women, differentiated by family history of breast and ovarian cancer and age at issue of a 20-year annually renewable term life insurance policy. The insurance demand behavior of these women is tracked, incorporating elastic demand for insurance. During the 20-year period, women may get tested for BRCA1/2 mutations. Each

Krupa S. Viswanathan is at Temple University, 471 Ritter Annex (004-00), Philadelphia, PA 19122. Jean Lemaire is at University of Pennsylvania, The Wharton School, Department of Insurance and Risk Management, Philadelphia, PA 19104. Kate Withers is at the Georgetown University Law Center, Washington, DC 20001. Katrina Armstrong is at the Department of Medicine, Center for Clinical Epidemiology and Biostatistics, University of Pennsylvania, Philadelphia, PA. Agnieszka Baumritter is the Managing Director, Robert Wood Johnson Clinical Scholars Program, University of Pennsylvania, Philadelphia, PA. John C. Hershey is at the Operations and Information Management Department, The Wharton School, University of Pennsylvania, Philadelphia, PA. Mark V. Pauly is at The Wharton School, University of Pennsylvania, 208 Colonial Penn Center, Philadelphia, PA 19104. David A. Asch is at the Department of Medicine and the Leonard David Institute for Health Economics, University of Pennsylvania, Philadelphia, PA, Center for Health Equity Research and Promotion, Philadelphia, VA Medical Center. The author can be contacted via e-mail: krupa@temple.edu.

year, the insurer calculates the expected premiums and expected future benefit payouts which determine the following year's premium schedule. At the end of each policy year, women can change their life insurance benefit, influenced by their testing status and premium changes. Adverse selection could result from (i) differentiated benefits following test results; (ii) differentiated lapse rates according to test results; and (iii) differentiated reactions to price increases. It is concluded that with realistic estimates of behavioral parameters, adverse selection could be a manageable problem for insurers.

INTRODUCTION

The initial phase of the human genome project was completed in 2003, with the sequencing of the human genome. Researchers hope that this sequencing will allow them to develop new drugs and therapies and to identify genetic risk factors for a variety of conditions. At the same time, many fear that the human genome map may open a new frontier for potential discrimination, particularly in insurance. Senators James Jeffords and Tom Daschle stated that "misuse of genetic testing could create a new underclass: the genetically less fortunate" (Jeffords and Daschle, 2001). In many countries, an intense legislative and lobbying activity, reminiscent of the debate over access to HIV tests in the 1980s, is taking place that could shape the environment of underwriting in life and health insurance. Consumer groups, fearing discrimination and the creation of a class of uninsurable individuals, want insurers and employers prevented from gaining access to medical information obtained through genetic testing.

In opposition to these views, insurance companies point to the risk of adverse selection. With over 1,000 genetic tests offered, they fear that policyholders may gain a financial advantage through insurance purchase decisions, from genetic information known to them but not revealed to insurers.¹ Insurers claim that without a level playing field, a death spiral of increasing premiums and decreasing portfolio size may threaten their financial solvency. They emphasize the positive implications of DNA testing for annuitants and the benefits of early diagnosis. They discuss the ethics and inconsistency of prohibiting the use of genetic tests, while allowing other medical tests and family history to be used for underwriting purposes. Both sides, consumer groups and the insurance industry, recognize that the predictive information obtained from genetic tests could be relevant to the actuarial calculations used by insurers in establishing policies and premiums. The issue is whether the use of such information by insurers in underwriting is justified on economic and market grounds to overcome social concerns. Actuaries in the United States voice their concerns through bodies such as the American Academy of Actuaries; by means of Issue Briefs (American Academy of Actuaries, 1998, 2002), articles, and Capitol Hill briefings. Congress is urged to proceed with extreme caution when it considers legislation aimed at preventing genetic discrimination in insurance.

The word "discrimination" is often used neutrally by economists to reflect the ability to distinguish among groups, but the same word is used by the public to reflect socially unfair ways of classifying groups. In the economic sense, is adverse

¹ More information about specific genetic conditions and genetic tests can be obtained from the website <http://www.genetests.org>, sponsored in part by the National Institutes of Health.

selection a sufficiently plausible threat that discrimination based on genetic test results is justified? On average, in the United States, women live longer than men and Caucasian-Americans live longer than African-Americans. Both of these differences in life expectancy could be used to establish lower term life insurance premiums for women and Caucasian-Americans compared to men and African-Americans. Insurance companies typically charge lower premiums for women than for men, but they do not charge lower premiums for Caucasian-Americans than for African-Americans. This is not because discrimination by sex is actuarially more important than discrimination by race, but because discrimination by race is not socially tolerated. To that end, the use of race as an underwriting factor for insurance is prohibited in all states. In Montana alone, the use of gender in rating for any type of insurance is illegal. If in these cases, failure to discriminate by race or gender led to sufficient adverse selection—for example, if the protected groups overpurchased life insurance as a result, raising premiums to a level that drove the other groups from the market—the balance between socially intolerable discrimination and actuarially fair discrimination might shift in the other direction.

In the debate about whether insurers should be allowed to use genetic testing results in underwriting, the actuarial profession can contribute by designing models to analyze adverse selection and quantify its impact, thereby generating a more informed discussion. Several recent articles have been published, estimating the potential impact of the test for a BRCA1/2 mutation on the term insurance and critical illness markets, and of the test for specific alleles of the ApoE gene that may predispose one to Alzheimer's disease on long-term care insurance (MacDonald and Pritchard, 2000, 2001; MacDonald, Waters, and Wekwete, 2003; Subramanian et al., 1999). These models all rely on the assumption of inelastic demand. These articles model insurance purchase behavior following a genetic test, but do not account for the fact that policyholders may elect to reduce their coverage following the price increases resulting from adverse selection. This research introduces elastic demand for term insurance into the analysis.

A discrete-state, discrete-time Markov chain is used to follow the evolution of twelve cohorts of women, differentiated by age at issue and family history of breast and ovarian cancer. All women own term insurance at time 0. Policyholders can get tested for BRCA1/2 mutations and, after receiving the test results, either change their face amount or lapse their policy. The adverse selection that results forces the insurer to raise premiums each year. In the model, the firm uses an anticipatory pricing approach, following the theoretical framework of Hoy and Polborn (2000) and MacMinn, Brockett, and Raeburn (2004), which models the adverse selection implications from genetic testing and insurer responses. Here, the insurer considers both the supply and demand sides of the market and sets the price and quantity to be supplied accordingly. Marshall's Law of Demand, resulting in a constant price elasticity of demand, models the reaction of policyholders when confronted with premium changes.

The article proceeds as follows: First, current regulatory and underwriting procedures in various countries are discussed, to illustrate the diversity of country response to insurer use of genetic tests results. The elastic demand Markov model is described next and the estimation procedure for all parameters is described, including the questionnaire used to estimate price and risk elasticities of demand. Results and sensitivity analyses are then presented, followed by our concluding remarks.

CURRENT REGULATORY CONDITIONS

Insurance companies are concerned about being restricted from access to genetic tests taken by their potential and current customers. The questions that regulation needs to address are:

1. Should insurers be permitted to reflect in their rates the information provided by genetic tests?
2. Should insurers be permitted to require applicants to disclose the results of genetic tests taken prior to the application for insurance?
3. Should insurers be permitted to require applicants to take genetic tests prior to consideration of the application?

Regulatory authorities also need to provide a definition of "genetic information" and "genetic test." A genetic test can be defined in a narrow way as a chemical test involving examination of the constitution of a gene or chromosome, or in a much larger way that would include examination of family history.

The answers to these questions have led to four major types of genetic information laws, which can be classified as follows (Bartram et al., 2000; Berberich and Fischer, 1999; Breyer, 2001; Doble, 2001; Knoppers, Godard, and Joly, 2004; Lemmens, Joly, and Knoppers, 2004; Munich Reinsurance Company, 2004). Under a *Laissez-Faire* approach, insurers have full freedom to request new tests and the disclosure of existing tests, and to incorporate test results in underwriting and rating. This is practiced in Australia, Canada, China, Japan, Korea, Ireland, Portugal, Russia, Singapore, Spain, and South Africa.² Through *Disclosure Duty*, applicants have to disclose the results of existing tests, at the insurer's request, but cannot be required to take additional tests; this approach is used in Germany, New Zealand, and the UK. By *Consent Law*, applicants are not required to divulge genetic tests results. If they do, insurers may use this information; this approach exists in the Netherlands and Switzerland. In Austria, Belgium, Denmark, France, Israel, Italy, and Norway, under *Strict Prohibition*, insurers cannot request genetic tests, cannot require applicants to provide existing tests results, and cannot use any genetic information in underwriting and rating.

In the absence of (or in addition to) legislation, three approaches have been used by insurers' associations. Through a *Voluntary Agreement*, the Swedish Insurance Federation and the state have agreed that no genetic tests can be made a condition for issuance or modification of a life insurance policy. In addition, the results of tests taken prior to the application will not be considered in the risk assessment, unless the sum insured exceeds 15 times an inflation-adjusted base amount (\$62,000 in 1999). In Canada, Germany, Finland, France, Greece, Ireland, the Netherlands, New Zealand, Switzerland, and the UK, insurers have adopted a voluntary *Moratorium* on the use of genetic tests. The moratorium may apply to all life insurance policies (Germany), or to all policies with a sum insured under a given limit (Netherlands, UK). Finally, in Australia, Germany, South Africa, and the UK, insurers' associations have put together *Mandatory Guidelines* or a *Code of Conduct*. The Life, Investment and

² It is noted that legislative activity concerning the regulation of genetics in insurance is proceeding at a fast pace such that some of these countries may already be considering new regulation at this time.

Superannuation Association of Australia passed a position paper "Genetic Testing and Life Insurance" that was accepted as an underwriting guide in 1997.

In the UK, the Association of British Insurers introduced a Code of Practice on Genetics in 1997, which enforced a ban on insurers asking anyone to take a genetic test (Daykin et al., 2003). At that time, results from seven specific tests, approved by a genetics advisor, were required to be disclosed and could be taken into account.³ Genetic test outcomes could not be used to underwrite another member of the family. More importantly, a moratorium was imposed on the use of genetic tests for life insurance policies with a sum insured not exceeding £100,000 sold in connection with a mortgage. In the UK, mortgage-based life insurance is common and considerably reduces the potential for adverse selection, since the sum insured is limited to the price of the house; over-insurance is unlikely.

In 1997, the British government set up a Genetics and Insurance Committee charged with assessing requests from insurers to be allowed to use specific genetic tests for specific policies. The Committee ruled that a test could be approved if medical and actuarial evidence demonstrates that a positive test result implies an extra mortality exceeding 50 percent or an extra morbidity exceeding 25 percent. In 2000, the Committee approved the Huntington's disease test for policies not covered by the existing moratorium; it is currently considering the BRCA tests as well as tests for the PS1 and APP genes that impact Alzheimer's disease.

In 2001, a major British insurer was forced to admit that it had been using unapproved tests in underwriting, in violation of the code of conduct (Kite, 2001). Following this disclosure, the House of Commons Science and Technology Select Committee issued a report strongly critical of the industry, concluding that self-regulation by insurers is not working, and that some companies are trying to set up a "genetic ghetto." The Human Genetics Commission recommended that the government place a moratorium on the use of genetic test results. During that moratorium, the Commission would investigate the use of family history in underwriting. In October 2001, the insurance industry and the government reached an agreement on a five-year moratorium on access to genetic test results for all life insurance policies with an aggregate sum insured not exceeding £500,000 for an individual. During the moratorium, the government and insurance industry will fund research by independent experts on the use of family history and explore risk pooling so that those with adverse genetic test results will be able to access affordable insurance postmoratorium. In such an arrangement, policyholders would be insured by the risk pool and companies would share in the pool's experience. At the 2002 UK Forum for Genetics and Insurance, some insurance companies, mentioning the poor experience of the diabetes pool, expressed their belief that risk pooling may not be a viable idea due to high administrative costs. In summary, in the UK, during the five-year moratorium that expires in November 2006, the only predisposition genetic tests insurers can use relate to Huntington's disease, only for life insurance policies over £500,000.

In the United States, Wisconsin became in 1991 the first state to pass a law barring insurers from using existing genetic test information and requesting new tests from

³ The seven tests are for the following conditions: Huntington's disease, hereditary breast cancer, familial adenomatous polyposis, myotonic dystrophy, early-onset Alzheimer's disease, multiple endocrine neoplasia, and hereditary motor and sensory neuropathy.

health insurance applicants. Other states have followed suit, periodically revising their laws to adapt to advances in genetic testing. A vast majority of states now prohibits the use of genetic test results for health insurance risk classification and pricing. Far fewer states have regulated life insurance. In Missouri and Minnesota, insurers may not require individuals to take a genetic test, may not base rates on any test result, and may not refuse to insure based on genetic traits. In Florida and North Carolina, no insurer may refuse to issue a life policy because the insured person has the sickle-cell trait. Several states require informed consent before submitting to a genetic test, and confidentiality of results. In many of these states, insurers also cannot request genetic information from family members. Interestingly, several states have laws whereby insurers may not use genetic test results “unless the applicant’s medical history and condition and claims experience or actuarial projections establish that substantial differences in claims are likely to result from the genetic condition.” This provision would allow insurers to invest in and use medical studies to calculate the mortality risks associated with a particular test and justify its use for future premium determination. At the federal level, the Senate, in February 2005, passed the Genetic Information Non-Discrimination Act of 2005, which is now being debated in the House of Representatives. This bill (S 306, HR 1227) places restrictions on insurers, banning the use of genetic information in underwriting health insurance; it does not however address the use of genetic testing results in life insurance underwriting.

DESCRIPTION OF MODEL

To model the degree of potential adverse selection to an insurer from life insurance purchase, a discrete-state, discrete-time, Markov chain is used to track the insurance purchase and genetic testing behavior of different cohorts of women over a 20-year period. At time 0, 1,000 healthy women of the same age and family history, untested for BRCA1/2 gene mutation, are insured for an amount of \$100,000 under an annually renewable term insurance policy, with the premium paid at the beginning of each year and benefit paid at the end of the year of death. Three ages at time 0 are considered: 30, 40, and 50, along with four different family histories: no family history (No FH) of breast (BC) or ovarian (OC) cancer, one first-degree relative (a mother or a sister) with onset of BC between the ages of 20 and 30 (1FDR-BC), two first-degree relatives with onset of BC between 20 and 30 (2FDR-BC), and one first-degree relative with OC (1FDR-OC). This leads to a total of twelve cohorts. These cohorts are closed: there are no new entrants into the group after time 0.

The adoption of a discrete-time Markov chain rather than a continuous-time model reflects the belief that insurance decisions are usually taken at the end of the policy year, just before renewal. Policyholders rarely cancel a policy in the middle of the year; rather, they lapse after receiving the renewal invoice. Policyholders with an elastic demand for insurance react to price increases when they learn about them through the renewal notice.

Each year, the initial cohort reduces through the combined effect of three decrements: policy lapse, death, and test for BRCA1/2 mutations. Lapses take place at the end of the year and are final: once her policy has lapsed, a woman does not reenter the cohort later on. Deaths and tests take place during the year; a uniform distribution of decrements in each year of age is assumed both for deaths and tests, to model the competing interaction between these two decrements. Within a particular policy

year, women who undergo a BRCA1/2 test receive the result (positive or negative). As the test for the BRCA1/2 is believed to be very accurate, with sensitivity and specificity exceeding 99 percent, testing errors (false positives and false negatives) are not considered (Myriad Genetic Laboratories, 2003). Tested women then constitute their own sub-cohort, from which lapses and deaths occur over the remainder of the 20-year period. The insurer is not allowed to learn about any genetic testing results at any time during this period.

At the end of each policy year, all women make their insurance decision for the following year: they can change their benefit amount or let the policy lapse. This decision is influenced by their testing status/outcome and the prices faced for insurance. When all decisions are taken, an adverse selection process may begin to develop at the expense of the insurer. Three factors contribute to this process:

- (i) Differentiated benefits: women testing positive are more likely to increase their benefit; women testing negative may reduce their benefit. It is assumed that women may increase their benefit without having to provide medical evidence of insurability.
- (ii) Differentiated lapsing rates: women testing positive are expected to lapse at a lower rate than untested women; women testing negative may exhibit a higher lapsing rate.
- (iii) Women who test positive may be more likely to accept a premium increase than women who are untested or who test negative. Facing an increase, they may decrease their benefits less than others.

A combination of the factors listed above may lead to higher expected death benefits; consequently, the company must raise premiums for the following year. Since the insurer cannot use genetic test results in its pricing, it must continue to price all contracts using family history and thus must increase the premiums in each cohort by the same percentage. Since insurers have access to family history information, each of the twelve cohorts is assumed to constitute a separate rating cell; price increases are calculated for each cell separately. We are not considering any cross-subsidization between cells.

Elastic demand is incorporated into the consumers' demand system. Behavioral changes in benefits as a result of price increases are modeled using Marshall's Law of Demand, linking the price P of an economic good to its quantity sold Q through the relationship:

$$P^\lambda Q = A, \quad (1)$$

where A is a constant. Parameter λ is the (constant) price elasticity of demand:

$$\lambda = -\frac{dQ/Q}{dP/P}. \quad (2)$$

With this demand equation, the price elasticity remains constant at various magnitudes of price changes. At the end of a policy year, a woman who remains untested reacts to an annual premium change according to the price elasticity $\lambda_{\text{untested}}$,

which would then, using the demand equation above, determine her benefit for the following year.

For a woman who gets tested during policy year t , the insurance benefit demanded for year $t + 1$ is solely influenced by this test result. For each test outcome, the relative degree of change in the woman's known death risk depends on the information known to her prior to testing, specifically her family history. This relative change in risk level then influences the quantity of insurance demanded. This (constant) risk elasticity of demand with respect to health risk, δ , is defined as

$$\delta = \frac{dQ/Q}{dR/R}, \quad (3)$$

where R denotes the woman's family history health risk—her 20-year probability of death given her family history of BC or OC. $\delta_{(+)}$ denotes the risk elasticity after the shock of a positive test that doubles the death risk, while $\delta_{(-)}$ denotes the risk elasticity after a negative test that halves the death risk.

The insurance benefit demanded in year $t + 2$ and each year after will be determined using Marshall's Law of Demand with a price elasticity parameter corresponding to the woman's test status, $\lambda_{\text{positive}}$ or $\lambda_{\text{negative}}$. Thus, three different price elasticities of demand are estimated for the model, with the relationship $\lambda_{\text{positive}} < \lambda_{\text{untested}} < \lambda_{\text{negative}}$, for each family history, reflecting the expected level of responsiveness to benefit changes. Summarizing, a woman who tests positive in year 5 modifies her insurance benefit according to a price elasticity $\lambda_{\text{untested}}$ at times 1–4, a risk elasticity $\delta_{(+)}$ at time 5, and a price elasticity $\lambda_{\text{positive}}$ at times 6–19 (unless she decides to lapse at some intermediate time or if death occurs).⁴ Again, in our model, if a woman gets tested in year t , the insurance decision made for year $t + 1$ is determined only by her risk elasticity corresponding to the test result; the amount of insurance benefit demanded in $t + 1$ is not simultaneously affected by her price elasticity of demand. We use this as each woman's decision-making approach; a recently obtained result of a genetic test overwhelmingly affects the woman's thoughts and subsequent insurance strategy; thus we assume that any premium change for year $t + 1$ would be accepted in full.

In calculating the premium to be charged each year, the insurer begins by estimating the actuarially fair rate, then it adopts a pricing strategy to determine the premium charged. In practice, an insurer may follow a variety of pricing strategies, among which are to simply react to adverse mortality experience by attempting to recoup any past

⁴ As noted, we use the demand function $P^\lambda Q = A$. At time 0, all women in each cohort choose an initial benefit of \$100,000 and their price elasticities are the same. Within each cohort then, the value of A would be the same for all women at time 0. The value of A would vary across the twelve cohorts, corresponding to the different initial premium P . After time 0, the value of A is recalibrated each year to recognize that the actuarially fair price increases each year. In this model, prices are expected to increase each year due to age and adverse selection. A woman is willing to purchase the same level of coverage as the previous year as long as price increases are actuarially fair; however, she will be sensitive to the price increases due to adverse selection.

losses or try to anticipate the reactions of policyholders to future price changes and set premiums accordingly. The latter approach is considered here.

Under an anticipatory approach, following the framework of Hoy and Polborn (2000), Villeneuve (2003), and MacMinn, Brockett, and Raeburn (2004), the insurer incorporates supply considerations into the pricing process. The insurer recognizes that any change in premium will impact the benefit demanded, which will of course determine the expected losses; these expected losses should then drive the premium to be charged. Thus, there is a simultaneous adjustment of price and purchasing. As derived in these articles, the cyclical impact of supply on demand on supply and so forth can lead to an equilibrium whereby the appropriate premium to be charged results in a zero profit/loss for the insurer. Our model follows this approach; the insurer calculates how much to supply at each possible price and then determines the equilibrium premium and quantity to be supplied. Due to the anticipated adverse selection from women undergoing genetic testing and then changing their quantity demanded, the firm will be increasing premiums each year such that the expected loss becomes zero.

This pricing strategy implies that there is no front-loading of premiums whereby a consumer would pay higher than actuarially fair premiums initially. In insurance models by Pauly et al. (2003) and Hendel and Lizzeri (2003), front-loading induces policyholders to remain committed to a particular contract; because of this prepayment, a consumer may not be later on attracted by a cheaper contract in the spot market. Our conservative assumption of no front-loading, which conveys single-period decision making by the insurer, will lean in the direction of making adverse selection more likely.

Each year, premiums increase because of (i) increased mortality due to age, and (ii) adverse selection. To identify the increase due to adverse selection alone, it is assumed that policyholders do not reduce their benefits in response to the age-related portion of the most recent price increase; instead, policyholders accept all past price increases and react only to the most current adverse selection premium increase. Sensitivity analyses will be performed on the various parameter estimates to investigate the variability of our results.

PARAMETER ESTIMATION

The model requires the estimation of many parameters. Annual probabilities of death for the different ages at issue, family histories, and test results are required to set premiums and determine expected and observed benefit payouts. These death probabilities were estimated in Lemaire et al. (2000). Probabilities to test positive according to family history (0.40 for women with 2 FDR with BC, 0.15 with 1 FDR with BC, 0.08 with 1 FDR with OC, 0.005 with no family history) were derived in Subramanian et al. (1999). These estimates were based upon initial findings of relatively high penetrance for BRCA1/2 mutations among linkage families. Although it was believed in the late 1990s that these estimates may be inflated by the selection of highly penetrant families for inclusion in linkage analysis, the most recent evidence suggests that the risk of breast and ovarian cancer associated with BRCA1/2 mutations is not much lower in the population as compared to just high-risk families (Antoniou, 2003; Begg, 2002; Brose et al., 2002). Given the controversy that surrounds the exact BRCA1/2 risk, we choose to base our analyses on the early, slightly higher, estimates, as this conservative

approach assumes the greatest impact of testing on cancer risk and will provide the highest estimate of adverse selection. An annual effective rate of interest of 5 percent is used for discounting.

We assume that 5 percent of women undergo BRCA testing each year, which is a conservative figure. Indeed, it is estimated that, while the number of genetic tests performed increases at an annual rate of 10 percent to 30 percent, depending on the country, currently less than 0.2 percent of the population of industrialized countries has undergone genetic testing. In the UK, in one year (1998/99), only 2,179 women took the BRCA1 or BRCA2 test (Munich Reinsurance Company, 2004). This situation could change if the cost of the BRCA test substantially drops from the current \$2,760, thus this rate of 5 percent is used.

However, the testing rate for each of the four family histories should vary since women with a strong family history of breast cancer are much more likely to get tested than women without any family history of the disease. We assume that testing rates for each family history class are proportional to the probability of testing positive (2 FDR-BC: 40 percent; 1 FDR-BC: 15 percent, 1 FDR-OC: 8 percent, No FH: 0.5 percent). Our estimated testing rates of 20.78 percent (2 FDR-BC), 7.79 percent (1 FDR-BC), 4.16 percent (1 FDR-OC) and 0.26 percent (No FH) result in 5 percent of the population being tested annually.

Price and risk elasticities are estimated by means of a questionnaire completed by 48 individuals working in the health care industry, 18 males and 30 females. These respondents were sorted into three age groups: under 36, 36–45, and above 45. Each was asked 15 life insurance coverage questions, as shown in Appendix A. In each question, 10 possible life insurance amounts were presented, ranging from no coverage to \$1,500,000 and a premium for each amount given. On the first question, respondents were asked how much insurance they would buy given their current health level and benchmark premiums obtained from a leading insurer. As expected, older individuals selected higher benefit amounts. The average benefit was \$200,400 in the “under 36” age group, \$446,667 in the “36–45” group, and \$523,077 in the “over 45” group. Males selected much higher benefits than females: \$433,889 *versus* \$274,000, for an overall average of \$333,958. In the next four questions, respondents were asked to select benefit amounts under different pricing scenarios, holding their mortality risk level constant. The premiums for the different insurance benefit amounts were varied from one-half to two and a half times benchmark premiums. These first five questions measured respondents’ price sensitivity for term life insurance, holding mortality risk constant. Answers to these questions are used to estimate $\lambda_{\text{untested}}$.

In questions 6–10, a hypothetical situation was presented in which respondents were told their risk of death had doubled after the result of a special blood test. In question 6, the same set of possible life insurance benefit amounts was offered as in question 1, at the same benchmark premiums. Respondents were asked to choose their desired benefit amount given this higher death risk level. In the next four questions, premium schedules were varied in the same way as in questions 2–5; these questions are used to estimate $\lambda_{\text{positive}}$, the price elasticity of demand for term insurance under the high death risk scenario. Questions 11–15, used to estimate $\lambda_{\text{negative}}$, followed the same format, but represented a situation in which the death risk was halved after the blood test. Respondents exhibited a high degree of inertia in the presence of a test result that halves the death risk; 71.25 percent did not change their benefit, with little variation

across gender. The average benefit change was not significantly different from 0. This emphasizes that, for most people, term insurance is an essential purchase driven by family need; the amount of insurance purchased is fairly independent of the mortality risk and the annual premium. Respondents reacted more to a doubling of the death risk; in this situation, only 48.33 percent did not change their benefits (61.11 percent of males *vs.* 40.67 percent of females). The average benefit increase was a highly significant \$145,600. Males increased their benefit by an average \$115,000, females by an average \$164,000.

To estimate $\lambda_{\text{untested}}$, a stacked cross-section regression analysis is performed on all questionnaire responses to questions 1 through 5. The regression uses the percentage change in benefit as the dependent variable and the percentage change in premium as the exogenous price variable. For each individual, four observations are recorded, the changes in selected benefit from question 1 to questions 2–5 respectively. Maximum likelihood estimation with an error components error structure is used to allow for correlation across observations drawn from the same individual. Regression equations are of the form:

$$\%(\Delta \text{Benefit}) = \lambda \%(\Delta \text{Premium}) + \beta(\text{Control Variables}) + \mu, \quad (4)$$

where the error term includes a fixed effect for each individual and an independent and identically distributed error term. Dummy variables for demographic characteristics, such as age, sex, total number of dependents, and income of the respondents, are included in the regression. The overall price elasticity coefficient $\lambda_{\text{untested}}$ is estimated at 0.6579; this estimate is robust across all categories of respondents and insensitive to changes in age, gender, education level, income, or marital status.

Pauly et al. (2003) also estimated the price elasticity of demand for annually renewable term life insurance, using two sets of data: the January 1997 data set sold by CompuLife that contains firm-level premium data for term contracts from all major companies in the US market, and the 1997 US Buyer's Study sold by LIMRA International that consists of a random sample of policies bought by the customers of over 35 life insurance companies. Their regression analyses suggest that the price elasticity of demand for annually renewable term insurance ranges from 0.3 to 0.5, depending on the dataset and the control variables used.

Table 1 compares annually renewable term insurance to common goods and services in terms of price elasticities. It shows that consumers consider term insurance to be an important good in their lives. It is more inelastic than everyday use goods such as shoes and kitchen appliances and only slightly more elastic than tobacco, a product that is not only highly addictive, but in addition shows little substitution effect across brands.

A similar regression analysis on all fifteen questions, using death risk level dummies to allow price elasticity to change across risk scenarios, provides estimates of the three price elasticities $\lambda_{\text{positive}}$, $\lambda_{\text{untested}}$, and $\lambda_{\text{negative}}$, which are not significantly different from each other. However, it is anticipated that women who test positive are less price sensitive than women who test negative because of their desire to remain insured in the face of material changes in health status. Thus, $\lambda_{\text{positive}}$ is set equal to 0.45 and $\lambda_{\text{negative}}$ is set equal to 0.68. We also expect that while in the untested state, women with different family histories of BC/OC will vary in their responsiveness to price changes.

TABLE 1
Short-Run Price Elasticity of Demand of Several Goods

Good	Elasticity
Electricity	0.13
Rental housing	0.18
Water	0.20
Telephone	0.26
Eyeglasses	0.37
Jewelry and watches	0.41
Tobacco products	0.46
Term Insurance	0.66
Kitchen appliances	0.67
Movie tickets	0.87
Shoes	0.91
Shoe cleaning and repair	1.31
China, glassware, tableware	1.54
Restaurant meals	2.27

Source: Houthaker and Taylor (1970) and this research.

A woman with 2FDR-BC is expected to be less price elastic, thus more willing to accept premium changes, than a woman with no FH. Their corresponding difference in future health risk would influence their purchasing behavior. Thus, using the set values of $\lambda_{\text{positive}}$ and $\lambda_{\text{negative}}$ as anchors, values of $\lambda_{\text{untested}}^{\text{FH}}$ are estimated for each of the four family histories. These four elasticities are estimated such that after accounting for the relative weights of these family histories in the population and the differences in risk levels, the overall value of $\lambda_{\text{untested}}$ equals 0.6579, the parameter estimate derived from the questionnaire responses. The family history-specific elasticities are $\lambda_{\text{untested}}^{2\text{FDR-BC}} = 0.588$, $\lambda_{\text{untested}}^{1\text{FDR-BC}} = 0.646$, $\lambda_{\text{untested}}^{1\text{FDR-OC}} = 0.662$, and $\lambda_{\text{untested}}^{\text{No FH}} = 0.679$.

To obtain estimates for the risk elasticity of demand, our attention focuses on an individual's responses to questions 1 and 6, which uses the same premium pricing schedule. Question 1 asked the respondent to indicate the desired level of benefit given current death risk; in question 6, the death risk was hypothesized to be doubled. For each respondent, a risk elasticity of demand is determined by calculating the percentage change in benefit given this doubling of health risk in the question; these individual elasticities are then averaged across all respondents to determine $\delta_{(+)}$. An estimate for $\delta_{(-)}$ is calculated in a similar manner, using responses to questions 1 and 11. $\delta_{(+)}$ and $\delta_{(-)}$ are estimated at a 0.9851 increase and a 0.1279 decrease, respectively.

As stated above, the estimate for $\delta_{(+)}$ is obtained assuming a death risk increase of 100 percent. The results of a positive test for BRCA1/2 mutations do not imply that the death risk has doubled. Rather, the degree of change in known health risk depends upon the woman's family history and age. Table 2 presents the change in mortality risk following a genetic test, for the twelve cohorts of women. These probabilities were derived in Lemaire et al. (2000). They showed that, for instance, a 30-year old woman with 2FDR-BC who tests positive experiences a 56.1 percent increase in her 20-year death risk. A linearity assumption is used to interpolate/extrapolate the risk elasticity parameters for women in each cohort, both for positive and negative tests.

TABLE 2

Increase or Decrease of Death Risk Following the Outcome of BRCA1/2 Testing

Age	Test	No FH	1FDr-BC	2fdr-bc	1fdr-oc
30	Positive	+175.7%	+119.2%	+56.1%	+141.2%
40	Positive	+150.8%	+113.8%	+64.0%	+122.4%
50	Positive	+68.7%	+56.2%	+34.4%	+56.6%
30	Negative	-0.9%	-21.2%	-43.9%	-13.3%
40	Negative	-0.8%	-15.4%	-35.1%	-12.0%
50	Negative	-0.4%	-7.8%	-20.7%	-7.5%

Source: Lemaire et al. (2000)

Lapse rates that are differentiated according to test results are introduced. LIMRA International (1996) reported average lapse rates for annually renewable term insurance policies of 15 percent during policy year 1, 14.8 percent during year 2, 12.4 percent during years 3–5, 9.4 percent during years 6–10, and 6.5 percent during years 11+. These lapse rates do not vary much by age at issue. With these rates, out of 1,000 issued policies, only 151.75 remained in force after 20 years. To correspond with this figure, for untested women, a constant lapse rate of 13.4 percent is adopted in our model for years 1–5; a rate of 7.5 percent is used for years 6–20. These rates lead to the same total number of lapses as the LIMRA rates. From the questionnaire, it was observed that no respondents selected a \$0 benefit after learning of a positive or negative test result. This can be interpreted, for this sample, as the initial purchase of insurance serving to fulfill the need to protect a beneficiary rather than a hedge against future dramatic changes in health. Also, as we noted above, respondents did not change their benefit significantly after a negative test. So, for women who test negative, we expect their purchasing behavior to be similar to those who remain untested; thus, the same constant lapse rates of 13.4 percent during years 1–5 and 7.5 percent during years 6–20 are used. For women who test positive, a primary adverse selection concern, as discussed previously, is that they will lapse at a lower rate than women who test negative or remain untested. Following this, as a conservative approach in our benchmark model, the lapse rate is set at 2 percent for women who test positive, regardless of when in the 20-year period they undergo testing.

It is reported earlier in this section that among the respondents to the questionnaire, males demanded higher benefits and average benefits increased with age. This corresponds to predictions of the life cycle model under which lifetime savings and consumption decisions are formed (Modigliani and Brumberg, 1954; Ando and Modigliani, 1963). Extensions of the model allow for funds to be used in creating intergenerational transfers, either by direct bequests and through the purchase of life insurance (Bernheim, 1991; Kotlikoff and Summers, 1981). A household's life insurance holdings aim to maintain the standard of living of survivors; factors to be considered include future income and family size along with spending needs. The amount of life insurance necessary to protect a surviving spouse should take into account that spouse's future income (usually increasing with age) and consumption plans. Over the life cycle, an individual balances the price of adequate life insurance against other consumption needs. Bernheim et al. (2001), Gokhale and Kotlikoff

(2002), and Gandolfi and Miners (1996) examine actual life insurance holdings for participants in the Consumer Finances and the Health and Retirement Survey. They all find that within households, there is a significantly greater amount of insurance on the husband's life, an aspect that insurers should consider when investigating the adverse selection behavior of women.

RESULTS

For each of the twelve cohorts, premiums collected and benefits paid year by year are tracked and term insurance benefits change according to elasticity parameters. The model is first run using the parameter estimates discussed above. As the model conveys, the change in benefits in response to a BRCA test result widely varies across cohorts, as the significance of a test result depends on family history. For women age 30 at the beginning of year 1 with no family history of BC or OC, the prior probability of having the BRCA mutation is only 0.5 percent; a negative test hardly carries any information, while a positive test brings disastrous news and a huge shock. Consequently, the selected benefit—if the test is taken in year 1—only decreases by 0.12 percent if the test turns out to be negative, and increases by 173.07 percent for a positive result. For women age 30 in the 2FDR-BC cohort, the probability of a gene mutation is 40 percent. The outcome of the test conveys significant information, either way. Women testing positive increase their benefit by 55.26 percent, women testing negative decrease their benefit by 5.61 percent. For other family histories, benefit increases following a positive test range between 33.87 percent (2FDR-BC, age 50) and 173.07 percent (No FH, 30), corresponding to the amount of information revealed by a positive test. Benefit decreases following a negative test range between 0.05 percent (no FH, age 50) and 5.61 percent (2FDR-BC, age 30).

Our anticipatory pricing approach considers both the supply and demand sides of the market. At the end of each year, the insurer determines how much life insurance policyholders demand at each possible price for the following year. The firm anticipates how the women would change their benefits in response to a price change. The resulting premium and quantity to be supplied would be such that total premiums equal total expected losses in each year.

Table 3 summarizes the premium evolution for the cohort of women age 30, 2FDR-BC. It is found that the insurer would increase premiums by 1.2 percent after the first year to meet its expected obligations for the following year. The price increase results from the aggregate effect of women getting tested and changing their insurance benefit, untested women expected to reduce their insurance benefit because of a price increase and women who lapse. After 5 years, the actuarially fair premium increases by 17.5 percent; after 20 years, the cumulative premium increase, which we also interpret as cumulated adverse selection, reaches 44.12 percent. The degree of information provided by the BRCA test for this family history renders this case as one of the worst possible scenarios for potential adverse selection; however, with our benchmark parameter estimates, there is no “adverse selection death spiral.” Over time, the adverse selection process tapers off, as the portfolio runs out of insured women available to be tested. After 20 years, 712 policies lapse and 27 policyholders die. The vast majority of these lapses are women who remain untested.

TABLE 3
Cost of Adverse Selection

Year t	Premiums Collected	Age 30, 2FDR-BC		Entire Portfolio	
		Necessary % Increase in Year $t + 1$	Cumulative % Increase by Year $t + 1$	Necessary % Increase in Year $t + 1$	Cumulative % Increase by Year $t + 1$
1	72,753.53	1.1968	1.1968	0.3926	0.3926
2	75,622.09	2.8593	4.0904	0.9421	1.3384
3	80,191.65	3.8234	8.0702	1.3116	2.6675
4	86,030.70	4.2442	12.6569	1.5561	4.2651
5	92,831.57	4.2966	17.4973	1.7057	6.0436
6	100,371.03	2.8448	20.8399	1.1943	7.3101
7	111,141.19	2.5201	23.8852	1.1088	8.5000
8	122,341.78	2.2228	26.6390	1.0149	9.6011
9	133,868.55	1.9603	29.1215	0.9192	10.6085
10	145,628.27	1.7311	31.3567	0.8239	11.5198
11	157,526.82	1.5346	33.3725	0.7341	12.3384
12	169,488.92	1.3663	35.1947	0.6507	13.0694
13	181,444.59	1.2218	36.8465	0.5742	13.7187
14	193,328.20	1.0972	38.3479	0.5043	14.2921
15	205,077.90	0.9890	39.7162	0.4407	14.7958
16	216,635.04	0.8946	40.9661	0.3829	15.2353
17	227,943.88	0.8115	42.1101	0.3302	15.6159
18	238,951.32	0.7381	43.1590	0.2823	15.9423
19	249,606.74	0.6726	44.1219	0.2386	16.2189
20	259,861.97				

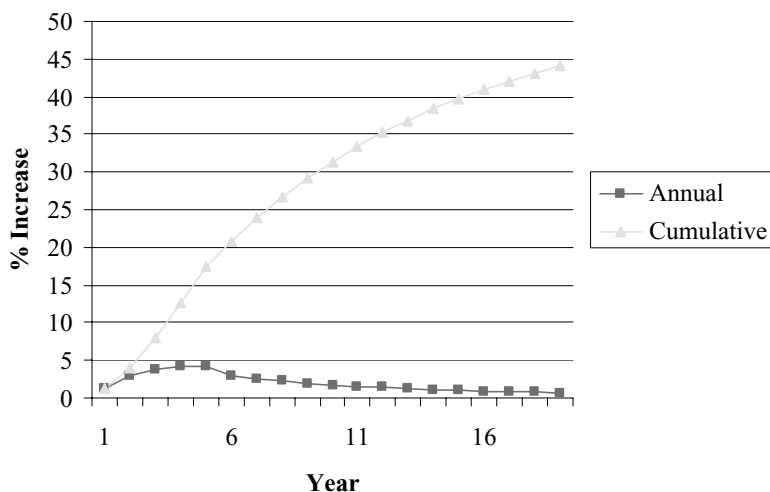
For other cohorts, cumulated adverse selection ranges from 0.04 percent (no FH, age 50) to 50.14 percent (1FDR-BC, age 30). The twelve cohorts are then pooled into a single portfolio in which each cohort of age and family history is weighted by its respective likelihood in the population. These weights are determined using observed age at issue of term insurance policies obtained from LIMRA, and probabilities for given family histories derived from fertility rates published by the National Center for Health Statistics (2000). The evolution of premium increases for the portfolio are tracked; these increases are also reported in Table 3. Aggregating the twelve cohorts into the portfolio, it is observed that the overall cumulative premium increase due to adverse selection reaches 16.22 percent. These required increases would bring the market to equilibrium each year. Despite uncertainties in the estimation of all parameters, it appears likely that adverse selection in term life insurance following a ban on the use of the BRCA1/2 genetic test should not be a major source of concern to insurers.

Sensitivity Analysis

To examine the varying degrees of potential adverse selection due to genetic testing for BRCA1/2 mutations, the sensitivity of our results to the behavioral assumptions is now explored. We examine the sensitivity in the age 30, 2FDR-BC case, one that

FIGURE 1

Age 30, 2 FDR-30 Case: Annual and Cumulative Percent Premium Increases



so far exhibits a high degree of adverse selection; as discussed above, the 20-year cumulative premium increase is found to be 44.12 percent.

Price Elasticity

Recall that the benchmark value of the main price elasticity parameter, $\lambda_{\text{untested}}^{2\text{FDR-BC}}$, is set at 0.588 and that $\lambda_{\text{positive}}$ and $\lambda_{\text{negative}}$ are set at 0.45 and 0.68, respectively. We first examine the sensitivity of these price elasticity estimates. The value for $\lambda_{\text{untested}}^{2\text{FDR-BC}}$ is varied from 0.25 to 1.00; simultaneously, the values for $\lambda_{\text{positive}}$ and $\lambda_{\text{negative}}$ also vary, keeping the original range between them intact. The 20-year cumulative premium increases are then calculated. Keeping all other assumptions constant, we find remarkably that cumulated adverse selection is quite insensitive to changes in price elasticities; it remains at approximately 44.1 percent in the age 30, 2FDR-BC case.

Next, keeping $\lambda_{\text{untested}}$ at 0.588, the range between $\lambda_{\text{positive}}$ and $\lambda_{\text{negative}}$ is expanded by setting these price elasticities equal to 0.00 and 1.00, respectively. Thus, under this scenario, women at a higher than average risk do not reduce their insurance benefit at all in the face of price increases, while women at a lower than average risk react heavily to price changes. We find that the adverse selection cost here reaches 45.73 percent, representing one extreme of behavioral response after genetic testing.

Risk Elasticity

Reiterating how the benefit demanded varies each year in the model, a woman changes the amount of her insurance benefit according to Marshall's Law of Demand, utilizing price elasticity estimates corresponding to her testing status. In the year of testing, a woman changes her insurance benefit solely based upon the risk elasticity of demand corresponding to her testing status. This risk elasticity of demand parameter does not enter into Marshall's Law of Demand because it is initially assumed that the informational impact from a genetic test outweighs any price considerations immediately

after testing. As an alternate method of estimating the benefit change after testing, we now use Marshall's Law of Demand in that determination. A woman would increase or decrease the benefit demanded based upon the percentage change in the price. The new "price" facing the woman would be $P/(1 + DR)$, where DR represents the change in death risk following BRCA1/2 testing. Thus, for a woman who tests positive, the inclusion of DR implies that the "real price," the price relative to her risk level, has fallen; this will lead her to demand a higher insurance benefit for the following year. For a woman who tests negative, this real price would increase, thus leading her to reduce her benefit. Thus, under this approach for determining benefits, for an age 30, 2 FDR-BC woman tests positive in year 1, she would increase her benefit by 22.2 percent; a woman who tests negative would decrease her benefit by 34.5 percent. This approach for determining the benefit change would make the women with stronger family histories of disease more responsive after a negative test. It is observed that the 20-year cumulative premium increase of 46.10 percent, slightly higher than that found in the benchmark model. Over all twelve cohorts, the cumulative increase in this portfolio would be 12.80 percent.

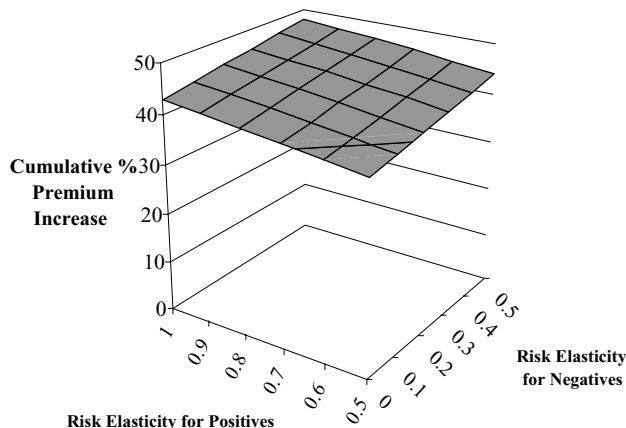
Now returning to the benchmark model and its method of determining price changes after testing, we keep all price elasticities at their initial levels and vary the two risk elasticities of demand. Again, these two parameters $\delta_{(+)}$ and $\delta_{(-)}$ convey the degree of benefit change after a test, which results in doubling or halving the death risk; the initial estimates for these parameters were 0.9851 and 0.1279. $\delta_{(+)}$ is varied from 0.50 to 1.00 and $\delta_{(-)}$ from 0.00 to 0.50. In Figure 2, the gradual increase in cumulated adverse selection is depicted for the age 30, 2 FDR-BC case; at the lowest pair of risk elasticities, the cumulative premium increase is 38.29 percent, and approaches 48.13 percent in the most risk-sensitive case.

Lapse Rates

To examine the incremental effect of lapsing, all lapse rates were kept at their benchmark levels and all price and risk elasticities were set at zero. In this scenario, women

FIGURE 2

Age 30, 2 FDR-BC: Cumulative Percent Premium Increases, Varying Risk Elasticities of Demand



do not change their insurance benefits year to year regardless of testing behavior and price changes; they either remain at \$100,000 throughout their insured life or lapse their policies. It is observed that adverse selection from lapsing forces the insurer to institute a 30.49 percent premium increase over 20 years. We then return the price and risk elasticities to their benchmark values and set only the lapse rates after testing to be zero; the lapse rates for untested women remain at the rates estimated from the LIMRA data. So, in this scenario, regardless of whether a woman tests positive or negative, she does not lapse her policy for the rest of the time period. We find that the 20-year adverse selection cost, which would be solely due to the varied price and risk elasticities of demand, is 13.64 percent.

Prior Testing

In the benchmark model, it is assumed that all women in each cohort are untested at time 0. It is conceivable that some women have already undergone BRCA testing prior to seeking life insurance and already would be demanding a higher insurance benefit than what would be demanded in the absence of this knowledge. Indeed, women who have a strong family history of breast or ovarian cancer could undergo such testing and then seek to become insured. To examine the impact of prior testing in our model, it is now assumed that 5 percent of all women have been tested for the BRCA mutation prior to time 0; these women are distributed among the twelve cohorts based upon their testing rate and representation in the population. Across the portfolio, a 20-year cumulative premium increase of 17.66 percent would be experienced. This would represent an increased risk to the insurer given that losses due to adverse selection would be begin at an earlier time. Insurers should consider the evolving rate at which individuals seek to undergo genetic testing.

Recall that in all of these models, a woman who lapses at an intermediate time does not reenter the market; these cohorts are closed. It must be noted that in the actual market, such a woman could purchase another life insurance policy, either from the same insurer or a different firm. The risk level that she would bring to the insurer's existing portfolio could be substantially different from the average risk level in the portfolio. As described in this article, a woman at higher risk is less likely to lapse her policy while lower risk women are more likely to lapse, thus contributing to the adverse selection problem. It is expected then that these reentrants into the market are more likely to be "good" risks, healthier than the average woman of the same age in the portfolio because she has just undergone medical questionnaires and testing at the time of this insurance purchase. Insuring these women would then infuse into the portfolio better risks over time, thus helping to alleviate some of the adverse selection problem. Given that we are not considering these reentrants in our model, this introduces an additional level of conservatism in our estimates.

Our model introduces three sources for adverse selection: differentiated benefits following test results, differentiated lapse rates after testing, and different reactions to price increases. Focusing on the age 30, 2 FDR-BC case, one of the cohorts that has the highest potential for adverse selection, at our benchmark parameter estimates, we calculated cumulated adverse selection costs to be 44.12 percent after 20 years. The

impact of differentiated lapsing rates is estimated at 30.49 percent while the impact of price and risk elasticities is found to be 13.64 percent. Given that differentiated reactions following premium increases were found to be negligible, we conclude that adverse selection costs come mainly from benefit changes following the shock of a test and varying lapsing rates after testing. The price elasticity of demand has a minimal impact on adverse selection costs.

CONCLUSIONS

Our analysis, performed with conservative behavioral assumptions, concludes that potential adverse selection due to BRCA1/2 testing may not result in a significant cost to term life insurers, as our benchmark estimate of the cumulative effect of adverse selection after 20 years only amounts to 16.22 percent. This cost is likely to be offset by the overall decrease in mortality rates, and the decline in breast and ovarian cancer mortality due to better prevention, detection, and treatment techniques.

Our study only deals with the consequences of a ban on the use of the BRCA1/2 test. A comprehensive ban on the use of all genetic tests by the life insurance industry obviously would generate more adverse selection. Many other genetic tests are now available. Among the most common are tests for familial adenomatous polyposis, myotonic dystrophy, early-onset Alzheimer's disease, multiple endocrine neoplasia, and hereditary motor and sensory neuropathy. The prevalence in the general population of the mutation for these disorders is generally much smaller than the prevalence of BRCA1/2. In addition, probabilities to develop the disease after a positive test are usually smaller than with BRCA1/2 mutations; thus their impact on life expectancy is likely to be smaller. Consequently, a similar model, specifically developed for other genetic diseases, will surely lead to smaller estimates of the cost of adverse selection. Noteworthy is the fact that all actuarial studies of the consequences of a moratorium or a ban on the use of genetic tests by insurers are unanimous in concluding that the cost of adverse selection arising from a ban that does not extend to family history should be negligible (MacDonald, 2003; MacDonald and Pritchard, 2000, 2001; Subramanian et al., 1999). Moreover, all of these studies are based on such extremely conservative assumptions that they probably overstate the costs of adverse selection to some extent.

We conclude that as long as current testing conditions prevail (few highly predictive genetic tests available, low testing rate due to high cost), adverse selection due to genetic testing could be a manageable problem for insurance companies. This conclusion is valid only in the term life insurance market; models to study the impact of genetic testing and adverse selection in health and long term care insurance, which require different inputs on morbidity and treatment, are currently being developed.

This conclusion could change if advances in genetics lead to the development of an inexpensive test that would simultaneously investigate many common genetic diseases. The availability of such a test may be several years away, at best. Indeed, there have been few, if any, major genetic discoveries in the last five years. The

TABLE A1
Question 1, Age Group 36–45

Given Your Current Health and the Basic Premiums Listed Below, How Much Personal Life Insurance Would You Buy?	
Annual Premium	Benefit Amount
No purchase	0
\$160	\$100,000
\$250	\$200,000
\$340	\$300,000
\$430	\$400,000
\$520	\$500,000
\$610	\$600,000
\$745	\$750,000
\$970	\$1,000,000
\$1,420	\$1,500,000

medical researchers' enthusiasm following the discovery of major gene mutations in the 1990s [Cystic Fibrosis (1989), Familial Colon Cancer (1993), Alzheimer's Disease (1993), BRCA1 (1994), BRCA2 (1995), Hemochromatosis (1996)] has led to recent frustration, as few advances on the genetic component of diabetes, asthma, hypertension, schizophrenia, and bipolar disorder have been reported (Knowlan, 2004). Optimistic predictions concerning the impact of genetics in the treatment of diseases have not materialized.⁵ This provides some time for actuarial research to further investigate the consequences of new tests. In the presence of huge uncertainties concerning the future of genetic testing, a limited-time moratorium on the use of genetic tests by insurers, a policy implemented in many European countries, could make sense.

APPENDIX A

Survey Questionnaire

After answering questions concerning employment, gender, marital status, years of education completed, number of people depending on their financial support, and annual household income, respondents were requested to imagine that they currently have no personal life insurance, through their employer or otherwise, and that they are contemplating purchasing a ten-year term life policy for themselves. After explanations about the policy, respondents had in question 1 to select one benefit amount and annual premium, given their current health conditions. For the 36–45 age group, premium and benefits are provided in Table A1. In subsequent questions, premiums and health conditions were varied, keeping the same benefit levels.

⁵ "By the year 2004, the typical primary care physician will no more be able to practice medicine without thinking genetically than he or she can practice today without knowing about infectious diseases" (Alan Guttmacher, Health Progress, 1999).

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