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October 20, 2000

Genetic testing when there is a mix of public and private health insurance *

by

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Abstract

Genetic insurance can deal with the negative effects of genetic testing on insurance coverage and income distribution when the insurer has access to information about test status. Hence, efficient testing is promoted. When information about prevention and test status is private, two types of social inefficiencies may occur; genetic testing may not be done when it is socially efficient and genetic testing may be done although it is socially inefficient. The first type of inefficiency is shown to be likely for consumers with public insurance only, while the second type of inefficiency is likely for those with a mix of public/private insurance. This second type of inefficiency is more important the less effective prevention is. It is therefore a puzzle that most countries have placed some kind of restrictions on what type of health information insurance companies have access to.

JEL classification: D82; H52; I18

Keywords: Genetic testing, insurance, private information, public/private mix

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1 Introduction

On June 26, 2000, the leaders of both the publicly and the privately funded human genome projects announced that a draft of the human genome now has been made. During the next few years, this knowledge is likely to be applied in the development of predictive tests for many diseases. The tests will be able to distinguish between high risk and low risk individuals at a presymptomatic stage of disease. Presently, around fifteen to twenty tests are offered, including tests for Huntington's disease and cystic fibrosis. Recently, two important breast cancer genes (BRCA1 and BRCA2) have been identified, and the U.S. Food and Drug Administration has approved a gene-based test that may help to predict the recurrence of breast cancer. The number of tests is expected to increase rapidly in a few years, in parallel to the mapping of the human genes. For instance, tests for genes that imply an elevated risk of several types of cancer, cardiovascular diseases, and Alzheimer's disease are already available or are expected to be available in the near future.

The information from gene-based tests may be important for initiating measures for postponement and prevention of disease. Genetic tests are also expected to have an important impact on the organization of health systems and, in particular, health insurance. There is a concern that insurers can make use of information to deny coverage for individuals with an increased risk of disease or require them to pay prohibitively high insurance premiums. Regulation of the access to, and the use of information from, genetic testing is therefore an important health policy issue in many countries. In Norway, the law on the application of biotechnology prohibits requests for information on individuals that stems from genetic tests. It is also prohibited to ask whether a genetic test has been done. In the U.S., a majority of the states have banned the use of genetic information by insurers. The Congress in 1996 passed legislation that forbids group health organizations from denying coverage on the basis of genetic information. Efforts are also made to extend the prohibition to all health insurers and to ban insurers from raising premiums based on genetic data (Schwartz, 1998).

Given the economic and social concerns related to the possible use of genetic tests, an important question is whether some institutions are better fit than others to reap the benefits and avoid the costs of genetic testing. Benefits accrue from testing as a precondition for prevention and postponement of disease, while social costs are both related to inefficient testing (as defined below) and less insurance coverage. In addition we are concerned with access to and costs of insurance for high-risk persons.

Two regulatory issues emerge. Firstly, there is the regulation of access to information about a person's test status. Notice that in this case the existence of private or public information is a policy issue, while in many other situations it is a characteristic of the market. Secondly, there is the regulation of the insurance market and especially the mix of compulsory and voluntary insurance.

We study how the demand for genetic testing is likely to be influenced by the regulation of what information insurers have access to. The insurance system considered is a mix of public compulsory insurance and private supplementary insurance. In particular, we are interested in the extent to which possible inefficiencies depend on the mix of compulsory and voluntary insurance in a system of health insurance. Two types of inefficiencies may occur. Firstly, tests may not be undertaken when testing is socially efficient, in the sense that testing implies a Pareto-improvement. Secondly, tests may be undertaken when testing is socially inefficient. We show that the first type of inefficiency is likely for systems with a high proportion of compulsory public insurance while the second type of inefficiency is likely for systems with substantial private supplementary insurance. We further show that inefficiencies are more likely to occur when information about a person's test status is private than it is when the information is public. In relation to these results it is a puzzle that the legislation in many countries emphasises the privacy of information.

The paper draws on previous literature on this and related topics. Section 2 introduces the basic insurance model. Tabarrok (1994) offers a discussion of the potential benefits and costs related to genetic testing. He proposes a compulsory insurance against the consequences of being identified as a high-risk person through genetic testing. We derive Tabarrok's main conclusion in section 3 of this paper, and use the full information case as a benchmark for our further analysis. In section 4 we assume private information of costs of prevention. In accordance with initiatives in many countries, we also impose the institutional constraint that insurers have no access to genetic information. Our analysis makes use of results from Doherty and Thistle (1996). In contrast to what is assumed in most of the literature, Doherty and Thistle (1996) assume that a consumer's information about his risk status is endogenous. A consumer decides whether or not he wishes to obtain the information from testing. The optimal decision from the consumer's point of view is shown to depend on the insurer's access to information about test status and result. In this paper we take the analysis further by introducing the following two new features:

- Prevention: An important motive for testing is the prospects of a reduction in risk of disease my means of prevention. The effect of self –protection technologies on social welfare under alternative assumptions of access to information is studied by Hoy (1989). In Hoy (1989) the consumers' information about their risk status is exogenous. In the present paper the information is made endogenous by the consumer's decision about whether to be tested or not.

- The public/private mix of health insurance: Public insurance is assumed to be compulsory with everybody paying the same premium. Private insurance is assumed to be voluntary with a premium adjusted to individual risk of illness. The mix of compulsory (public) and voluntary (private) insurance is an important health policy issue in most countries. It is of importance for policy makers to know whether the availability of genetic testing is likely to influence the properties of alternative systems.

An important distinction is whether private insurance is considered to be a supplement or an alternative to public insurance. A few examples may clarify the distinction. A person with symptoms of disease and with public coverage is likely to make use of the public insurance in the first contact with a physician. The visit may result in diagnosis and treatment or a referral to a specialist for further diagnostics and treatment. A referral may be accompanied by a waiting time before a specialist can be seen. The waiting time may be shortened by means of privately funded provision of health services. A privately funded specialist is then an alternative to a publicly funded. Once a diagnosis is made, treatment may or may not be provided by the public sector. For instance, expensive treatment may be rationed and some patients with treatment indications may be turned down. The private sector may then be a supplement for those patients experiencing rationing in the public sector. Also, a waiting time for publicly funded treatment may occur. The waiting list may be bypassed by means of privately funded treatment. In this case private care is an alternative to the publicly funded care. Hence, we see that some parts of privately funded health services may be considered an alternative to publicly funded services, while others may be considered a supplement. For instance, Besley, Hall and Preston (1998) consider UK private health insurance to be somewhere between the two stylised alternatives.

Section 5 discusses implications for public policy. In the concluding remarks in section 6 we suggest that an inefficiently high level of testing is likely to occur in the coming years, since genetic therapy is likely to lag behind the development of genetic diagnostics, and hence, limit the scope for effective prevention. Limitations of the analysis and suggestions for future research are also given.

2 The basic insurance model

Individuals are assumed to differ along two dimensions: The risk of having a disease in the future, and the loss of income, ℓ, if disease strikes. These two characteristics are assumed to be unrelated.

The level of risk is assumed to be related to genetic disorders that may be revealed by means of genetic testing. Individuals belonging to group H have a risk, p_H, while individuals in group L have the risk, p_L, where $0<p_L< p_H<1$. The proportion of low risk individuals in the population is θ_L and the proportion of high risks is θ_H, where $0< \theta_L, \theta_H <1$ and $\theta_L+ \theta_H =1$. The parameters p_L, p_H, θ_L and θ_H are assumed to be common knowledge.

All individuals are assumed to have the same exogenously determined income, w, as sick. The loss of income related to disease differs between individuals because their income or productivity as healthy is assumed to differ. The higher the productivity as healthy, the greater is the loss of income, ℓ, as sick. As mentioned above, the distribution of ℓ is the same in the group H as it is in the group L.

By means of insurance, income can be transferred from the healthy state to the state of poor health. In this specific context insurance can be thought of as covering the costs of medical treatment necessary to (partly or fully) compensate the loss of income due to illness.

In this paper we consider private health insurance as a supplement to compulsory public insurance. Compulsory public insurance is assumed to cover a portion $x \leq \ell$ of the loss, where x is assumed to be exogenous and equal for all[1]. Hence, the higher the productivity as healthy, the lower is the proportion of the loss covered by public insurance. The loss from poor health is in the analysis restricted to the loss of income. Good health obviously has a value in itself, but this component is not drawn into the analysis at the present stage.

Insurers are assumed to break even. In a competitive insurance market where insurers are risk neutral expected profit maximisers, expected profits will be driven to zero. If the insurer is the public sector or a private non-profit institution, the zero expected profit is imposed as an institutional constraint or by the implication of funding from public budgets. Since we ignore administrative costs, insurance can then be offered at actuarially fair rates.

The premium paid for public insurance is assumed to be independent of individual risk. Each individual is assumed to pay an equal premium, with a calculated risk equal to the average population risk, $Q = \theta_H p_H + \theta_L p_L$, and a premium equal to Qx.

[1] It is assumed that the lowest ℓ-value in the distribution is equal to or larger than x. Nothing of importance would be changed if we instead had assumed that some ℓ-values were lower than x, and that the public insurance for these cases covered the whole loss ℓ.

Voluntary private insurance covers loss in excess of x. A private insurance policy, (q, k), is characterised by the premium as a proportion of the covered loss, denoted by q, and the proportion of the loss, $k \in [0,1]$, that is covered. Consumers are assumed to choose the policy that maximise their expected utility, given the public coverage. The expected utility of an insurance policy for a person with probability of disease equal to p, is:

$$
\begin{aligned}
v(w, p, q, k, \ell, x) = (1-p)u(w - Qx - qk(\ell - x) + \ell) + \\
pu(w - Qx - qk(\ell - x) + x + k(\ell - x))
\end{aligned}
\tag{1}
$$

where $w+\ell$ is the gross income in the healthy state and $w+x+k(\ell-x)$ is the gross income when unhealthy. In both states, the insurance premium (compulsory public plus supplementary private) is $Qx+q(\ell-x)$. We assume risk aversion, implying that the marginal utility of net income is declining with the amount of income. Hence, $u(\cdot)$ is strictly concave.

We assume that, prior to the introduction of genetic testing, nobody knows his true risk type. Hence, initially, as uninformed, the whole population is assumed to have an identical perception of their own risk equal to a weighted average of the actual risk of the two groups; $Q= \theta_H p_H + \theta_L p_L$. From the assumption of actuarially fair insurance rates it thus follows that the premium rate for private insurance is equal to the premium rate for public insurance.

FIGURE 1

In figure 1, income in the unhealthy state is measured along the horizontal axis and income in the healthy state along the vertical axis. Full insurance coverage, i.e. an equal income in both states, is illustrated with the 45-degree line from the origin. The vertical line through E shows the range of incomes in the healthy and the unhealthy state for a person with public insurance only and alternative values of the loss, ℓ. A person with an income point located at the intersection between this vertical line and the 45-degree line from the origin has a loss as sick that gives full coverage from the public insurance, ℓ=x. Those with incomes in the healthy state above the 45- degree line from the origin after public insurance is accounted for (ℓ-x>0), say point E in figure 1, are not fully covered by public insurance. EA shows all combinations of income in the two states compatible with actuarially fair insurance for the low risk group, and EB similarly for the high-risk group. EB is steeper than EA because the high-risk group must forego more income than the low risk group in the healthy state to have one dollar in the unhealthy state because of the higher risk of ending in the unhealthy state. EC describes feasible combinations of income in the two states when both groups pay an equal premium calculated on basis of the weighted average risk of the population, Q. Risk averse uninformed consumers prefer full insurance when premiums are actuarially fair. Since no one is assumed to know his risk type prior to genetic testing, Q, corresponds to the apparently actuarial fair premium rate. Hence, C describes the optimal income in the two states with compulsory insurance and supplementary private insurance for a person located at point E with public insurance only.

3 Test status, test result and prevention as public information

The purpose of genetic testing is to discover disease in an asymptomatic stage, in order to take preventive measures to reduce the probability of contracting the disease. Whether prevention is available and likely to be demanded, is therefore an important factor in determining the demand for predictive testing. Two cost components may be involved in prevention. The first component is the costs of providing professional medical care. To simplify the exposition, we shall without any substantial loss set these costs equal to zero. The second cost component is personal costs related to preventive measures. These costs are of two kinds. The first kind is costs related to activities that can easily be observed, for instance travelling and absence from work to attend disease prevention programmes. The other kind of personal costs are unobservable for others than the person who carries the costs. Examples are time used in preparation of a special diet and pain and discomfort experienced from preventive measures as healthy diet and physical exercise.

In Hoy (1989) the risk of illness is assumed to depend on the amount of prevention, z, and of exogenous individual characteristics like genetic factors. Hence, the probability of illness for a high risk person is $p_{Hz} = p_H(z) = f(G_H,z)$ and similarly for a low risk person, $p_{Lz} = p_L(z) = f(G_L,z)$, where G_H and G_L denote the genetic factor for a high and a low risk person, respectively. We simplify by assuming that $p_{Hz} = sp_H$ and $p_{Lz}=p_L$, where s is a parameter. Hence, we assume z to take the alternative values 0 or 1 for a high risk person, with z=0 implying s=1 and z=1 implying s<1. Prevention is assumed to have no effect is you are a low risk person. Assume that effective prevention exists for high risks; i.e. s<1. With all information public, an individual insurance contract can be made contingent upon both test status and upon whether prevention is undertaken. With prevention, the initial point for the high risk group moves from E to E´ in figure 2, because individual costs of prevention accrues ex ante and hence, diminish income in both states.

FIGURE 2

In the subsequent analysis, we shall make the following simplifying assumptions about testing and preventive measures:

(a) test costs are zero

(b) testing is socially efficient (defined precisely below)

(c) the effect of prevention is less favourable than bringing a high-risk person to the same risk level as a low-risk person

(d) for a person who can buy unlimited supplementary insurance at an actuarially fair price and who does not know whether he/she is high-risk or low-risk, it is not worthwhile to undertake prevention.

Assumption (b) is defined as follows: if unlimited insurance possibilities exist (i.e. no moral hazard or adverse selection problems), testing will increase utility levels. This is the same as saying that testing will increase average income in society. Clearly, testing in itself cannot increase average income. However, average income can be increased if preventive measures can be undertaken that increase the average income of the high-risk group. Without preventive measures the average income of the high-risk group is $w+(1-p_H)\ell$, and with preventive measures it is $w-\gamma+(1-sp_H)\ell$. Our definition of efficiency is thus that $w-\gamma+(1-sp_H)\ell > w+(1-p_H)\ell$, i.e.

$$\gamma < (1-s)\,p_H\,\ell \tag{2}$$

In words, testing is socially efficient if the increase in expected income due to testing is larger than the monetary equivalent of personal costs of prevention.

Assumption (c) implies that $sp_H>p_L$. Taken together with (2) we thus have

$$\frac{p_L}{p_H} < s < 1-\frac{\gamma}{p_H\,\ell} \tag{3}$$

Assumption (d) may be written as

$$v(w-\gamma,\theta_L p_L+\theta_H sp_H, c(\theta_L p_L+\theta_H sp_H,1),\ell,x)<v(w,\theta_L p_L+\theta_H p_H, c(\theta_L p_L+\theta_H p_H,1),\ell,x) \quad (4)$$

Using (1), it is straightforward to verify that this inequality may be rewritten as

$-\theta_H p_H(\ell\text{-}x) > -\gamma-\theta_H sp_H(\ell\text{-}x)$. Our assumption (d) is thus that

$$\gamma>(1-s)\theta_H p_H(\ell-x) \quad (5)$$

It is obviously possible for γ to be so low that the inequality in (5) is violated, especially for persons with high income as healthy, i.e. high ℓ. However, since the focus of this paper is the efficient use of genetic testing, we choose to rule out this case.

The two inequalities (2) and (5) give us the following constraint on the cost of prevention:

$$(1-s)\theta_H p_H(\ell-x)<\gamma<(1-s)p_H\ell \quad (6)$$

FIGURE 2

Figure 2 illustrates efficient testing for a person who demands private insurance. The line E´F shows the collection of actuarially fair insurance contracts for a high-risk person who has taken preventive measures. We see that the line E´F intersects the 45-degree line for a higher income than the line EB. Hence, the certainty equivalent income with prevention is higher than without. The line E´F is however steeper than the line EA, which shows the price of insurance for a low risk person.

Private supplementary insurance with full coverage can be offered for all alternative probabilities of disease. (Q,1) (point C in figure 2) is offered if a person chooses to stay uninformed, (p_H,1) (point B) if a positive test shows up and no prevention is undertaken, (sp_H,1) (point F) if positive test and prevention and (p_L,1) (point A) if a negative test occurs. At the initial, uninformed state each person has four options:

1) Do not test and do not undertake preventive measures
2) Do not test, but undertake preventive measures
3) Test, but do not undertake preventive measures even if the test reveals that one is high-risk
4) Test, and undertake preventive measures if the test reveals that one is high-risk

Our assumption (d) rules out alternative 2. Denote expected income under alternative 1 by y^1. Since we in this section assume the full information, full insurance will be chosen at an actuarially fair premium. The income is y^1 whether healthy or not, and is given by

$$y^1 = w + \ell - (\theta_L p_L + \theta_H p_H{*})x - (\theta_L p_L + \theta_H p_H)(\ell - x) \qquad (7)$$

where p_H* is the share of high-risk persons who become ill. If no one undertakes preventive measures, we of course have p_H*= p_H. If a share α of the high-risk persons undertake preventive measures, p_H*= αsp_H+(1-α) p_H.

Consider next alternative 3. In this case the income a person will get will depend on the test result. Given the risk class, income is independent of whether one is healthy or not (as in alternative 1). Expected income y^3 is in this case

$$y^3 = \theta_L\left[w + \ell - (\theta_L p_L + \theta_H p_H{*})x - p_L(\ell - x)\right] + \theta_H\left[w + \ell - (\theta_L p_L + \theta_H p_H{*})x - p_H(\ell - x)\right] \qquad (8)$$

The first term in brackets is the income the person will get if he/she turns out to be low-risk, and the second term in brackets is the income the person will get if he/she turns out to be high-risk. It is straightforward to verify that y^3=y^1. Since we have assumed risk aversion, it is therefore clear that alternative 1 will be preferred to alternative 3.

Alternative 4 gives the same income as 3 if the test reveals that one is low-risk. If the test reveals that one is high-risk, the income is different from alternative 3. The expected income y^4 is in this case given by

$$y^4 = \theta_L[w+\ell-(\theta_L p_L+\theta_H p_H*)x - p_L(\ell - x)] + \theta_H[w+\ell-\gamma-(\theta_L p_L+\theta_H p_H*)x - sp_H(\ell - x)] \quad (9)$$

where the first term in brackets is identical to the first term in brackets in (8)

An individual will choose alternative 4 instead of alternative 1 if the expected utility with testing and prevention is greater or equal than the expected utility as uninformed. A *necessary* condition for this to be the case is that $y^4 > y^1 = y^3$. Comparing (9) with (8) we see immediately that $y^4 > y^3 = y^1$ if and only if

$$\gamma < (1-s)p_H(\ell - x). \quad (10)$$

Even if the inequality (10) holds, the existence of risk aversion may still imply that a person chooses to stay uninformed. To undertake the test is for an individual a lottery, since the income under alternative 4 is uncertain, while the income under alternative 1 is certain. In figure 2, this lottery is illustrated by the two outcomes A and F. One may win and go to A or lose and go to F, while one without the test obtains C. Testing is less likely to be chosen the larger s is and the larger γ is, since the loss that comes from a positive test is then larger. Likewise, testing is less likely to be chosen the more risk averse a person is. Finally, it follows from (10) that testing is less likely the lower income the person has as healthy, and the larger is the coverage of the compulsory health insurance.

Notice that (10) is a stricter condition than the condition for testing to be socially efficient (given by (2)), since $(1-s)p_H(\ell - x) < (1-s)p_H\ell$. Hence, when an individual decides to be tested, testing is socially efficient. Testing may however be social efficient although chosen not to be undertaken by an individual.

Compulsory insurance offers full coverage independent of test status and prevention. The premium reduction from prevention is divided equally among all individuals. For a large population an individual's share in the premium reduction is negligible. For a person who is fully covered by the compulsory insurance (i.e. ℓ=x) prevention will therefore not be undertaken (since $\gamma > 0$, cf. also (10) for ℓ=x), although prevention may be socially efficient.

In the full information case the government can encourage socially efficient testing and prevention by compensating individuals for personal costs. A person with only public insurance is indifferent between staying uninformed and undertaking testing and prevention when[2]:

$$\begin{aligned} &u(w+x-(\theta_L p_L+\theta_H p_H^*)x)= \\ &\theta_L u(w+x-(\theta_L p_L+\theta_H p_H^*)x)+\theta_H u(w+x-\gamma-(\theta_L p_L+\theta_H p_H^*)x+r) \end{aligned} \qquad (11)$$

where the premium reduction is assumed to be negligible and r is the compensation for undertaking prevention. We see that indifference is fulfilled for r = γ. Problems in practice are likely to arise since individual variation in γ is likely to occur.

To encourage a person with mixed public and private insurance to undertake testing and prevention, the government may offer insurance against the costs of being identified as a high-risk person. Since the costs of being identified as a high-risk person compared to a low risk person is $(sp_H - p_L)(\ell - x) + \gamma$, actuarially fair insurance can be offered at the cost

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[2] Utility is the same whether healthy or sick in the present case of full information. When comparing the consequences of testing or not, it is therefore sufficient to consider the healthy state of the two cases.

$\theta_H[(sp_H - p_L)(\ell - x) + \gamma]$. With fair insurance against the loss of being identified as high risk, an uninformed person will choose the testing and prevention option since this option now offers the highest expected income and utility.

This result supports the policy statements in Tabarrok (1994). He argues that the potentially negative effects of predictive testing on insurance coverage and income distribution could be avoided by introducing compulsory insurance against the financial consequences of becoming high risk when a person decides to be tested, i.e. genetic insurance. He claims that this suggestion would make the implementation of socially beneficial testing more likely.

The full information case is considered as a benchmark for the further analysis where private information is assumed either because of characteristics of the preventive activities or because of regulation imposed on the insurance market.

4 Test status, test result and prevention as private information

In this case the prevention an individual undertakes is assumed to be his private information. Accordingly, also the personal cost of prevention is private information. Hence, an insurance contract cannot be made contingent on whether prevention is undertaken. We also impose the institutional constraint that insurers have no access to information about whether a person is tested. Since those tested then cannot be distinguished from those not tested, insurance contracts can neither be contingent on whether a person is tested nor on the test result.

The premium for a person with only compulsory public insurance is assumed to be independent of their individual risk. This means that the self-selection mechanism used by the private insurer is not applicable to the public insurer. Hence, when preventive costs are private information, socially efficient testing is not likely to be undertaken by those with only public insurance when personal costs of prevention occur.

We consider next the optimal decisions for a person with private supplementary insurance. Assume first that insurers expect consumers to be informed of whether they are H (high-risk) or L (low-risk). Clearly, if there were full insurance coverage, there would be no incentive to undertake prevention, since prevention has a cost. The actuarially fair premium for a high-risk person who has undertaken prevention is sp_H, and the insurance coverage k that can be offered to such a person is constrained by

$$v(w-\gamma, sp_H, sp_H, k, \ell, x) \geq v(w, p_H, sp_H, k, \ell, x) \qquad (12)$$

If this constraint were not satisfied, a person would be better off without preventive measures than with. From the definition of the function v given by (1), it is clear that this inequality will be violated if k=1 (since, by assumption, $\gamma>0$). If γ is sufficiently large, the inequality (12) will not be satisfied for any positive k. In this case, prevention is so costly that it will never be undertaken. For lower values of γ, there will exist positive values of k satisfying the inequality (12). Denote the highest value of k satisfying (12) by k'. The insurance contract (sp_H,k') is thus the insurance contract offered to the high-risk persons, inducing them to undertake prevention. Notice that k' in general will depend on ℓ, i.e. the coverage as a per cent of the income loss will depend on the income loss. However, without making further assumptions on the utility function u we cannot say whether k' is increasing or decreasing in ℓ.

The low-risk persons are offered insurance at a premium p_L. The coverage they are offered cannot be too high, otherwise high-risk persons would prefer this contract to the more expensive contract (sp_H,k'). More precisely, the self-selection constraint is given by

$$v(w, p_H, p_L, k, \ell, x) \leq v(w, p_H, sp_H, k', \ell, x) \tag{13}$$

Since we have assumed $p_L < sp_H$ (assumption c in Section 3), it follows directly from the definition of the function v that this inequality is violated for $k \geq k'$. Denote the highest value of k satisfying (13) by k''. The insurance contract (p_L,k'') is thus the insurance contract that will be chosen by the low-risk, but not the high-risk, persons. Just like k', k'' will in general depend on ℓ, but we cannot say whether k'' is increasing or decreasing in ℓ.

In an appendix, we show that a consumer's best choice is to acquire information through testing and do prevention if the test result turns out to be positive. The intuitive reason is this: Assume that I choose (sp_H, k') as uninformed. With the information acquired through testing, I shall know whether I am a low-risk or a high-risk individual. If it turns out that I have low risk, I can choose a better contract than (sp_H, k'), namely (p_L, k"). If it turns out that I am a high-risk person, I can do equally well as I could as uninformed by means of prevention. We therefore have an equilibrium (a Nash equilibrium) where the insurer's expectations of testing is fulfilled, with all the low-risk persons choosing the insurance contract (p_L,k'') and all the high-risk persons choosing to undertake prevention and choosing the insurance contract (sp_H,k'). A similar reasoning applies if (p_L, k") is chosen as uninformed.

Doherty and Thistle (1996) show that if the insurer does not expect consumers to be tested, no Nash equilibrium exists. Doherty and Thistle do not consider the availability of preventive measures. Since availability of prevention makes testing more attractive, their result also applies to the present model.

Compared to the full information contract there is a social loss since the insurance coverage for both groups declines. If there are not too many high-risk individuals in the population, even the low-risk group is worse off because the loss from less insurance coverage outweighs the gain from fewer subsidies to the high-risk group.

5 Policy questions

An implication of the analysis is that public insurance can only encourage efficient testing if individual prevention costs are public information, so that individuals can be compensated for these costs. If the individuals' costs of prevention are private information, there is a bias towards not undertaking socially efficient testing because an individual will only have a negligible proportion of the social benefit.

A reduction in the amount of public insurance (i.e. a reduction in x) is compatible with efficient testing and prevention when information about test status is public, and redistribution, for instance by mean of a compulsory insurance against the consequences of being identified as a high risk, occurs. The basic rules for income taxation could be combined with rules for tax reductions (according to a publicly known set of standards) that are given to persons who can document that they are of high-risk types. Such tax reductions according to criteria beyond the control of the individual are often used, e.g. for age or disability in Norway. A tax system of this kind would to a large extent eliminate the distributional consequences of being identified as a high risk.

However, with private information about test status and prevention, a reduction in the amount of public insurance encourages testing also when testing is socially inefficient (s=1). The reason is that the price of private insurance as untested worsen when the insurer cannot distinguish the truly uninformed and the high-risk persons who pretend to be uninformed. Also, only partial insurance can be offered in this case because of the incentive compatibility constraints.

This means that a high-risk person cannot obtain any better terms of insurance in the private information case than he does in the public information case. In fact, the terms are likely to be worse, because he cannot be offered full insurance if costs of prevention are private information. Additionally, genetic insurance is not possible with private information about test status.

Given these unfavorable effects of private information about test status, it is a puzzle that the policy of most international organizations and individual countries are against making the information from genetic tests public. For instance, the Council of Europe, recommends (R(92)3 and R(97)5) that predictive genetic tests should not be used when the terms of insurance is decided. Among European countries[3], Belgium, Denmark, France, the Netherlands, Norway and Austria has approved restrictive laws while other countries have less formal regulation and might prepare regulation by law. In Norway, the majority of a public commission (Ministry of Health and Social Affairs, 2000) has suggested that insurance companies should have the right to require information about health status, including genetic information, for insurance contracts exceeding a certain amount. The suggestion has led to much public debate and strong opposition among many politicians.

An important reason behind the privacy of information is that a person has a right not to know. But, as showed in section 4, the incentive to undergo genetic testing is in fact greater

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[3] This is according to information in Ministry of Health and Social Affairs (2000)

with private information than with public information. Hence, the right not to know seems to be better protected with public information about test status than with private information.

If we, despite of what is said above, take for granted that the privacy of information is a concern that health policy must adhere to, then a high degree of public insurance has a virtue regarding both income distribution and access to comprehensive insurance. However, a high degree of public insurance makes it less likely that socially efficient testing is done. On the other hand, a low degree of public insurance makes it more likely that also socially inefficient testing is initiated due to incentives for risk sorting. The optimal mix of public and private insurance therefore seems to depend on the kind of mistakes one is most eager to avoid.

6 Concluding remarks

Two types of social inefficiencies may occur when information about prevention and test status is private; genetic testing may not be done when it is socially efficient and genetic testing may be done although it is socially inefficient. The first type of inefficiency is likely for those publicly insured, while the second type of inefficiency is likely for those with a mix of public/private insurance. Hence, regulations imposed to protecting individuals from insurers' use of genetic information may have the side effect that genetic tests are done in a larger scale than is socially efficient.

This second type of inefficiency is likely to be more important the less effective prevention is. Genetic tests are likely to be offered before effective treatment of genetic disorders are available (see for instance, Schwartz, 1998). The potential social inefficiency attached to this uneven development of technologies is likely to be more prevalent the less compulsory insurance that a system contains.

This paper contains assumptions that should be modified and explored in future research. We assumed that private insurance is a supplement to compulsory insurance. It should be studied whether it makes any difference for our conclusions if private insurance is assumed to be an alternative. We also considered the level of public insurance as exogenously determined. An interesting extension would be to allow for an interaction between the level of private insurance and public insurance. For instance, the decision to buy private insurance may have an impact on the level of public insurance a consumer prefers and hence, his voting behaviour.

We also assumed that all consumers consider their health risk to be average prior to genetic testing. As mentioned above in connection with the possibility of insurance against the financial consequences of testing, this is not quite realistic. For instance, family history may be used to distinguish between high risk and low risk individuals. An important modification is then to allow for consumers to have some ex-ante information of their risk type.

Finally, we assumed no preferences for good health, per se. The motivation for good health was confined to preferences for income. The consequences of including health as a separate argument in the utility function should be explored in future work. Hence, the introduction of state dependent utility functions, as in Strohmenger and Wambach (2000), will be an important analytic tool in future work.

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Appendix: Derivation of a consumer's best choice with test status, test result and prevention as private information

The consumer's choice is among the two alternatives staying uninformed with insurance contract (sp_H,k') or (p_L,k'') or do testing and prevention and choose the contract contingent on the test result. Let I be the difference between the expected utility of doing the test and the expected utility of being uninformed and assume that the individual chooses (sp_H, k') as uninformed:

$$
\begin{aligned}
& I = \{\theta_H v(w-\gamma, sp_{H,} sp_H, k', \ell, x) + \theta_L v(w, p_L, cp_L, k'', \ell, x)\} \\
& -v(w-\gamma, \theta_L p_L + \theta_H sp_{H,}, sp_H, k', \ell, x) \\
& = \theta_H \{sp_H u(w-\gamma+(1-Q)x+(1-sp_H)k'(\ell-x)) + \\
& (1-sp_H)u(w+\ell-\gamma-Qx-sp_H k'(\ell-x))\} \\
& +\theta_L\{p_L u(w+(1-Q)x+(1-p_L)k''(\ell-x)) + \\
& (1-p_L)u(w+\ell-Qx-p_L k''(\ell-x))\} \\
& -(\theta_H sp_H + \theta_L p_L)u(w-\gamma+(1-Q)x+(1-sp_H)k'(\ell-x)) \\
& -(1-\theta_H sp_H + \theta_L p_L)u(w+\ell-\gamma-Qx-sp_H k'(\ell-x)) \\
& = \theta_H \{sp_H u(w-\gamma+(1-Q)x+(1-sp_H)k'(\ell-x)) + \\
& (1-sp_H)u(w+\ell-\gamma-Qx-sp_H k'(\ell-x))\} \\
& +\theta_L\{p_L u(w+(1-Q)x+(1-p_L)k''(\ell-x)) + \\
& (1-p_L)u(w+\ell-Qx-p_L k''(\ell-x))\} \\
& -\theta_H\{sp_H u(w-\gamma+(1-Q)x+(1-sp_H)k'(\ell-x)) \\
& +(1-sp_H)u(w+\ell-\gamma-Qx-sp_H k'(\ell-x))\} \\
& -\theta_L\{p_L u(w-\gamma+(1-Q)x+(1-sp_H)k'(\ell-x)) \\
& +(1-p_L)u(w+\ell-\gamma-Qx-sp_H k'(\ell-x))\} \\
& -u(w+\ell-\gamma-Qx-sp_H k'(\ell-x)) \\
& +(\theta_H+\theta_L)u(w+\ell-\gamma-Qx-sp_H k'(\ell-x)) \\
& = \theta_L\{v(w, p_L, p_L, k'', \ell, x) - v(w, p_L, sp_H, k', \ell, x)\} > 0
\end{aligned}
$$

since (p_L,k'') is the insurance contract that will be chosen by a low- risk person.

By similar reasoning it may be shown that I>0 also if the consumer chooses (p_L, k'') as uninformed.

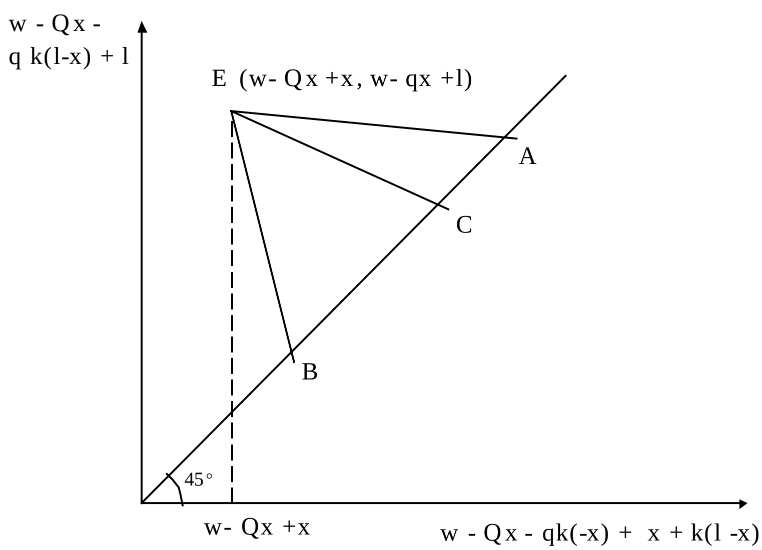

Figure 1

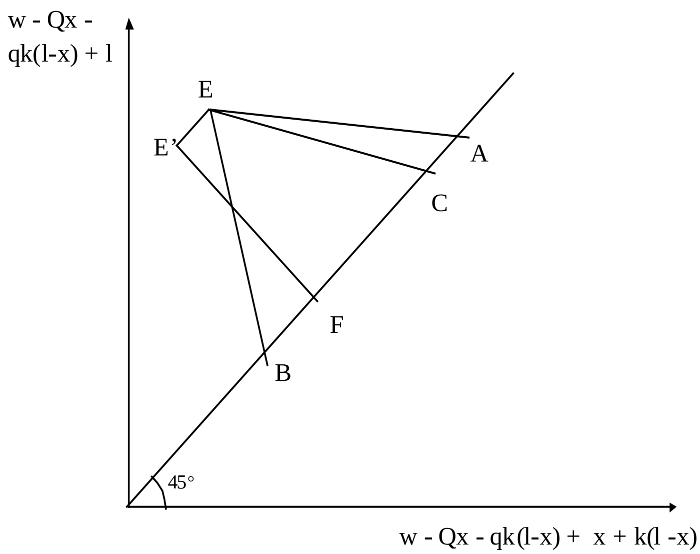

Figure 2