DISCUSSION PAPER SERIES

No. 3111

BREAKDOWN OF WILL AND THE VALUE OF INFORMATION

Astrid Kuehn and Achim Wambach

INDUSTRIAL ORGANIZATION

Centre for Economic Policy Research

www.cepr.org

Available online at: **www.cepr.org/pubs/dps/DP3111.asp**

ISSN 0265-8003

BREAKDOWN OF WILL AND THE VALUE OF INFORMATION

Astrid Kuehn, University of Munich
Achim Wambach, University of Munich

Discussion Paper No. 3111
December 2001

Centre for Economic Policy Research
90–98 Goswell Rd, London EC1V 7RR, UK
Tel: (44 20) 7878 2900, Fax: (44 20) 7878 2999
Email: cepr@cepr.org, Website: www.cepr.org

CEPR Discussion Paper No. 3111

December 2001

ABSTRACT

Breakdown of Will and the Value of Information*

It is commonly observed that people refuse to obtain more detailed information about their health status, e.g. by not taking genetic tests, even if this information is costless and only disclosed to the individual. This observation is in contrast to the predictions of expected utility theory.

We present a model that accounts for this phenomenon by using time-inconsistent preferences. It is shown that if people devise strategies against their inconsistency, which in line with the literature will be called 'will', then information about a serious illness might lead to a breakdown of will. In those cases information might have a negative value.

We derive some comparative statistics results and provide empirical evidence.

JEL Classification: D80 and I10
Keywords: breakdown of will, genetic testing, hyperbolic discounting and time inconsistent preferences

Astrid Kuehn
Department of Economics
University of Munich
Ludwigstrasse 28 VG
8059 Munich
GERMANY
Tel: (49 89) 2180 2943
Fax: (49 89) 2180 6282
Email: astrid.kuehn@lrz.uni-muenchen.de

For further Discussion Papers by this author see:
www.cepr.org/pubs/new~dps/dplist.asp?authorid=156564

Achim Wambach
Department of Economics
University of Munich
Ludwigstrasse 28 VG
D-80539 Munich
GERMANY
Tel: (49 89) 2180 2227
Fax: (49 89) 2180 6282
Email: wambach@lrz.uni-muenchen.de

For further Discussion Papers by this author see:
www.cepr.org/pubs/new~dps/dplist.asp?authorid=144997

* We thank Ray Rees, Klaus M Schmidt, David Laibson, Friedrich Breyer, and the seminar participants at the Jahrestagung des Vereins fur Socialpolitik 2000, Berlin, at the Tinbergen Institute, Amsterdam and the participants in SET 2001, Venice International University, for helpful comments. We gratefully acknowledge support from the Deutsche Forschungsgemeinschaft (DFG) grant no. WA 1433 1-1.

Submitted 23 November 2001

1 Introduction

Von Creutzfeldt-Jakob (vCJK) disease, a fatal illness, can potentially be transmitted via blood transfers.[1] In 2000, the British National Blood Authority revealed that at least seven people who had died from vCJK so far donated blood regularly. They also found out the names of several people who obtained this contaminated blood. However, the physicians in charge decided not to inform the patients about this potential threat to their health. The argument was that without knowing that they were at risk of getting vCJK the persons would be more likely to live a happy life. Furthermore, the illness can not be treated.

Even if people can decide for themselves whether to obtain information about their health status or not they sometimes do not want to. This is particularly the case if this information might potentially be really bad news. For example, out of 396 individuals, 169 (46%) declined costless genetic testing for the breast cancer gene (Lerman et al., 1998).

These observations stand in contrast to standard expected utility theory. In this theory, more information is individually always better than less, as long as this information is private, i.e. not revealed to other parties. Less information might be better from a social point of view, the famous Hirshleifer paradox. Information might also be undesirable if two parties interact in a strategic relationship (see e.g. Schmidt, 1996). However, these models are not applicable to the situation we want

[1] Due to the recent cases of mad cow disease in Great Britain, which potentially leads to vCJK, American, Canadian and German authorities forbid blood transfusion from people who spent more than six months in Britain during the time period 1980-1996.

to discuss here: Why do people in some cases reject obtaining better information on their health status?

In recent years, one branch of modelling boundedly rational behaviour has attracted many economists (see e.g. Laibson, 1997, 1998; O'Donoghue and Rabin, 1999a; Carillo and Mariotti, 2000). These models come under the heading of "hyperbolic discounting" or "present biased preferences". The basic model is very simple: An individual discounts the next period very strongly (e.g. by $\lambda\delta$ with $0 < \lambda, \delta < 1$), while all subsequent future periods are marginally discounted by δ only. In such a model, time inconsistent behaviour occurs: E.g. if someone is asked today whether she prefers one apple in five days or two in six days, she might choose the latter (if $\delta > 1/2$). However, if the day arrives, she might prefer obtaining one apple today instead of two tomorrow (if $\lambda\delta < 1/2$). This theory has been applied to numerous phenomena like savings behaviour (Laibson, 1996, 1997, 1998; Laibson, Repetto and Tobacman, 1998; O'Donoghue and Rabin, 1999b), self-confidence (Benabou and Tirole, 1999), haste (Brocas and Carillo, 1998), and also to the value of information (Carillo and Mariotti, 2000), on which we will comment below.

Here we will apply the theory of hyperbolic discounting to the decision whether or not to obtain information on one's own health status. The basic intuition for our results is the following:
People who have time-inconsistent preferences and who are aware of this fact, might devise strategies to overcome the resulting inefficiencies. As an example, a person might be willing not to drink alcohol today, not because she does not like to drink, but because she is aware that if she once starts to consume alcohol, she will

never be able to resist the temptation of drinking alcohol again.[2] The psychologist Ainslie (1992) calls such a behaviour *willpower*. A person behaves contrary to her short term interest in order to sustain a long term behaviour. In theoretic terms, willpower is similar to a trigger strategy in a dynamic game: If someone deviates from the equilibrium path, she will be punished in future periods. Note that in the present case, the different players are different incarnations of the same person. But due to time-inconsistency, different "selves" have different preferences for future consumption streams and behave according to their own preferences.

Based on this definition of will, and given the analogy with dynamic games, it becomes clear that will can only be sustained if the future is valued sufficiently highly. With the example given above: If a person does not value the future very much, she might as well drink today. The threat that she will drink tomorrow and in the future, which from today's point of view is not desired, is not enough to forgo the pleasure of consuming drinks today.

Now consider tests on your health status. Take the example of genetic tests.[3] In contrast to standard diagnostic tests like e.g. measuring blood pressure, most genetic tests indicate, if the test result is positive, a high probability for getting

[2]This extreme form is in line with the rules of the *Alcoholics Anonymous*, who proclaim a strict "no-alcohol" policy.

[3]Although our model is suited for different forms of information gathering, genetic testing fits the analysis extremely well for the following reasons. First, the test result is either positive or negative, either the person has the genetic mutation or not. In our model we also discuss only two possible states of the world with regard to the health status. Second, for many genetic tests a positive result indicates a severe health problem, which may plausibly lead to a breakdown of will.

a severe illness. Three well-known examples are the tests for Chorea Huntington, which is a terminal illness, Alzheimer's disease and breast cancer. A person who is offered the possibility to undertake such a test might reason the following way: If I undertake the test, I have better information on my illness risk, so I can plan my future life accordingly. E.g., if I have a high chance of obtaining Alzheimer's disease I might plan to undertake a trip around the world earlier in life, and not after retirement. On the other hand, a positive test result indicates a very large illness probability. Thus, there is a real danger that my will might break down, that I will lose faith in myself. Or more formally, the strategies devised to overcome the problem of time-inconsistency might no longer be stable. If this latter effect dominates the first, then it can indeed be rational not to undertake the test.

So people might refrain from taking genetic tests (or other tests for serious diseases like HIV) if they fear that a positive test result leads to a breakdown of will. There exists one piece of empirical evidence which enforces this effect: Sieff et al. (1999) asked people who came to a clinic for an HIV test how they thought they would feel five weeks later if the test turned out to be positive. Five weeks later those who were tested positive filled in a similar questionnaire asking how they currently felt. It turned out that before the test people overestimated how bad they would feel. This wrong perception might enforce the effect we outline here: Even if a positive test result does not imply that people can not cope with the new circumstances, the individuals perceive that they might come to a bad end.

The fundamental trade-off in our theory is that on the one hand more information

is better because one can structure future life better.[4] On the other hand, more information is worse because it might lead to a breakdown of will. The latter effect only sets in if the consequences of the negative information are sufficiently severe, otherwise willpower can be sustained. Interestingly, if the consequences are extremely bad, the former effect might dominate the latter. Consider an extreme case: If someone were told that she will live for only one further period, breakdown of will does not matter anymore, as there are no future periods. Thus there is a non-monotonicity in the value of information: If the illness is light, information is positively valued. For illnesses which are severe, but not extremely so, information has a negative value. Finally, for extremely severe illnesses, information might be valuable again.

Apart from this non-monotonicity in the value of information, we obtain a third hypothesis based on our model. If before the acquisition of information the health status is already quite bad, which implies that a breakdown of will is already imminent, people are more willing to obtain information.

Two arguments might be brought forward against our modelling approach. One is phenomenological, the other methodological.

First, one might want to question the intuition which we just gave for the reluctance to obtain certain information. Some people may argue that individuals do

[4] In addition, a better diagnosis might lead to better precautionary behaviour and more specific treatment. We do not model this effect explicitly. However, for our results to go through we only require that someone whose test result is positive is worse off than an average person who is untested.

not really fear a breakdown of will, but that they simply do not want to live the rest of their lives with the knowledge that they may come to a bad end. A model adressing this issue should then be able to capture the notion of feeling depressed. The notion of willpower is a widely discussed concept in psychology and economics. One can plausably argue that the notion which people may call "fear of depression" is actually the fear of a breakdown of will in our terminology, in particular if depression is associated with an unwillingness to do taks, a lack of self control and so on. So even if people do not really think about a breakdown of will when they reject information, they actually behave as if they thought about it.

A second, methodological criticism of our approach is to question the modelling of time inconsistent behaviour. An apparent alternative could be the use of state dependent utility. If people feel bad after obtaining negative information they might be considered to be in a different state. However, the state dependent utility approach has one crucial weakness in the present context, which in our opinion does not allow us to use this concept. A health test provides information on the probability of obtaining an illness. Claiming that a positive test result leads to a different state then implies that the knowledge of a higher probability of illness induces a different state of the world. But at which level does this switch occur? Is 65% a high enough probability to be in another state, or only 68%? The state dependent utility approach is not helpful in describing and understanding the critical probability levels. Our approach does indeed fill this gap. The interesting feature about the use of time inconsistency is that we have a tool at hand to explain at which probability levels there is a switch between different states of the world: The utility function

is different when the risk of illness is large enough such that a breakdown of will occurs. Thus, the time inconsistency approach goes one step further in explaining why a person after a test might be in a different state of the world.

We provide evidence for the implications of the theory based on studies reported in the literature and on our own investigations. We questioned students on their willingness to gather information on genetic and blood tests. The data were used to test three hypotheses derived from our model. The first claims that people are more willing to get information about mild diseases than about severe ones, as for light illnesses breakdown of will does not occur. The second hypothesis states that the individuals are more likely to want information about extremely severe diseases compared to severe ones, as in the first case a breakdown of will does not matter any more. It turned out that the data were in good agreement with these predictions. The third hypothesis tested says that individuals are more likely to seek information if their ex ante probability of illness is already high. We capture this by including two questions for Chorea Huntington in the questionnaire, one describing a situation with and one without a family history (high vs. low ex-ante probability of falling ill) of the relevant genetic mutation. Our data suggest that those individuals whose attitude towards information gathering differs in both cases are indeed more likely to want this information in the case of a high ex-ante probability. Evidence from the literature is presented which confirms our results.

A better understanding of the reason why people might not obtain information about their health status is of crucial importance for political decision making. Cases like the hospital example we gave above are sure to recur over time, due

to better means of diagnosis and better data available for the hospitals. Should hospitals/doctors/the government disclose such information? Another problem concerns genetic testing. There is a long debate in the literature on whether insurance companies should be allowed to ask for previous results from genetic tests, or even demand genetic tests as a prerequisite for an insurance contract (see e.g. Ad Hoc Committee on Genetic Testing, 1995; Hall, 1996; Strohmenger and Wambach, 2000; Tabarrok, 1994, 1996). Suppose that it is decided that the insurer should have the same information as the insured.[5] However, if tests can be made secretly at home, the only viable possibility to give the insurer the desired information will be to allow the insurer to demand genetic tests to be undertaken before a contract is signed. The theory and evidence presented here however suggest that such a scenario might entail a further welfare loss, because people might not want to obtain further information about themselves. A welfare improving policy would then be to require tests only to be undertaken by certified physicians and not to be freely available to everyone. The insurer might then obtain the information whether a test was undertaken or not and, when a new contract is to be signed, he only needs to ask for results of tests already taken. There would be no need to require further tests to be done.

Before going into the details of our model, we briefly discuss the work of Carillo and Mariotti (2000). These authors also show that if people have time-inconsistent

[5]This is not necessarily optimal (see e.g. Strohmenger and Wambach, 2000). Presently, it seems to be the case that such a regulatory scheme applies in the US life insurance market and in the German and British insurance markets (Chuffart, 1996).

preferences, it might be optimal for them not to obtain further information. One instructive example which the authors present is the following: Suppose you are a non-smoker and you believe that the long term consequences of smoking are very bad. Now you are offered the possibility of obtaining further information about the health risks of smoking. Suppose that with some probability the information can be such that smoking is less risky than you thought but still quite risky. In that case you might like to smoke today, but you would prefer to forbid your future selves to smoke. However, due to time-inconsistency, future incarnations will also smoke. Under these circumstances it might be rational not to obtain this information at all. So Carillo and Mariotti argue that more information might be undesirable because it leads to a more severe problem of time-inconsistent behaviour. We differ in our model in several respects. First, information in our case does not concern the severity of the consequences of the action, but the probability of occurance. Second, more information does not lead to different degrees of time-inconsistent behaviour. If the illness probability is low, individuals succeed in overcoming the inefficiencies due to time-inconsistency. However they are afraid that in case of e.g. a positive test result these strategies will no longer be stable. A third difference between the two models is the 'size' of information: In subsequent work (Brocas and Carillo, 2000) it is shown that the value of information is more likely to be negative if the flow of information is 'small'. In contrast, our model predicts that if information has little content, then the tests will be undertaken, as there is no risk of a breakdown of will. Only tests for severe illnesses might have a negative value.

The paper is structured as follows. In the next section we will discuss the basic

model of hyperbolic discounting. This model is then applied to genetic testing. Comparative statics results are derived in Section 3. In Section 4, empirical evidence is presented before we summarize in Section 5.

2 A Model of *Will*

2.1 Hyperbolic discounting

In recent years, the following model of time inconsistent preferences has been widely used (see e.g. Laibson, 1997, 1998; O'Donoghue and Rabin, 1999a; Carillo and Mariotti, 2000). Let $U(c_t, c_{t+1}, ...)$ be the utility in period t, depending on consumption in periods t, t+1, ... Then:

$$U(c_t, c_{t+1}, ...) = u(c_t) + \lambda \sum_{\tau=1}^{\infty} \delta^{\tau} u(c_{t+\tau}) \tag{1}$$

where $0 < \lambda < 1$ and $0 < \delta < 1$. The only difference to the standard exponential discounting model lies in the parameter λ. $\lambda < 1$ implies a strong discounting between today and next period, namely $\lambda\delta$, while two subsequent future periods are only discounted by δ.

The model used here follows the line of Phelps and Pollak (1968). Let there be a capital stock K_t in period t. If a person chooses consumption $c_t = (1 - \sigma_t)K_t$ in period t, where $0 < \sigma_t < 1$, then $K_{t+1} = \beta\sigma_t K_t$. Here σ_t is the savings ratio in period t and β measures productivity, which is constant over time. This is the interpretation of the variables we will use in the rest of the paper. However, the model goes far beyond such a simple consumption/savings problem. c might be

interpreted as the size of any decision which is such that a person enjoys pleasure from it today, but choosing a smaller c allows a larger pleasure in future periods. For example, c could be the amount of cigarettes a person smokes, while K would then be interpreted as a stock of health. Or, c could be leisure, or time and effort not spent on studying. K would then be human capital. Therefore the model is general enough to encompass many situations where a person has discretion over one variable and she faces the trade-off between a larger utility today and a larger utility in the future. To make the model tractable, we further simplify by assuming that utility is logarithmic, i.e. $u(c_t) = ln(c_t)$.

Next we consider the case where no time-inconsistency problem is present. Formally, this is obtained by setting $\lambda = 1$. In decision theoretic terms, this is the utility that the $t = -1$ person, who has already chosen her consumption level, would maximize. We call this person the planner. Let K denote the initial capital stock. If this planner could decide on a savings rate σ for all future periods, her optimization problem would be:

$$\max_{\sigma} U_P(\sigma) = \sum_{t=0}^{\infty} \delta^t \ln[(1-\sigma)\beta^t \sigma^t K] \tag{2}$$

Here we use the fact that if the savings rate is σ, then $c_t = (1-\sigma)\beta^t\sigma^t K$. $\beta^t\sigma^t K$ is the capital stock at time t, and $(1-\sigma)$ is the proportion of this stock the person consumes.[6]

Simple calculation gives:

$$U_P(\sigma) = \frac{1}{1-\delta}\ln[(1-\sigma)K] + \frac{\delta}{(1-\delta)^2}\ln[\beta\sigma] \tag{3}$$

[6]Although we let the person choose the same savings rate for every period, it is easy to show that this will be optimal from an ex-ante perspective even if different savings rates were allowed.

Taking the first order condition with respect to σ yields:

$$\frac{dU_P(\sigma)}{d\sigma} = -\frac{1}{1-\delta}\frac{1}{1-\sigma} + \frac{\delta}{(1-\delta)^2}\frac{1}{\sigma} = 0 \quad \Rightarrow \quad \sigma = \delta \equiv \sigma^c \tag{4}$$

If the planner could decide how much she will save in the future, she would choose the savings rate equal to the discount rate, a well-known result. To make the analogy with a dynamic game, we call this the cooperative savings rate σ^c. Note that λ does not enter the optimal savings rate, as the planner does not suffer from short-sightedness.

In contrast to this, consider now the case where future selves cannot be forced to save σ^c. We then look for the "non-cooperative"-savings rate, i.e. the amount of savings each incarnation would choose if she took the savings of future selves as given. Let s be the savings rate of the period t individual, where $t \geq 1$.[7] Then in period 0, the person would optimize her consumption according to the following maximization problem:

$$\max_{\sigma} U_0^{\delta}(\sigma) = \ln[(1-\sigma)K] + \lambda \sum_{t=1}^{\infty} \delta^t \ln[(1-s)\beta^t s^{t-1}\sigma K] \tag{5}$$

Reformulating this expression gives:

$$U_0^{\delta}(\sigma) = \ln[(1-\sigma)K] + \lambda\frac{\delta}{1-\delta}\ln[(1-s)\beta\sigma K] + \lambda\frac{\delta^2}{(1-\delta)^2}\ln[\beta s] \tag{6}$$

The optimal "non-cooperative" saving rate is then given by:

$$\frac{dU_0^{\delta}(\sigma)}{d\sigma} = -\frac{1}{1-\sigma} + \lambda\frac{\delta}{(1-\delta)}\frac{1}{\sigma} = 0 \quad \Rightarrow \quad \sigma = \frac{\lambda\delta}{1-\delta+\lambda\delta} \equiv \sigma^{nc} \tag{7}$$

If $\lambda = 1$, i.e. in the limit where there is exponential discounting, $\sigma^{nc} = \sigma^c$. This is the well known result: If discounting is exponential, decisions will be taken consistently.

[7] It is common in the literature to restrict attention to symmetric equilibria.

However, if $\lambda < 1$, σ^{nc} will be smaller than σ^{c}, i.e. a hyperbolic discounter will save less than she would prefer from an ex-ante perspective.

2.2 Will

In the previous subsection we have shown that each incarnation prefers to save less than is optimal from an ex-ante point of view. One way to get around this problem of undersaving might be the following strategy for the person in period t:
Save σ^{c} if in all previous periods σ^{c} was the savings rate. If in any period before, the savings rate was different from σ^{c}, then save σ^{nc} instead.

This behavioural rule operates like a trigger strategy. As long as all incarnations cooperate, i.e. choose σ^{c}, there will be cooperation in the future. However, if someone deviates, then the inefficient non-cooperative equilibrium will be played in all future periods. Although this is an extreme form of punishing oneself, namely by never returning to the cooperative path, it is not uncommon. For example, the Alcoholics Anonymous proclaim a strict "no-drink" policy, as they fear that any drink will lead the person back into being an alcoholic.

The psychologist Ainslie (1999) calls such a behaviour *willpower*: Although the agent prefers to consume more immediately, she will save instead in order to support her future selves to behave in the same way.[8]

We are therefore lead to the following definition:

[8] Ainslie argues that such a behaviour is similar to Kant's categorical imperative: Behave as if this were a universal rule. Here this is not a rule for different persons, but for a single person with different selves at different points in time.

Definition 1

An individual is said to possess will, if there exists an equilibrium of the savings game where σ^c will be chosen in every period.

Before formalizing this notion of will, let us first comment on the specific properties of the equilibrium concept. It seems to be that there is widespread agreement in the literature that 1) hyperbolically discounting people suffer from time inconsistency, and 2) that they might devise strategies against this inconsistency. However, how this should be modelled explicitly is far from obvious. In particular, the interaction between different selves is not well understood. The trigger strategy we propose here suffers from the fact that future selves cannot cooperate again. This seems a rather harsh assumption, as future selves are incarnations of the same person, so at least they should be able to communicate with each other. This possibility is taken up by Kocherlakota (1996). He uses the notion of "reconsideration-proofness" where future selves are allowed to reconsider their strategies. However, the concept he proposes is defined only for stationary decision problems. An alternative would be the concept of "revision-proof" decision rules introduced by Asheim (1997). Here an axiomatic setup is proposed which captures the notion that a person will, by devising a decision rule, take into account that she can reselect the rule at any later point in time. However, also in this approach the general case of an infinite horizon capital accumulation problem has not been analysed. While the debate on the "right" solution concept is interesting and deserves more consideration, the focus of the present paper is different: We intend to model the notion of will in a simple, tractable way. This is done by allowing only trigger strategies of the form described

above. Formally, we restrict the agent to use only one of two strategies: Either to save the cooperative savings rate σ^c, or to save the non-cooperative savings rate σ^{nc}.

Based on this, we can now show that a person can only possess will if the future is not discounted too much. This is done by comparing the utility of e.g. the period 0 type when she chooses σ^c and σ^{nc}. Noting that dependent on her choice of σ^i, $i = c, nc$, all future selves will choose the same σ^i in equilibrium, her utility is given by:

$$\begin{aligned} U_0^\delta(\sigma^i) &= \ln[(1-\sigma^i)K] + \lambda \textstyle\sum_{t=1}^{\infty} \delta^t \ln[(1-\sigma^i)\beta^t(\sigma^i)^t K] \\ &= (1+\lambda\tfrac{\delta}{1-\delta})\ln[(1-\sigma^i)K] + \lambda\tfrac{\delta}{(1-\delta)^2}\ln[\beta\sigma^i] \end{aligned} \tag{8}$$

Therefore:

$$\Delta U = U_0^\delta(\sigma^c) - U_0^\delta(\sigma^{nc}) = (1+\lambda\frac{\delta}{1-\delta})\ln[\frac{1-\sigma^c}{1-\sigma^{nc}}] + \lambda\frac{\delta}{(1-\delta)^2}\ln[\frac{\sigma^c}{\sigma^{nc}}] \tag{9}$$

We can now formulate our first proposition:

Proposition 1

There exists a δ^1 and δ^2 with $0 < \delta^1 \leq \delta^2 < 1$ such that if $\delta < \delta^1$ ($\delta > \delta^2$) the agent cannot (can) possess will.

The proof is relegated to the appendix. There we show that for small values of δ we get $\Delta U < 0$, while for large values of δ it holds that $\Delta U > 0$. Note that for both $\delta = 0$ and $\delta = 1$ the savings levels σ^c and σ^{nc} are the same, which implies $\Delta U = 0$. In Figure 1, we provide a numerical example for $\Delta U(\delta)$ where breakdown of will occurs for $\delta < 0.69$.

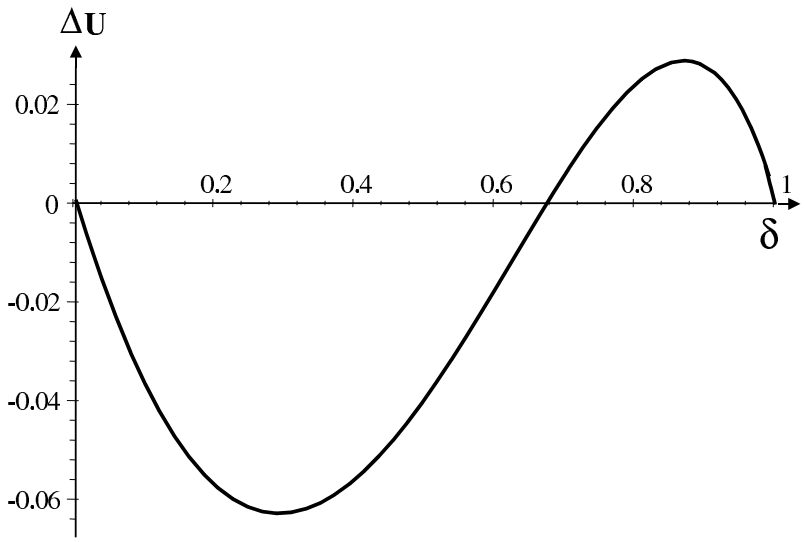

Figure 1: Breakdown of will for small δ (numerical example: $K = 2, \beta = 1.5, \lambda = 0.2$)

Having outlined the model to discuss will, we now turn to genetic tests.

2.3 The value of information

Assume that the planner has the choice to obtain information about her health status. Let us consider as an example that this person might undertake a genetic test. The ex-ante probability of being tested positive is γ. If the test result is positive, the person has a lower survival probability. Denote by δ_l the corresponding discount rate. If however, the test turns out to be negative, the survival (discount) rate will be $\delta_h > \delta_l$. Note that the size of δ_l measures two effects: First, the severity of the illness itself, i.e. in how far the illness affects the life of the person. Second,

the probability with which the illness occurs if the test turns out to be positive, i.e. how precisely the test works. A very precise test for a less severe illness would be similar to an imprecise test for a very severe illness.[9]

In the previous subsection we modelled a situation with a constant discount rate. The model here is slightly more complicated, as the person, if she remains untested, learns over time about her illness risk. If she survives another period she is more likely to be the type who would obtain a negative test result. Or, in other words, γ changes from period to period. In the optimal savings decision without a test this has to be taken into account.

Let us start by calculating the optimal savings rate from the perspective of the planner if no test will be undertaken.

$$U_P^u(\vec{\sigma}) = \sum_{t=0}^{\infty}[\gamma\delta_l^t + (1-\gamma)\delta_h^t]\ln[\beta^t(1-\sigma_t)K\prod_{\tau<t}\sigma_\tau] \tag{10}$$

$\vec{\sigma} = (\sigma_0, \sigma_1, ...)$ is the vector of savings rates. Note that because the discount rate varies between periods, the optimal savings rate will not be constant over time. Taking the derivative with respect to σ_t gives:

$$-[\gamma\delta_l^t + (1-\gamma)\delta_h^t]\frac{1}{1-\sigma_t^c} + \sum_{\tau=t+1}^{\infty}[\gamma\delta_l^\tau + (1-\gamma)\delta_l^\tau]\frac{1}{\sigma_t^c} = 0 \tag{11}$$

After some calculations:

$$\sigma_t^c = \frac{\gamma\frac{\delta_l^{t+1}}{1-\delta_l} + (1-\gamma)\frac{\delta_h^{t+1}}{1-\delta_h}}{\gamma\frac{\delta_l^t}{1-\delta_l} + (1-\gamma)\frac{\delta_h^t}{1-\delta_h}} \tag{12}$$

[9] In the following, we use the notion of "extremely severe", "severe" and "mild/light" diseases as descriptions of the overall impact of a positive test result. That is, a "severe" illness can be a severe illness with a very precise test or an extremely severe illness with an imprecise test.

The individual uses the information from having survived one more period for updating γ in the appropriate way. Consequently, σ_t^c is increasing over time.[10]

As before, the person still has the temptation to consume more than the cooperative consumption rate. To calculate the non-cooperative savings rates, we maximize the utility of the time t self, if she takes all future savings rates as given. This time not everyone will choose the same savings rate, due to the change in discounting over time.

$$\max_{\sigma_t} U_t^u(\sigma_t, \vec{s}) = \ln[(1-\sigma_t)K_t] + \lambda \sum_{\tau=1}^{\infty} \frac{[\gamma\delta_l^{t+\tau} + (1-\gamma)\delta_h^{t+\tau}]}{[\gamma\delta_l^t + (1-\gamma)\delta_h^t]} \ln[(1-s_{t+\tau})\beta^\tau \prod_{0<\rho<\tau} s_{t+\rho}\sigma_t K_t] \tag{13}$$

Taking the first order condition and solving for σ_t gives us the non-cooperative saving rate:

$$\sigma_t^{nc} = \frac{\lambda A_t}{1+\lambda A_t} \tag{14}$$

with

$$A_t = \frac{\gamma \frac{\delta_l^{t+1}}{1-\delta_l} + (1-\gamma)\frac{\delta_h^{t+1}}{1-\delta_h}}{\gamma\delta_l^t + (1-\gamma)\delta_h^t} \tag{15}$$

[10] Take γ as the ex-ante probability of being tested positive in $t=0$. Then $\hat{\gamma} = \frac{\gamma\delta_l}{\gamma\delta_l + (1-\gamma)\delta_h}$ is the updated ex-ante probability in $t=1$ if the individual has survived until $t=1$. If we calculate

$$\sigma_0^c = \frac{\gamma\frac{\delta_l}{1-\delta_l} + (1-\gamma)\frac{\delta_h}{1-\delta_h}}{\gamma\frac{1}{1-\delta_l} + (1-\gamma)\frac{1}{1-\delta_h}}$$

we can use $\hat{\gamma}$ for calculating

$$\sigma_1^c = \frac{\hat{\gamma}\frac{\delta_l}{1-\delta_l} + (1-\hat{\gamma})\frac{\delta_h}{1-\delta_h}}{\hat{\gamma}\frac{1}{1-\delta_l} + (1-\hat{\gamma})\frac{1}{1-\delta_h}}$$

Plugging in $\hat{\gamma}$ yields after some calculations exactly the result of the above formula

$$\sigma_1^c = \frac{\gamma\frac{\delta_l^2}{1-\delta_l} + (1-\gamma)\frac{\delta_h^2}{1-\delta_h}}{\gamma\frac{\delta_l}{1-\delta_l} + (1-\gamma)\frac{\delta_h}{1-\delta_h}}$$

σ_0^c is decreasing in γ, and as $\hat{\gamma} < \gamma$, $\sigma_1^c > \sigma_0^c$. A similar reasoning holds for any other period.

The interesting case is where the agent can sustain will if the test result is negative, i.e. $\delta = \delta_h$, but not if the test result is positive $\delta = \delta_l$. We can now formulate a lemma about the possibility to sustain will if the person remains untested.

Lemma 1 *Suppose that δ_h (δ_l) is such that the person can (cannot) sustain her will with such a discount rate. Then there exists a γ^1 and γ^2 with $0 < \gamma^1 \leq \gamma^2 < 1$ such that if $\gamma < \gamma^1$ ($\gamma > \gamma^2$) the agent can (cannot) possess will if she remains untested.*

Proof:

Note that if $\gamma = 0$ we are back to $\delta = \delta_h$. Here the agent at period 0 strictly prefers to save σ^c than σ^{nc}. By continuity, for small values of γ the agent can still sustain her will. The same reasoning applies for γ close to 1. **QED**

This result is straightforward. If γ is small, the agent has a very small probability of obtaining the bad news if tested. So if untested, she can behave as if there is no threat from this illness.

To get some feeling for the relevant parameters take Alzheimer's disease as an example. When you are young, the probability of getting Alzheimer's disease at some point in life is very low. At age 65, the probability is between 12% and 15%. US data show that people of age 85 and more have a 50% chance of suffering from Alzheimer's disease. For Chorea Huntington, e.g., the contrary holds. In the late thirties and early forties, the probability of an outbreak of the disease is highest, getting smaller and smaller as one gets older. That means that young people have a stronger fear of Chorea Huntington inducing a breakdown of will than of Alzheimer's disease.

Now suppose we are in a situation where the agent can sustain will if untested. We can then calculate the gain (or loss) in utility from the planner's perspective from undertaking a genetic test.

$$\Delta = \gamma U_0^{\delta_l}(\sigma_l) + (1-\gamma)U_0^{\delta_h}(\sigma_h) - U_0^u(\vec{\sigma}^c) \tag{16}$$

Here, $U_0^{\delta_i}(\sigma_i)$ is the utility of the planner if her discount factor is δ_i and she saves with the savings rate σ_i, where $i \in \{l, h\}$. In (16), σ_l is either δ_l if the agent can support her will even if tested positive, otherwise $\sigma_l = \frac{\lambda\delta_l}{1-\delta_l+\lambda\delta_l}$. Because we assumed that the agent can sustain will if untested, it must be the case that she can do so if the test turns out to be negative. Therefore $\sigma_h = \delta_h$.

We can now show that the value of a genetic test might indeed be negative.

Proposition 2

There exist values for δ_l, δ_h and λ such that the value of information is negative.

Proof:

The utility of the person if untested and if she uses the optimal consumption strategy is larger than if she consumes a ratio $(1-\delta_h)$ in every period. Therefore:

$$\Delta < \gamma \sum_{t=0}^{\infty} \delta_l^t \{\ln[\beta^t(1-\sigma_l)\sigma_l^t K] - \ln[\beta^t(1-\delta_h)\delta_h^t K]\} \tag{17}$$

Some further calculations give:

$$\Delta < \gamma \frac{1}{1-\delta_l}\{\ln[\frac{1-\sigma_l}{1-\delta_h}] + \frac{\delta_l}{1-\delta_l}\ln[\frac{\sigma_l}{\delta_h}]\} \tag{18}$$

With $\sigma_l = \frac{\lambda\delta_l}{1-\delta_l+\lambda\delta_l}$, we obtain $\Delta < 0$ if e.g. $\delta_l = 0.5$, $\delta_h = 0.8$ and $\lambda = 0.2$. Note that for these values expression (9) is larger than zero if the test result is negative,

but not if it is positive. That is, the person with $\lambda = 0.2$ can sustain will if her discount rate is 0.8, but not if it is 0.5. As the sign of expression (18) is independent of γ, we can according to Lemma 1 find γ small enough such that will is sustained if the person remains untested. **QED**

This is our first main result. There exist parameter values such that a person will reject taking a genetic test, even if the test is costless and even if the information is only disclosed to her.

The model allows to say somewhat more about the circumstances under which this effect is most likely (not) to occur. First consider changes in the severity of the illness which is modelled by δ_l.

Proposition 3

(i) If λ and δ_l are such that expression (9) is positive, i.e. the person can sustain will independent of the information she obtains, then $\Delta > 0$, i.e. the value of the information is always positive.

(ii) For all values of δ_h, there exists a $\delta^* > 0$ such that if $\delta_l < \delta^*$, then $\Delta > 0$. That is, if the survival probability after a positive test is very low, the agent will prefer to be tested.

Proof:

(i) This can be seen by noting that if the agent can sustain her will always, she might choose the same consumption stream if tested as if untested. Due to the additional choice she now has, namely to condition consumption on the test result, she can only do better.

(ii) We go to the limit of $\delta_l = 0$. As all functions are smooth, one can find a δ^* positive but small enough, such that the following statement holds for all $\delta_l < \delta^*$. In the limit $\delta_l \to 0$, the agent knows that if she survives period zero, she is the type who would obtain a negative test result. Thus she will choose $\sigma_h = \delta_h$ from period one onwards. Her choice in period zero if she remains untested is given by

$$\sigma_0 = \frac{(1-\gamma)\frac{\delta_h}{1-\delta_h}}{\gamma + (1-\gamma)\frac{\delta_h}{1-\delta_h}} = \delta_h \frac{1}{1 + \frac{\gamma}{1-\gamma}(1-\delta_h)}$$

which follows from (12) by setting $t = 0$ and $\delta_l = 0$. On the other hand, if the person becomes tested, she will consume K in case the test is positive, while if the test is negative, she will immediately start saving with rate δ_h. In both cases, she is better off if she obtains the test result before deciding how much to consume. Overall, this difference is given by:

$$\Delta = \gamma \ln[\frac{1}{1-\sigma_0}] + (1-\gamma)\frac{1}{1-\delta_h}\{\ln[\frac{1-\delta_h}{1-\sigma_0}] + \frac{\delta_h}{1-\delta_h}\ln[\frac{\delta_h}{\sigma_0}]\} > 0 \qquad (19)$$

The first term is the difference in utility if the test is positive. This expression is positive. The second term is also positive, because the savings rate δ_h maximizes the expression. **QED**

This result shows that if the severity of a positive test result is either very low, in which case there is no danger of a breakdown of will, or very high, in which case a breakdown of will does not matter very much, the person will prefer to become tested. Figure 2 shows a numerical example for our result. For low levels of δ_l, the value of information is positive because a breakdown of will does not matter very much. For intermediate levels, the negative impact of a breakdown of will is so strong that the value of information becomes negative. Then there is a jump

back to a positive value of information when δ_l becomes so large that will can be sustained even with a positive test result.

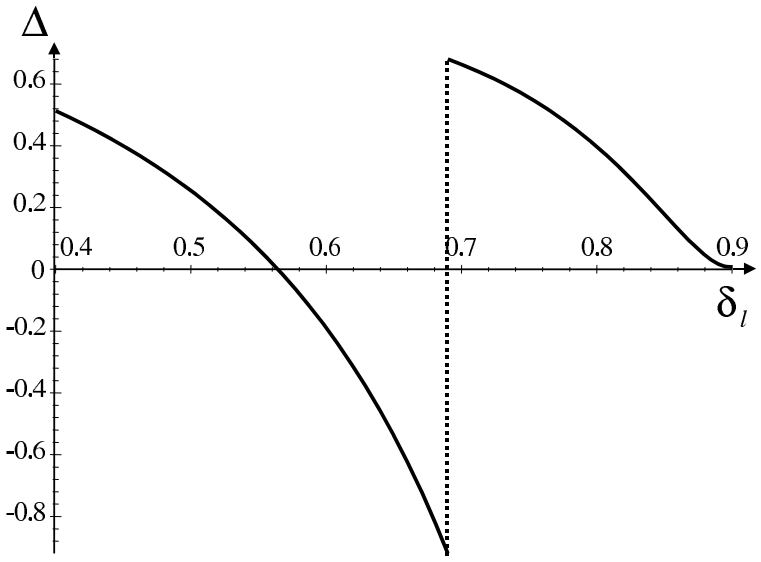

Figure 2: Negative value of information for intermediate levels of δ_l (numerical example: $K = 2, \beta = 1.5, \lambda = 0.2, \gamma = 0.5, \delta_h = 0.9$)

Next consider changes in the probability of obtaining the bad news which is given by γ. In particular, if γ is large the person already faces a breakdown of will if she remains untested. It is not possible to make any general claim in this case, as there are several effects which interact. If the person undertakes the test, she might obtain a negative test result which allows her to sustain her will. However, if the test result is positive, the breakdown of will can lead to a much worse situation as savings rates will drop. In this case an effect of the type of Carillo and Mariotti (2000) might set in: It is better not to obtain the information as the problem of

time inconsistency without this information is less severe than with the information. However, consider a critical $\gamma*$ such that for $\gamma > (<)\gamma*$ breakdown of will does (not) occur if the person remains untested. Then around $\gamma*$ the expected utility of the person if she undertakes the test is continuous in γ. However, the utility of the planner if she remains untested is lowered by a discrete step when γ reaches $\gamma*$. Thus testing becomes more attractive. We formulate this as a claim:

Claim: The larger the ex ante probability of obtaining an illness, the more likely it is that the value of information is positive.

Let us summarize the results:

- Agents might reject undergoing genetic tests if they are afraid that their will will break down if the test is positive.
- Tests for illnesses which are not severe are less likely to lead to a breakdown of will. Therefore these tests are more likely to be taken.
- Tests for illnesses which are extremely severe might also be taken, as here a better consumption planning dominates the negative effects of a breakdown of will.
- If the survival probability is already low before obtaining the information, the test is more likely to be undertaken.

3 Empirical Evidence

By questioning students on their interest in the results of genetic tests and blood tests we tried to test the predictions of the model empirically.

In principle, three hypotheses were tested. The first one says that tests for rather mild diseases are more likely to be taken than those for illnesses considered as severe, as they do not induce a breakdown of will.[11] The empirical findings confirm this result. The second hypothesis says that tests for extremely severe illnesses are also more likely to be taken as compared to the middle range of diseases, because a breakdown of will does not matter much. Our empirical results also confirm this theoretical postulate. The third hypothesis tested says that tests are more likely to be taken if the ex ante risk of illness is high, as then the will of an individual is already broken. In the case of genetic testing this can be modelled by a high ex-ante probability to develop a certain illness, for instance by genetic mutations in the family history. Also in this case, the empirical results provide significant evidence. In the literature, similar studies obtained significant results regarding our hypotheses, too.

3.1 Data Description

We tested the model by asking 222 undergraduate students of economics and business administration whether they wanted to be informed about the results of one blood test and various tests for mutations in genes causing monogenetic diseases.

[11] Recall that severe illness implies two things: 1) the illness itself is indeed severe, and 2) the probability of obtaining the illness conditional on a positive test result is large.

The students were told that this information was purely private and costlessly available to them.

Each disease was described by its major characteristics, i.e. symptoms, course of illness, age and probability of outbreak etc. The descriptions allowed a ranking of the diseases by severity.[12] Ranked as rather mild or least severe was "hemochromatosis" (HE, rank 5), an iron metabolic disorder leading among other things to a malfunctioning of organs. Not drinking alcohol can heavily reduce the negative effects of this disease. Rank 4 was occupied by "alpha1-antitrypsin deficiency" (AL), causing a high risk of chronic lung illnesses. To stop smoking can clearly reduce this risk. The middle category contained "Alzheimer's disease" (AZ, rank 3) and "Chorea Huntington" (CH1, rank 2). Carriers of the CH gene mutation experience the outbreak of this illness of the nervous system before the age of 40 with 100 % probability. It leads to death within a few years. CH is the most severe illness among the well-known monogenetic diseases. We feared that the description of CH might not be perceived as severe enough to be able to explain the answering behaviour predicted by our model for extremely severe illnesses. Therefore we included a question about a blood test for the Lassa virus (LA, rank 1) to be taken after a vacation in Africa. Being tested positive means a high probability of dying within one week.

For each disease, the following question had to be answered by "yes" or "no": "Do you want to be informed about the test result concerning the relevant gene mutation (blood test)?". The answering behaviour is described in table 1. In the

[12]The ranking we propose has been confirmed by questioning a different sample of students.

		HE	AL	AZ	$CH1$	$CH2$	LA
1=want	frequ.	211	203	145	166	182	212
info	%	95.0	91.4	65.3	74.8	82.0	95.5
0=doesn't want	frequ.	11	19	77	56	40	10
info	%	5.0	8.6	34.7	25.2	18.0	4.5

Table 1: Answering Behaviour

questionnaire, the diseases were listed in the rank order 1, 3, 5, 4, 2. A supplementary question (CH2) was asked with regards to CH1. In addition to the standard question people were asked whether they would want to know the test result if in their family history there had been cases of CH1. This would raise their ex-ante probability to be carriers of the relevant mutation to 50%. The question (CH2) was meant to provide evidence for hypothesis 3. The questionnaire also asked for personal data which were of interest for the quality of the answers. Descriptive statistics of the individuals' characteristics are given in table 4 and 5 in the appendix.

3.2 Model Specification

For the analysis, a probit model was used. In the regression framework

$$y_{ij} = \beta' x_j + u_{ij}$$

y_{ij} can take the value of 1 or 0, depending on whether individual i's answer to question j is "yes" or "no". x_j is a vector of dummy variables, one for each of the 6 questions asked. The dummies take the value of 1 if the observation y_{ij} belongs

to question j, otherwise 0. This is the reference case to start with. To check the robustness of our results and to correct for hidden heterogeneity between individuals, a random effects probit model was estimated. In extensions of the standard probit model, further explanatory variables like age, school grade etc. were included or used to control for the results in certain subsamples.

3.3 Results

Table 2 shows the results of the probit and random effects probit estimations (coefficients and simulations) for hypotheses 1 and 2. The reference case is AZ (rank 3). The data confirm a significant increase in positive answers from AZ to AL and HE, i. e. from the severe to the light diseases. This finding confirms our claim that people are more likely to want to know about mild illnesses as they do not fear a breakdown of will when getting this information.

The same holds when going from AZ to LA and, interestingly, also to CH1. There is a significant increase in positive answers from AZ to LA, but also from AZ to CH1 and from CH1 to LA. This goes in line with our hypothesis that people do want to get information about extremely severe illnesses as a better consumption planning outweighs the effects of a breakdown of will. The significant difference in answering behaviour between AZ and CH1, which both were ranked by us as "severe" but not extremely so, could indicate that people indeed perceive CH1 as "extremely severe". But, when analysing various subsamples, it turns out that the significant increase from AZ to CH1 is the only result which is not robust in all subsamples, so it is clear that our initial ranking indeed was correct. In fact, the data nicely confirm

Dependent Var: Dummy, 1=yes			
Indep Variables	Probit	% Change (Probit)	Random Effects Probit
LA	1.301	17.1	1.837
	(7.638)**		(8.140)**
CH1	.273	5.1	.415
	(2.175)*		(2.699)**
AL	.974	14.2	1.451
	(6.586)**		(7.249)**
HE	1.255	16.8	1.832
	(7.540)**		(8.014)**
const	.394		.601
	(4.552)**		(4.390)**
Pseudo R^2	.1296	.1296	
Log L	-418.1	-418.1	-378.4
# observations	222	222	222
t-values in brackets	**signif. at 1% level	*signif. at 5% level	

Table 2: Probit and Random Effects Probit - Reference Case: AZ

the predicted U-shape in the probability for positive answers across the 5 ranks.

Table 3 presents the results of the tests of hypothesis 3. This hypothesis says that individuals will be more likely to want to be informed about a disease if their will is already broken. In the questionnaire, we tried to capture the effect of breakdown of will by the supplementary CH2 question. The model predicts that if there is already a high ex-ante probability to be carrier of the relevant genetic mutation (in this case: because of CH in the family history), the individual should be more willing to get the information about the test result. In the probit estimation, we obtain a significant effect at the 10% significance level, but in the random effects probit estimation we find a significant increase in positive answers from CH1 to CH2 at the 1% significance level. So, the data also confirm our third hypothesis.

As already mentioned, including further explanatory variables does not change the overall picture of our results. The significant differences between severe and extremely severe as well as severe and mild diseases can be found in all subsamples. Nevertheless, some significant deviations can be found concerning the answering behaviour in our middle ("severe") category. Age, A-level grade[13], being a smoker or drinking alcohol increase the propensity to obtain the information about one's health status even in the case of severe illnesses. The effects are between 2% and 5% only, but significant at least at the 5%-level[14]. Being a student of economics or of economics and business education reduces the willingness to obtain information

[13]Note that the best grade in Germany is a 1.0, the worst a 4.0.

[14]Also living in a students' accomodation increases the percentage of positive answers by 7%, but as only a small number of participants in the study is in this subsample, the result is only weakly significant.

Dependent Var: Dummy, 1=yes			
Indep Variables	Probit	% Change (Probit)	Random Effects Probit
CH2	.247	7.2	.567
	$(1.844)^{+}$		(2.689)**
const	.667		1.520
	(7.311)**		(5.678)**
Pseudo R^2	.0074	.0074	
Log L	-230.1	-230.1	-198.9
# observations	222	222	222
t-values in brackets	**signif. at 1% level	$^{+}$signif. at 10% level	

Table 3: Will Already Broken - Reference Case: CH1

compared to a student of business administration by 5% and 11%, respectively. The interpretation of the results goes beyond our model. Nevertheless, some more comparative statics analysis could provide an interesting field for future research.

Being privately insured has a significant negative influence on the answering behaviour of nearly 6%. People may either fear - although we emphasised the exclusiveness and private availability of the data - that the results might be used by insurers to increase premia, or publicly insured persons might want to use the information in order to improve their insurance coverage.

In the case of differences between having or not having a family history of CH, we obtain a similar result for the coefficients of age, being a smoker (positive influence) and being privately insured (negative influence)[15]. A positive influence here means that the gap between positive answers without (lower probability) and with (higher probability) a family history of CH is smaller and therefore less significant.

3.4 Further Empirical Literature

There is a vast literature in the field of genetics about attitudes towards genetic testing. In all studies, there is a significant fraction of individuals who do not want to become tested.

Most studies have only considered high risk groups, i.e. individuals with a family history of genetic mutations. These studies are therefore only partly useful to provide evidence for the hypotheses we derive from our theory. It is convenient, though, to

[15]Being married has a strong and significant positive influence on the willingness to obtain information, but again the subsample is very small.

have a brief look at the literature on Chorea Huntington in order to control the magnitude of our results. Kessler et al. (1987) asked 66 individuals at 50% risk of inheriting Chorea Huntington whether they would use genetic testing if available. 79% of them said they would use it. Mastromauro et al. (1987), when asking 131 persons at risk for Chorea Huntington the same question, obtained 66% of positive answers. The last figure is significantly smaller than the 82% which we obtained in our study but the first one is very similar. It is obvious, though, that a more valid analysis should be made between groups of individuals with and without a family history of Chorea Huntington within a single study.

Only very few studies can be found that compare the interest in becoming tested between high and low risk groups. One such study has been done by Hofferbert et al. (1998). The authors found an increased propensity to genetic testing in the case of a family history of breast cancer. They analyzed the behaviour of 52 families, out of which 29 were high risk families with a family history of the relevant genetic mutation. 97 % of the high risk families opted for becoming tested but only 39% of the low risk families did so. Lipkus et al. (1999) compared African-American women with and without a family history of breast cancer (sample size of 130 and 136 women, respectively). Women with such a family history were significantly more interested in genetic testing than the other group. Among women with a family history, 11%, 17%, and 72% reported being not at all/slightly interested, somewhat interested, and interested/very interested, respectively. Among women without a family history, 25%, 16%, and 58% reported being not at all/slightly interested, somewhat interested, and interested/very interested, respectively.

Both studies thus confirm our third hypothesis. They also confirm that among low risk individuals, a significant proportion refuses to become tested.

4 Summary

We present a formal model on the basis of time inconsistent preferences which allows us to discuss the existence of will and the possibility of a breakdown of will. An individual has discretion over one variable, and she faces the trade-off between pleasure today and pleasure in the future. Due to her present biased preferences she has a tendency to consume too much too early. She might devise strategies to overcome this inefficiency. Such a behaviour is called will. However, these strategies are only viable if the future is valued sufficiently highly. If this is not the case, will can not be sustained.

The model is then applied to the value of information. Empirically we observe that many people reject undertaking genetic tests, or more generally, that (some) people do not want to obtain certain information about their future. This is particularly the case if this information is potentially very bad news. We provide an explanation for this observation by arguing that people may rationally prefer not to undertake e.g. a genetic test if they are afraid that in case of a positive test result they will not longer be able to sustain their will.

Comparative statics show that a test might be undertaken if a positive result indicates a mild illness or a very extreme illness, but not if the severity is in between. Tests will also more likely be undertaken if a person's risk of illness even without

a test is already high. Experimental results from a questionnaire distributed to students and evidence from the literature confirm the hypotheses derived from the theory.

Appendix

Proof of Proposition 1:

We first show that for small values of δ we get $\Delta U < 0$, where ΔU is defined in equation (9). First note that at $\delta = 0$ it holds that $\Delta U = 0$, as in that case $\sigma^c = \sigma^{nc} = 0$. So it suffices to show that $\frac{d\Delta U}{d\delta}|_{\delta=0} < 0$ to prove the first statement. Using that $\sigma^c = \delta$ and $\sigma^{nc} = \frac{\lambda\delta}{1-\delta-\lambda\delta}$ gives after some reformulations:

$$\frac{d\Delta U}{d\delta}|_{\delta=0} = -\lambda \ln[\lambda] - (1-\lambda) \tag{20}$$

which is smaller than zero for all values of $0 < \lambda < 1$.

Next we show that for large values of δ we get $\Delta U > 0$. To do so, multiply ΔU by $(1-\delta)^2$. This expression has the same sign as ΔU. Now this new expression is equal to 0 at $\delta = 1$, so it remains to show that the derivative of this expression with respect to δ at $\delta = 1$ is negative, to prove the statement. We get:

$$\frac{d(1-\delta)^2\Delta U}{d\delta}|_{\delta=1} = -\lambda \ln[\lambda] - \frac{(1-\lambda)}{\lambda} \tag{21}$$

which is also smaller zero as long as $\lambda < 1$. This proves Proposition 1. **QED**

References

Ad hoc committee on genetic testing: Insurance issues, 1995, Background statement: Genetic testing and insurance, American Journal of Human Genetics 56, 327-331.

Ainslie, G., 1992, Picoeconomics - the strategic interaction of successive motivational states within the person, Cambridge University Press.

Ainslie, G., 1999, Breakdown of will, working paper presented at GREMAQ/CEPR conference "Economics and Psychology", Toulouse.

Asheim, G., 1997, Individual and collective time-consistency, Review of Economic Studies 64, 427-443.

Azfar, O., 1999, Rationalizing hyperbolic discounting, Journal of Economic Behaviour and Organization 38, 245-252.

Benabou, R. and J. Tirole, 2000, Self-confidence: Intrapersonal strategies, CEPR Discussion Paper Series 2580.

Brocas, I. and J.D. Carillo, 2000, The value of information when preferences are dynamically inconsistent, European Economic Review 44, 1104-1115.

Carillo, J.D. and T. Mariotti, 2000, Strategic ignorance as a self-disciplining device, Review of Economic Studies 67, 529-544.

Chuffart, A., 1996, Genetic testing in Europe, Journal of Insurance Medicine 28, 125-135.

Hall, J., 1996, Consumer utility, social welfare, and genetic testing. A response to 'Genetic testing: an economic and contractarian analysis', Journal of Health Economics 15, 377-380.

Hofferbert, S. et al., 1998, Familiäres Mamma- und Ovarial-Carcinom: Interdisziplinärer Ansatz zur genetischen Testung, Medizinische Genetik 10, 253-255.

Kessler, S., Field, T., Worth, L., and H. Mosbarger, 1987, Attitudes of persons at risk for Huntington Disease toward predictive testing, American Journal of Medical Genetics 26, 259-270.

Kocherlakota, N.R., 1996, Reconsideration-proofness: A refinement for infinite horizon time inconsistency, Games and Economic Behaviour 15, 33-54.

Laibson, D., 1996, Hyperbolic discount functions, undersaving, and saving for retirement, NBER Working Paper Series 5635.

Laibson, D., 1997, Golden eggs and hyperbolic discounting, Quarterly Journal of Economics 112, 443-477.

Laibson, D., 1998, Life-cycle consumption and hyperbolic discount functions, European Economic Review 42, 861-871.

Laibson, D., Repetto, A. and J. Tobacman, 1998, Self-control and saving for retirement, Brookings Papers on Economic Activity 1, 91-196.

Lerman, C. et al., 1988, What you don't know can hurt you: Adverse psychologic effects in members of BRCA1-linked and BRCA2-linked families who decline genetic testing, Journal of Clinical Oncology 16, 1650-1654.

Lipkus, I., Iden, D., Terrenoire, J., and J. R. Feaganes, 1999, Relationships among breast cancer concern, risk perceptions, and interest in genetic testing for breast cancer susceptibility among African-American women with and without a family history of breast cancer, Cancer Epidemiology, Biomarkers & Prevention 8, 533-539.

Loewenstein, G. and J. Elster, Eds., 1992, Choice over time, Russell Sage Foundation.

Mastromauro, C., Myers, R. H., and B. Berkman, 1987, Attitudes toward presymptomatic testing in Huntington Disease, American Journal of Medical Genetics 26, 271-282.

O'Donoghue, T. and M. Rabin, 1999a, Doing it now or later, American Economic Review 89, 103-124.

O'Donoghue, T. and M. Rabin, 1999b, Procrastination in preparing for retirement, in: H. Aaron, ed., Behavioral dimensions of retirement economics. Washington D.C.: Brookings Institution Press; New York: Russel Sage Foundation, 125-156.

Phelps, E.S. and R.A. Pollak, 1968, On second best national saving and game-equilibrium growth, Review of Economic Studies 35, 185-199.

Schmidt, K., 1996, The costs and benefits of privatization - an incomplete contracts approach, Journal of Law, Economics and Organization 12, 1-24.

Sieff, E.M., Dawes, R.M. and G.F. Loewenstein, 1999, Anticipated versus actual responses to HIV test results, American Journal of Psychology 112(2), 297-311.

Strohmenger, R. and A. Wambach, 2000, Adverse selection and categorical discrimination in health insurance markets: The effects of genetic tests, Journal of Health Economics 19, 197-218.

Strotz, R.H., 1956, Myopia and inconsistency in dynamic utility maximization, Review of Economic Studies 23, 165-180.

Tabarrok, A., 1994, Genetic testing: an economic and contractarian analysis, Journal of Health Economics 13, 75-91.

Tabarrok, A., 1996, Genetic testing and human welfare: Reply to Hall, Journal of Health Economics 15, 381-384.

Variable	*Mean*	*Std.Dev.*	*Description*
persnr			number of person
yesno			1=answer "yes, want info", 0="no"
LA			1=observation refers to question "LA", 0=not "LA"=Lassa virus
CH1			1=observation refers to question "CH1", 0=not "CH1"=Chorea Huntington
CH2			1=observation refers to question "CH2", 0=not "CH2"=Chorea Huntington with family history
AZ			1=observation refers to question "AZ", 0=not "AZ"=Alzheimer's disease
AL			1=observation refers to question "AL", 0=not "AL"=Alpha1-antitrypsin deficiency
HE			1=observation refers to question "HE", 0=not "HE"=Hemochromatosis
age	22.216	1.972	age in years
sex	.627	.484	1=male, 0=female

Table 4: Description of Variables and Sample Characteristics, I

Variable	*Mean*	*Std.Dev.*	*Description*
singlere	.548	.498	1=single, in stable relationship, 0=else
single	.415	.493	1=single, without stable relationship, 0=else
married	.032	.177	1=married, 0=else
divorced	.005	.068	1=divorced/separated, 0=else
alevel	.977	.149	1="Abitur"(A-Level), 0=else
alevgrad	2.183	.589	A-Level grade: best grade 1.0, worst 4.0
economic	.359	.480	1=student of economics, 0=else
business	.482	.500	1=student of business administration,0=else
econteac	.141	.348	1=student of economics education, 0=else
diffcare	.018	.134	1=different career from above, 0=else
ownflat	.280	.449	1=living alone, 0=else
parents	.431	.495	1=living at parents', 0=else
sharedfl	.115	.319	1=living in shared flat, 0=else
studenta	.050	.219	1=living in student accomodation, 0=else
partner	.096	.295	1=living with partner, 0=else
partnerk	.009	.095	1=living with partner and kids, 0=else
singleki	.009	.095	1=living alone with kids, 0=else
difflivi	.009	.095	1=living differently from above, 0=else
catholic	.603	.490	1=catholic, 0=else
muslim	.014	.116	1=muslim, 0=else
protesta	.228	.420	1=protestant, 0=else
diffrel	.046	.209	1=different religion from above, 0=else
norel	.110	.313	1=no religion, 0=else
smoke	2.484	.761	1=smoke regularly, 2=irreg, 3=not
drink	1.927	.490	1=drink regularly, 2=irreg, 3=not
health	7.521	2.134	0=very unhappy with health status, 10=very happy
insur	.688	.463	1=private (or priv. add.) insurance, 0=state insurance only
genmut	.073	.261	1=genetic mutation known in family, 0=not

Table 5: Description of Variables and Sample Characteristics, II