

*“An analysis of attitude towards risk in  
the National Health Services”*

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*By Reidar Tveiten*

*Lysaker, 10. Desember*

## Introduction

This paper is part of larger project, consisting of researchers from the University of Bergen and the Norwegian School of Economics. The team members are:

- Fred Schroyen, Professor, PhD, at the Department of Economics (NHH), project supervisor.
- Kurt Brekke, Research economist, Post Doctor, at the Department of Economics (NHH).
- Gaute Torsvik, Professor at the Department of Economics (UiB).
- Reidar Tveiten, student (NHH).

The project aims at gaining insight in the willingness of hospitals to accept financial risks, by investigating the risk attitudes among individuals with budgetary responsibility within the National Health Services. Their propensities to take risks are meant to provide a contribution to today's debate concerning hospital funding. We measure their risk aversion by exposing them to different combinations of uncertain and certain prospects of the yearly fixed grants. The methodology of the paper is first and foremost inspired by the work done by Barsky et al (1997) and Arie Kapteyn et al (2002).

My role in the project has been to assist the project team, and especially the project supervisor Fred Schroyen, in formulating the questionnaires, identifying private, both for profit and non-for-profit and public hospitals active in Norway, identifying CEOs and board directors for each active hospital, administrating the questionnaires and gathering financial information on each hospital in the survey. In this paper I report the findings of the survey. The structure of the paper is as follows: Initially a short introduction and motivation of the problem as presented is given. Thereafter, the theoretical fundament of the paper is derived in chapter 1 and 2, before the methodology of the paper is explained and discussed in chapter 3 and 4. Finally, the results from the survey are presented in chapter 5.

Finally I emphasise that this paper had not been possible without Prof. Fred Schroyen's help. I am thankful for his help as well as the opportunity he gave me to participate in the research team.  
Thank you!

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## Background Information and Motivation for Problem as Presented

In 2003 the total health expenditure (HE) in Norway amounted to 10.3% of gross domestic product (GDP), up from 4.4% in 1970, implying a yearly growth rate over the 33 year period of the HE/GDP-ratio at 2.6%. In other words, HEs have grown considerably faster than the rest of the economy in Norway the last three decades. This worrying state of fact is not unique for Norway. In the same period most OECD countries have experienced the same development. However, from 2000 to 2003 the yearly growth rate in the  $HE_{NOR}/GDP_{NOR}$  -ratio has been 6.6%, which is substantially higher than the OECD average at 3.2%, making the Norwegian National Health Service one of the most expensive in the world. As a matter of fact, if the trend continuous, Norway will eventually be on the same level as the United States of America, which have a highest HE/GDP-ratio in the world at approximately 15%. The trend in HEs is not sustainable, and must be confined or indeed turned around. (The introductory analyses are summarized in appendix 1.)<sup>1</sup>

What has been done? A number of actions have been taken to reverse the unsustainable development. Many hospitals have, in hope of exploiting cost reducing synergies, merged, the funding of the hospitals is reformed and the control over the pharmaceutical market is tighter. The funding of hospitals has gradually been changed from pure cost reimbursement to a system with both fixed and variable remuneration. The variable part is based on the Diagnosis Related Groups (DRG)-prices<sup>2</sup>, which is the same for all public providers of health care. Thus, the funding is prospective. Demographic and other differences between the providers are meant to be absorbed by the fixed lump-sum transfer that each receive. DRG-prices were introduced to improve the economic incentives in hope of encouraging more efficient operations of public health enterprises. Historically the activity based funding has amounted to either 40 or 60% of the total reimbursement. Today the portion of activity based funding is 40%.<sup>3</sup> The new system with both fixed and activity based funding is firmly deliberated over and there are indeed both pros

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<sup>1</sup> Source: "Health at Glance – OECD Indicators 2005, statistical annex A, page 150"

<sup>2</sup> DRG is a system to classify hospital cases into one of approximately 500 groups, expected to have the same resource use.

<sup>3</sup> Source: <http://www.regjeringen.no/nb/dep/hod/tema/Sykehus/Innsatsstyrte-finansiering.html?id=227811>

and cons with the system.<sup>4</sup> However, one important parameter is due to be discussed, and that is risk aversion, or risk preferences, among people within the National Health Service. This is an important parameter since the hospitals are exposed to several types of risks, both on the cost and the revenue side. Firstly, reimbursement based on DRG-prices entails that the hospital has to bear the risk of the treatment costs exceeding the DRG-price. And secondly, the demand both for emergency care and elective cases are uncertain. Should the fact that hospitals are exposed to risk influence the reimbursement system? The answer is yes. Principal-agent theory predicts that a person's willingness to accept monetary risks (their risk aversion) directly affects the optimal mixture between fixed and activity based reimbursement. (The principle-agent theory is derived in chapter 2.)

Thus by finding the adequate people to ask within the National Health Service and by exposing and quantifying their propensity to take budgetary risk, the research team hopes to improve the politicians unsound basis for making decisions concerning the hospital funding in Norway.

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<sup>4</sup> It can be shown that the system with DRG-prices, presumed that the system is lived up to by the organizations, through yardstick competition yields social optimal cost and production levels.

However, practice and surveys have revealed several problems with the system. Firstly, if the regulators cannot commit to let hospitals go bankrupt if they choose inefficient cost levels, the funding is retrospective and gives no incentive to efficient cost and production levels. Secondly, if the hospital does not on average face the same distribution of patients, hospitals with many severe/costly cases will suffer. Thirdly, strategic behavior from hospitals ("upcoding", cream-skimming, etc.) is a potential problem. Finally, incentives for innovation are limited with the system as it is today, since the DRG-prices do not adequately pay for innovative investments (for example new machinery).

Source: Chalkley M and J M Malcomson (2000) "Government purchasing of health services", Ch 15 in A J Culyer and J P Newhouse (eds) *Handbook of Health Economics*, vol 1B (Amsterdam: North Holland): 847-891." and Gaynor and Vogt (2000) "Antitrust and competition in health care markets", Ch 27 in A J Culyer and J P Newhouse (eds) *Handbook of Health Economics*, vol 1B (Amsterdam: North Holland): 1093-1139.

## 1. Theory

The object of this theoretical chapter is to define the concept of risk preference and to derive measures for its size.

The theoretical part is built upon a self-constructed example which will be used as illustration throughout this chapter<sup>5</sup>. With the example as basis basic microeconomic theory about expected value, expected utility and risk preferences is explained and commented. Deduced from this theory mathematical measures for absolute and relative risk aversion are elaborated.

Finally, some classical utility functions are discussed.

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<sup>5</sup>The theoretical part in general is inspired by: Layard & Walters (1978): *Microeconomic theory*. Page 351-391.



## 1.1 Individuals Behavior towards Risk

*“An ice-cream seller (ICS) is debating whether he should sell his business or not. The ICS is offered a price at \$20 for his shop. The income of his business is highly dependent on the weather. Up until now the forecasts have been fairly stable and the ICS’s risk has been limited, but due to the climate changes there is now considerable uncertainty concerning weather forecasts in the decades to come. To simplify, assume that there are only two outcomes, good or bad weather in the rest of the economic life time of the ice-cream shop. With good weather the net income (y) of the ice-cream business is \$30. However, if the climate changes from good to bad, the net income is \$10. Should the ICS sell his business or should he not?”*

The answer depends on his attitude towards risk, which will be this chapter’s main focus. The first the ICS has to do is to evaluate his own net income in each of the states of the world as a result of each possible plan. The example implies two states of the world and indirectly assumes two possible plans. It can either be good (state 1) or bad weather (state 2) and the ICS could plan to sell his business (plan A) or not sell his business (plan B). This information is summarized in the payoff matrix below.

**Table 1.1: The ICS's net income**

Plan		State of the world	
		1. Good	2. Bad
A.	Sell	\$20	\$20
B.	Not sell	\$30	\$10
(Probability)		( )	( )

In terms of symbols it can be presented as follows:

**Table 1.2: The ICS's net income**

Plan	State of the world	
	1. Good	2. Bad
A.	$y_{A1}$	$y_{A2}$
B.	$y_{B1}$	$y_{B2}$
(Probability)		( )

To fully understand his opportunities the ICS has to analyze the probabilities attached to each of the possible states of the world. The probabilities are a function of the ICS’s own perception of

the situation. Therefore they are usually called *subjective probabilities* enhancing the fact that they are not general but individualistic.

Suppose that the two states are equally likely, then:

$$(1) p_1 = .5 \text{ and } p_2 = .5$$

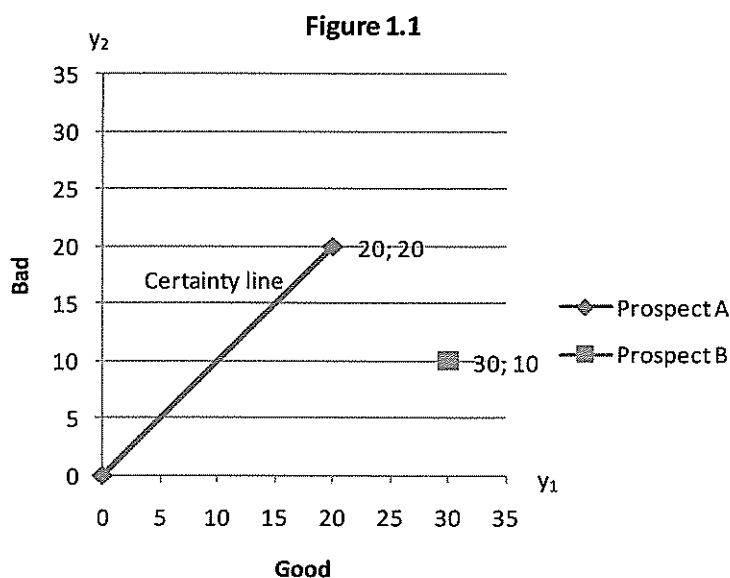
The ICS now has two alternative prospects. First, if he decides to follow plan A (to sell the shop) he receives a certain amount of \$20. Thus, prospect A can be written as follows:

$$(2) \text{Prospect A} = (20,20; .5, .5)$$

Prospect B implies different outcomes for the ICS. There is a 50% chance that the ice-cream business generates proceeds of \$30, but there is also a 50% chance that the business only generates a net income of \$10.

$$(3) \text{Prospect B} = (30,10; .5, .5)$$

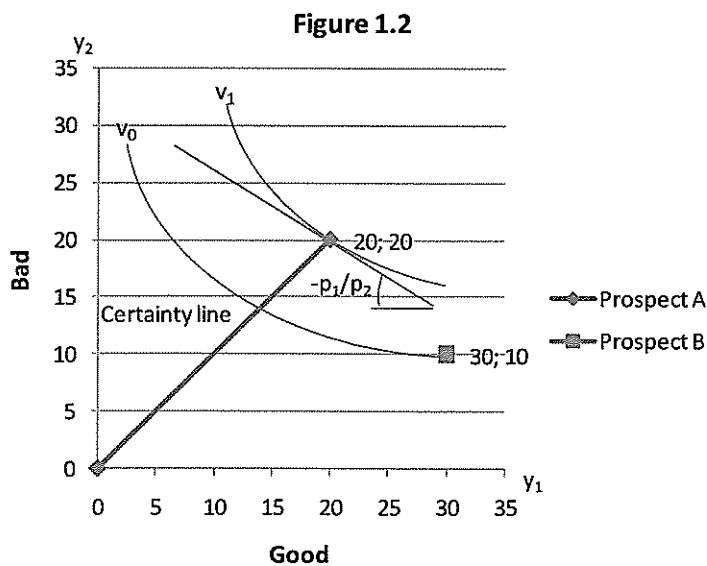
The two prospects are illustrated in figure 1.1. The horizontal axis measures the net income of the ice-cream store if the weather becomes "good",  $y_1$ , while the vertical axis measures the net income if the weather turns out to be "bad",  $y_2$ .



If we are willing to assume that the ICS is able to order all possible prospects, including prospects A and B and these are the only two states of nature, then his *ex-ante* utility can be written as follows:

$$(4) V = V(y_1, y_2; p_1, p_2)$$

V is the ICS's utility function which is dependent on outcome  $y_1$  and  $y_2$  and the subjective probabilities  $p_1$  and  $p_2$ . Consequently the ICS's choice will depend on his attitude towards risk, thus which combination of outcomes and subjective probabilities the ICS finds attractive. For given probabilities the utility just becomes a function of  $y_1$  and  $y_2$ . In figure 1.2 this is illustrated by the indifference curves  $V_0$  and  $V_1$ .



If the indifference curves in figure 1.2 are representative for the ICS, he dislikes risk. This fact can easily be seen after introducing the concept of *expected value*,  $E(y)$ .

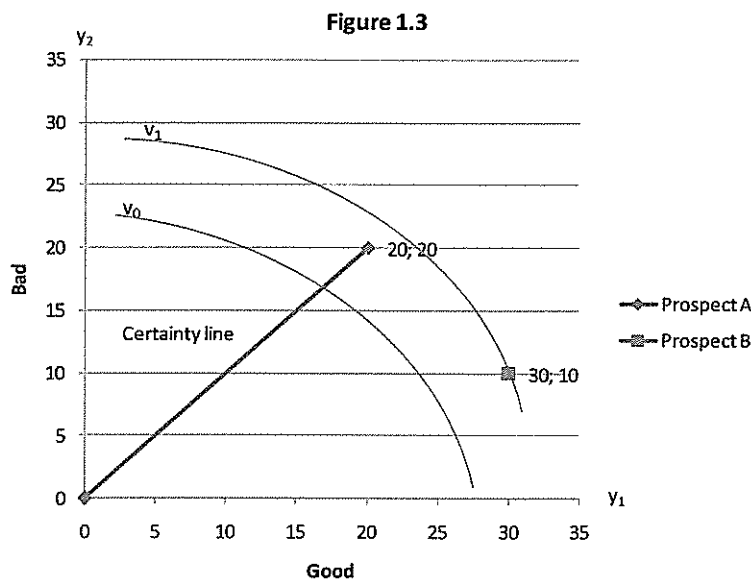
$$(5) E(y) = p_1 y_1 + p_2 y_2$$

Expected value of prospect A and B are respectively:

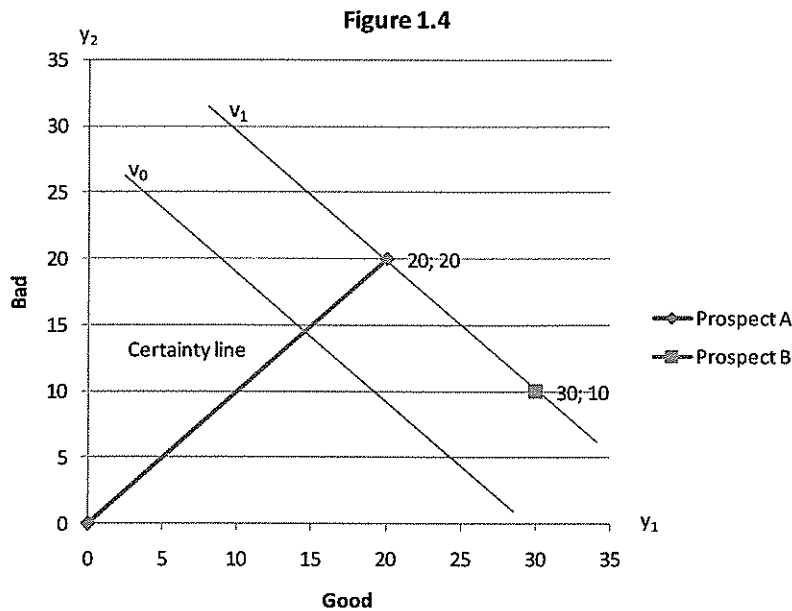
$$(6) E(y|A) = p_1 y_{A1} + p_2 y_{A2} = .5(20) + .5(20) = 20$$

$$(7) E(y|B) = p_1 y_{B1} + p_2 y_{B2} = .5(10) + .5(30) = 20$$

Even though the two prospects have the same expected value and the choice between them can be looked upon as a *fair gamble*<sup>6</sup>, prospect A is preferred to prospect B. This is so because  $V_1$  implies a higher utility than  $V_0$ , thus prospect A is more attractive than prospect B. In microeconomic theory this state of fact is defined as *risk-aversion*. A risk-averse person will not take a fair gamble, while a *risk-loving* person will. Risk-neutral individuals will, as the definition implies, be indifferent to take a fair gamble or not. As illustrated in figure 1.2, risk aversion implies indifference curves that are convex to the origin. Risk-lovers have indifference curves that are concave to the origin, while risk-neutral person's indifference curves are straight lines. This is illustrated in figure 1.3 and 1.4. The indifference curves are symmetric if a person's needs are the same in each state and he perceives the states to be equally likely.



<sup>6</sup>  $E(y|A) = E(y|B)$



A risk – lover, or *gambler*, prefers (figure 1.3) the fair gamble over the certain prospect. Thus he chooses prospect B over prospect A. It may be argued that the gambler really is not risk loving<sup>7</sup>, but his subjective preferences in fact are a result of a divergence between the subjective and objective probabilities. That is, the probabilities of winning are exaggerated by the gambler. If this is true, gambling can be consistent with risk aversion. The risk neutral person (figure 1.4), however, is indifferent between prospect A and B, since the expected values are equal in each prospect.

## 1.2 Expected Utility

The utility function derived in chapter 1.1 is totally general. However, for our purposes it is expedient to derive a more specific utility function, since it enables us to quantify of risk aversion. A quantification of the general results that follow from the state preference model can be provided by the model of *expected utility*.

<sup>7</sup> Arrow, 1971 "*Theory of Risk Aversion*", chapter 3, pp 91

According to the expected utility hypothesis alternative prospects are ranked after the *expected utility* they provide. In general, the utility in state  $i$  from income  $y_i$  can be written as  $u^i(y_i)$ . On the basis of the case presented, where there are only two possible outcomes and the notation above, the expected utility can be written as follows:

$$(8) V(y_1, y_2; p_1, p_2) = p_1 u^1(y_1) + p_2 u^2(y_2),$$

If we further are willing to assume that the ex-post utility function is the same in each state, the expected utility is:

$$(9) V(y_1, y_2; p_1, p_2) = p_1 u(y_1) + p_2 u(y_2),$$

where  $V(y_1, y_2; p_1, p_2)$  is unique up to a linear transformation. By definition this means that:

$$(10) V(y) = a + bu(y), \text{ where } a > 0 \text{ and } b > 0.$$

Thus,

$$(11) EV(y) = p_1 \tilde{u}(y_1) + p_2 \hat{u}(y_2)$$

$$(12) EV(y) = p_1(a + bu(y_1)) + p_2(a + bu(y_2))$$

$$(13) EV(y) = (p_1 + p_2)a + b[p_1 u(y_1) + p_2 u(y_2)]$$

Since  $p_1 + p_2 = 1$  and  $p_1 u(y_1) + p_2 u(y_2) = Eu(y)$ , (12) can be simplified as follows:

$$(14) EV(y) = a + b \times Eu(y)$$

Thus, adding any constant,  $a$ , or multiply by any positive constant,  $b$ , to the utility function does not change the preference ordering represented.

Before turning to the ICS's decision, look back at figure 1.2. The difference quotient to indifference curve  $V_1$  at point  $(20, 20)$ , is given by  $-p_1/p_2$ . This can be shown by differentiating (9) and setting it equal to zero:

$$(15) dV(y_1, y_2; p_1, p_2) = p_1 u'(y_1) dy_1 + p_2 u'(y_2) dy_2 = 0$$

$$(16) -\frac{dy_2}{dy_1} = \frac{p_1 u'(y_1)}{p_2 u'(y_2)}$$

Since  $20 = y_1 = y_2 = \tilde{y}$ ,  $u'(y_1) = u'(y_2) = u'(\tilde{y})$ , (16) can therefore be written as follows:

$$(17) \quad \frac{dy_2}{dy_1} = -\frac{p_1}{p_2}$$

If we use this insight on the ICS's decision, on whether to sell his business or not, the expected utility for prospect A is:

$$(18) \quad E(y|A) = p_1u(y_{A1}) + p_2u(y_{A2}) = .5u(20) + .5u(20) = u(20)$$

The expected utility for prospect B is:

$$(19) \quad E(y|B) = p_1u(y_{B1}) + p_2u(y_{B2}) = .5u(10) + .5u(30)$$

The ICS selects B if and only if:

$$(20) \quad E(u|A) < E(u|B)$$

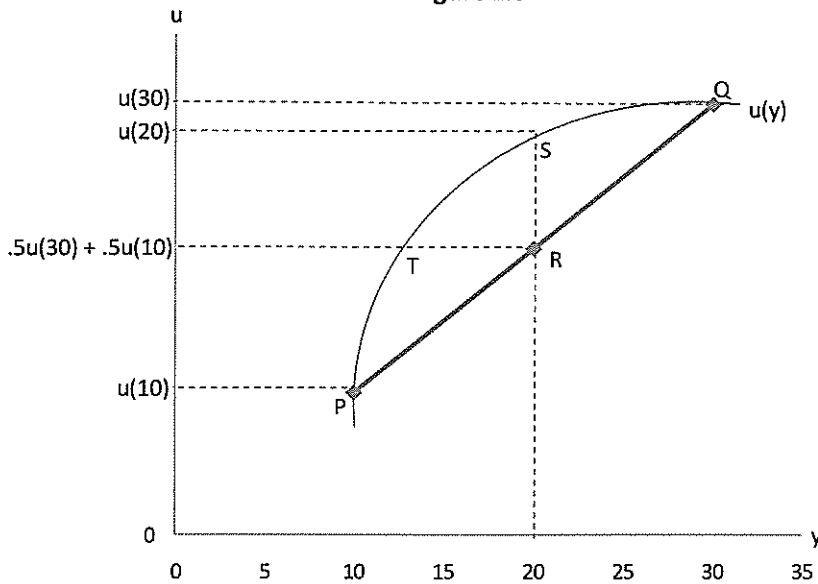
His choice clearly depends on the shape of the utility function.

If the utility function is concave, this means by definition that:

$$(21) \quad u(\lambda y_1 + (1 - \lambda)y_2) > \lambda u(y_1) + (1 - \lambda)u(y_2)$$

for all  $0 < \lambda < 1$ . Setting  $\lambda$  equal to  $p_1 = p_2 = .5$ ,  $u(20) > .5u(30) + .5u(10)$ . Thus, risk aversion, as a psychological characteristic, can be represented by the expected utility hypothesis and the assumption of a concave utility function, as illustrated in figure 1.5.

Figure 1.5

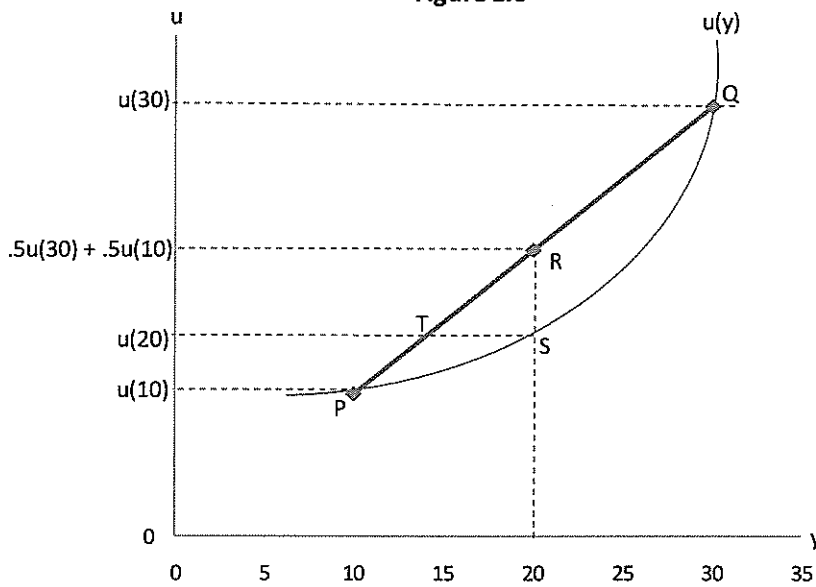


P measures the height of  $u(10)$  and Q measures the height of  $u(30)$ . If we draw the line PQ and bisect the line at R, the height of R measures the average of P and Q. The height  $u(20)$  is represented by point S. Since  $u(y)$  is concave it lies above for any chord, such as PQ. Obviously R lies on PQ, while S lies above, which proves that a risk averse person will not take a fair gamble. The intuitive explanation for this is that the gain from winning 10 is lower than the loss from losing 10. In other words, there is *diminishing marginal utility of income*.

However, the situation is exactly the opposite for risk lovers, as illustrated in figure 1.6. While risk aversion is characterized by a concave utility function, the same function is convex downwards for risk lovers.



Figure 1.6



With a function with this characterization,  $u(y)$  lies below any chords, such as PQ. When R clearly lies on PQ, S must lie below R. The intuitive explanation is that a risk lover gains more by winning 10 than he loses by losing 10. In other words there is *increasing marginal utility of income*.

With risk neutral preferences the utility function of income will be concurrent with PQ, since the only factor that is decisive of the decision is the expected value, not risk.

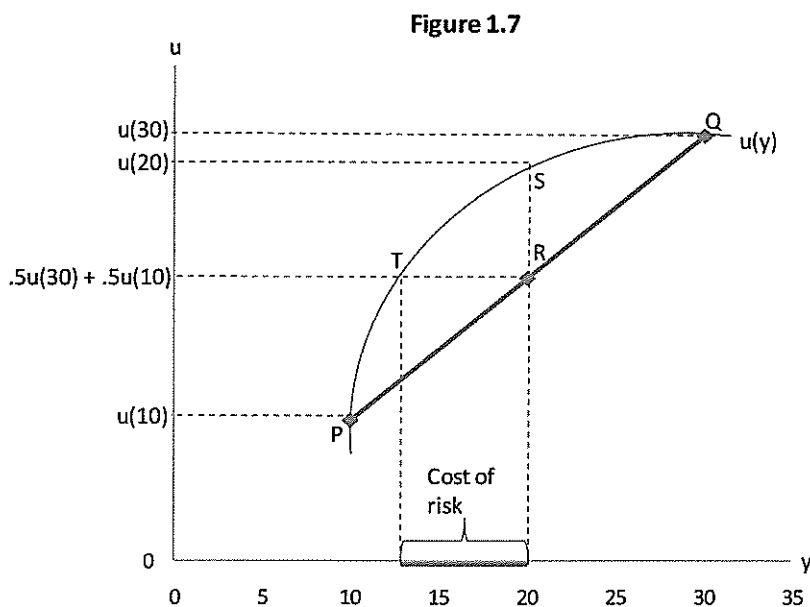
### 1.3 Insurance and Gambling – Mutual Exclusive “*Modus Operandi*”?

Risk-averse people are willing to pay to avoid risk. But how much are they willing to pay? What is the cost of risk? Turning to figure 1.5, the cost of risk involved is equal to the line TR. Suppose the ICS usually has a yearly income of \$30, but the income will fall to \$10 if the weather turns out to be disastrous. To illustrate this state of fact, assume that there is a 50-50 chance of this happening. In addition, assume that figure 1.5 is representative for his preferences. Without insurance the ICS has an expected income of \$20, giving him an expected utility measured at the height R. However, obviously he is equally happy with a guaranteed income of  $20 - TR$ , which is

usually defined as the certainly-equivalent income, since the height of point T is equal to the height of point R. The question then is: what premium is he willing to pay to the insurance company to get a guaranteed income of  $20 - TR$ ? The answer is,

$$(22) \quad 30 - (20 - TR) = 10 + TR$$

The situation is illustrated in figure 1.7. Generally the cost of risk is defined as the difference between the expected value of a risky prospect and its certainly-equivalent income.

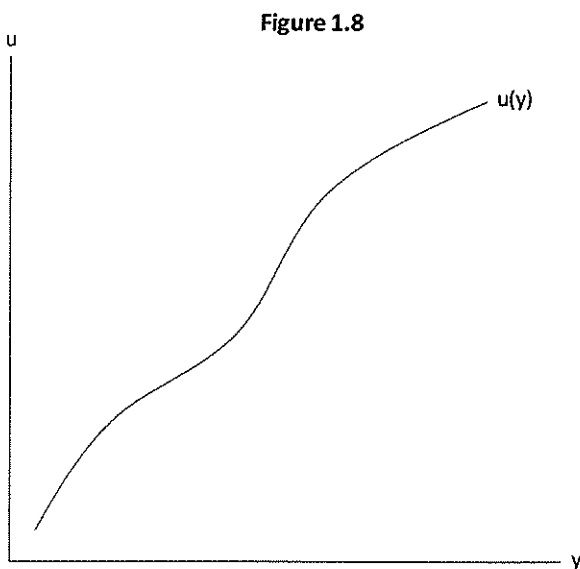


Turning to the gambler the situation is somewhat different. As proven earlier a gambler is willing to take a fair gamble, but is he willing to take an unfair gamble? The answer is yes, as long as it is not too unfair. Suppose a gambler faces the following prospects. Current income is for certain \$20, but he is offered a game where the bet is \$10 and potential winnings are \$10. Thus, he can choose to swap his certain income of \$20 to uncertain income of either \$10 or \$30. Will he take this bet? Look back to figure 1.6. He will do this only if he regards the probability of winning is exceeds or is equal to  $PT/PQ$ <sup>8</sup>. If he does, the uncertain prospect will be equal or increase his expected utility relative to the certain prospect.

<sup>8</sup> Explanation: The gambler will only take the gamble if:  $p_1 \times u(30) + (1 - p_1) \times u(10) \geq u(20)$ , where  $p_1$  is the gamblers subjective probability of winning. We can derive from figure 1.6 that  $p_1$  must be equal or higher than

An important insight of the discussion above is that the willingness to insure or for that sake gamble, depends on the curvature of the utility function, i.e. the degree of risk aversion or risk loving. Especially the degree of risk aversion and the magnitude of this variable will be stressed in greater detail below.

The cases described above are relatively plain and simple. Unfortunately, in this context, the world is more complex, because most people often both insure and gamble. As a response to this state of fact, Friedman and Savage<sup>9</sup> postulated a concave utility of income function at low incomes, convex at middle incomes and concave again at high incomes. Their utility function is illustrated in figure 1.8.



Can such a utility function explain why people both insure and gamble? Yes, it can. Consider a person with income  $y_0$  and suppose he faces a risk of .3 of losing  $L$ . In addition, assume that the utility function illustrated in figure 1.9 is representative for the person's preferences. If he is offered a fair insurance he will take it since,

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PT/PQ for the gambler to participate in the gamble. If the  $p_1 < PT/PQ$  than the "premium for gambling" will be more costly than the line segment TS, thus the gamble is too unfair.

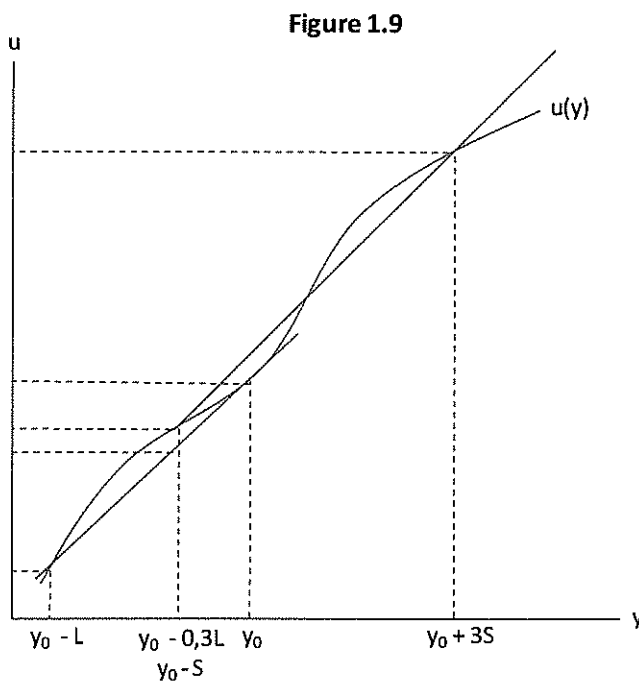
<sup>9</sup> Friedman.M and L.J Savage, "The Utility Analysis of Choises Involving Risks", Journal of Political Economy, 56, 1948, pp. 279-304.

$$(23) \quad u(y_0 - .3L) > .7u(y_0) + .3u(y_0 - L)$$

Does this mean that he will not take a fair gamble? The answer is no. Suppose he is offered a 3:1 bet, on a stake S, which means that if he wins he receives 3S while he must give up S if he loses. The probability of winning is .25, which he considers fair<sup>10</sup>. If we once again assume that figure 1.9 is representative for the person's preferences, then he is willing to take the gamble because,

$$(24) \quad u(y_0) < .75u(y_0 - S) + .25u(y_0 + 3S)$$

The two cases are reproduced in a simplified illustration in figure 1.9, which is a spin-off development of figure 1.8.



#### 1.4 The Cost of Risk and the Degree of Risk Aversion

In the previous chapter the cost of risk is firmly described and explained. However, by mathematically defining the cost of risk and manipulating this expression, measures of the degree of risk aversion can be developed. The cost of risk can be defined as:

$$(25) \quad u(\hat{y} - C) = \sum_{i=1}^N p_i u(y_i), \quad \text{where } N = \text{possible states of nature.}$$

<sup>10</sup> The gamble is fair since:  $\frac{1}{4}(y + 3S) + \frac{3}{4}(y - S) = y + \frac{3}{4}S - \frac{3}{4}S = y$

$\hat{y} = \sum_i p_i y_i =$  expected income.

$\hat{y} - C =$  the certain income giving utility equal to the expected utility of a risky prospect.

$C =$  cost of risk

To find a measure of  $C$  approximations on both sides of (25) are necessary.

$$(26) \quad u(\hat{y} - C) \approx u(\hat{y}) - u'(\hat{y}) \times C, \text{ based on the formula for linear approximation (71) in appendix 3.}$$

However, as indicated in appendix 1 this formula is only valid when  $y$  is close to  $\hat{y}$ . To allow for wider variations in  $y$  a quadratic approximation is needed. (You find the formula for quadratic approximation (72) in appendix 3.) Using this formula you end up with the following expression,

$$(27) \quad u(y) = u(\hat{y}) + u'(\hat{y}) \times (y - \hat{y}) + \frac{1}{2} u''(\hat{y}) \times (y - \hat{y})^2$$

So,

$$(28) \quad \sum_{i=1}^N p_i u(y_i) = u(\hat{y}) + u'(\hat{y}) \times \sum_{i=1}^N p_i (y_i - \hat{y}) + \frac{1}{2} u''(\hat{y}) \times \sum_{i=1}^N p_i (y_i - \hat{y})^2$$

Since  $\sum_{i=1}^N p_i (y_i - \hat{y})^2 \stackrel{\text{def}}{=} \text{var}(y)$  and  $\sum_{i=1}^N p_i (y_i - \hat{y}) = 0$ , we can write (25) as

$$(29) \quad \sum_{i=1}^N p_i u(y_i) = u(\hat{y}) + \frac{1}{2} u''(\hat{y}) \times \text{var}(y)$$

From (25) and (26) we have that  $\sum_{i=1}^N p_i u(y_i) = u(\hat{y}) - u'(\hat{y}) \times C$  and from (29) we have that  $\sum_{i=1}^N p_i u(y_i) = u(\hat{y}) + \frac{1}{2} u''(\hat{y}) \times \text{var}(y)$ , thus

$$(30) \quad u(\hat{y}) - u'(\hat{y}) \times C \approx u(\hat{y}) + \frac{1}{2} u''(\hat{y}) \times \text{var}(y)$$

$$(31) \quad C \approx -\frac{u''(\hat{y})}{2u'(\hat{y})} \times \text{var}(y)$$

From (31) it is obvious that  $C$ , or the risk premium, is proportional to the variance of income. However, more interesting now we can define absolute ( $A(\hat{y})$ ) and relative risk aversion ( $R(\hat{y})$ ) as,

$$(32) \quad A(\hat{y}) = -\frac{u''(\hat{y})}{u'(\hat{y})} = \frac{2C}{\text{var}(y)}$$

$$(33) \quad R(\hat{y}) = -\frac{u''(\hat{y})}{u'(\hat{y})} \times \hat{y} = \frac{du}{dy} \frac{\hat{y}}{u}$$

### 1.5 Absolute Risk Aversion

*Absolute risk aversion (32) measures the rate at which marginal utility declines when income is increased by one dollar (or the currency in present ( $\hat{y}$ )).*

This representation of the decision maker's propensity to accept risk is unique, since both the additive constant in a linear transformation of utility and the multiplicative constant is eliminated. As shown earlier this is done by taking the derivative of the utility and by forming the ratio of two derivatives, respectively.<sup>11</sup> Thus, the absolute risk aversion measure is equal for all utility functions representing the same risk preferences. In fact, it is the uniqueness that makes absolute risk aversion a potentially powerful and meaningful measure.

Despite its obvious advantages, Meyer & Meyer<sup>12</sup> stress two disadvantages with  $A(\hat{y})$ . First, both  $-u(\hat{y})$  and  $u(\hat{y})$  have the same absolute risk aversion measure. However, this is not really a problem since the utility function by definition is positive.<sup>13</sup> The second snag stressed by Meyer & Meyer is that the measure of risk aversion is changed in a small, but significant way if the same outcome variable is used using different units of measure. Example, if absolute risk aversion of the same utility function was measured in different monetary units, for example euro and dollars, the absolute risk aversion would be given in two different numbers. This causes a potential problem when comparing results. The easiest way to avoid this problem is of course to ensure that the outcome variable is consistent over various studies.

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<sup>11</sup> Look back at formula (9) – (14).

<sup>12</sup> Donald J. Meyer and Jack Meyer, "Measuring Risk Aversion", chapter 2.

<sup>13</sup> Look back to formula (9).

## 1.6 Relative Risk Aversion

*Relative risk aversion (33) can be interpreted as the elasticity of the marginal utility of income with respect to income. In other words, as the rate at which marginal utility decreases when income or wealth ( $\hat{y}$ ) is increased by one percent.*

Intuitively, the faster the utility falls, the more risk aversion. If a person is characterized with constant absolute risk he will rank projects the same way no matter how wealthy he is. By contrast a person with constant relative risk aversion will be less risk averse to risky projects, the wealthier he is.

One can easily, with one exception, go from  $A(\hat{y})$  to  $R(\hat{y})$  and back by multiplying and dividing by  $\hat{y}$ . (The exception is when  $\hat{y} = 0$ , then it is impossible to go from  $R(\hat{y})$  to  $A(\hat{y})$ .) This state of fact ensures that  $R(\hat{y})$  has the same pros as  $A(\hat{y})$ . In addition, problems concerning different units of measure is avoided, since  $R(\hat{y})$  is written as an elasticity rather than an absolute measure.

## 1.7 Two Hypotheses about $A'(\hat{y})$ and $R'(\hat{y})$

How  $A(\hat{y})$  and  $R(\hat{y})$  behave as  $\hat{y}$  changes, i.e. if  $A'(\hat{y})$  and  $R'(\hat{y})$  is positive or negative, is of great importance for predictions of economic behavior under uncertainty. Arrow<sup>14</sup> propounds two hypotheses:

1. Increasing relative risk aversion: *The relative risk aversion,  $R(\hat{y})$ , is an increasing function of  $\hat{y}$ . ( $R'(\hat{y}) > 0$ ).*
2. Decreasing absolute risk aversion: *The absolute risk aversion,  $A(\hat{y})$ , is an decreasing function of  $\hat{y}$ . ( $A'(\hat{y}) < 0$ )*

Decreasing  $A(\hat{y})$  predicts that, if  $\hat{y}$  increases, the amount of risky assets held will increase. In other words, risk aversion decreases as income (or, if you may, wealth) increases. The hypothesis is intuitively appealing, since the consequences of losing a gamble with small fixed amounts, if

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<sup>14</sup> Arrow, 1971 "Theory of Risk Aversion", chapter 3, pp 96

you are well-off, is smaller than if you are less moneyed. Indeed, decreasing absolute risk aversion seems to be supported by everyday observation.

However, the hypothesis of increasing relative risk aversion is not of the same intuitive nature. Arrows assertion is that: *“if both wealth and the size of the bet are increased in the same proportion, the willingness to accept the bet (as measured by the odds demanded) should decrease.”*<sup>15</sup> In other words, if  $\hat{y}$  increases, the portion of risky asserts held increases, but not to the same extent as income ( $\hat{y}$ ), thus relative risk aversion must be an increasing function of  $\hat{y}$ .

The assumptions concerning the behavior of the measures of absolute and relative risk aversion have directly affected the use and popularity of various utility functions.

## 1.8 Classical Utility Functions

The expected utility theory has reached a broad acceptance for decision making under uncertainty. However, researchers often restrict the expected utility model by considering a specific set of utility functions. This is done to obtain tractable solutions to many problems. In the following three specific utility functions will be commented; quadratic utility functions, constant-absolute-risk-aversion (CARA) utility functions and constant-relative-risk-aversion (CRRA) functions.

Quadratic utility functions were developed during the 1960s and are in the form of

$$(34) \quad u(y) = ay - \frac{1}{2}y^2, \text{ for } y \leq a$$

$$(35) \quad u'(y) = a - y$$

$$(36) \quad u''(y) = -1$$

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<sup>15</sup> Arrow, 1971 *“Theory of Risk Aversion”*, chapter 3, pp 97



$y$  can be interpreted as income or *wealth*. To ensure the necessary requirement that  $u$  is non-decreasing, which inevitably of necessity implies that  $y$  must be lower than  $a$ . By using the definition of absolute (32) and relative risk aversion (33) we obtain the following risk measures:

$$(37) \quad A(y) = \frac{1}{a-y}$$

$$(38) \quad R(y) = \frac{y}{a-y}$$

The quadratic utility function has, however, decreased in popularity. This is, among other reasons, due to the following attribute:

$$(39) \quad A'(y) = \frac{1}{(a-y)^2} > 0$$

In other words, quadratic utility functions exhibit increasing absolute risk aversion, which is not consistent with research on the matter.<sup>16</sup>

Most of the problems concerning the quadratic utility functions are solved with the so called CARA functions, which are exponential functions characterized by:

$$(40) \quad u(y) = -\frac{\exp(-ay)}{a}, \text{ where } a \text{ is a positive scalar.}$$

The absolute and relative risk aversion then become, respectively

$$(41) \quad A(y) = a, \text{ for all } y.$$

$$(42) \quad R(y) = ay$$

Constant absolute risk aversion is often useful when comparing different alternatives. However, this is also the strongest argument against its usage, since research exhibit that absolute risk aversion is decreasing rather than constant.<sup>17</sup>

Finally, the most acknowledged and used set of preferences, CRRA, takes the following form:

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<sup>16</sup> Arrow, 1971 "*Theory of Risk Aversion*", chapter 3, pp 97

<sup>17</sup> Look back at chapter 1.7

$$(43) \quad u(y) = \begin{cases} \frac{y^{1-\gamma}}{1-\gamma}, & \text{for } y \geq 0, \gamma \neq 1 \\ \ln(y), & \text{for } \gamma = 1 \end{cases}$$

$$(44) \quad u'(y) = y^{-\gamma}$$

$$(45) \quad u''(y) = -\gamma y^{-\gamma-1}$$

Once again by using definition (32) and (33), we obtain:

$$(46) \quad A(y) = -\frac{-\gamma y^{-\gamma-1}}{y^{-\gamma}} = \frac{\gamma}{y}$$

$$(47) \quad R(y) = \frac{\gamma}{y} \times y = \gamma, \text{ for all } y.$$

(43) in contrast to (40) both implies constant relative risk aversion and decreasing absolute risk aversion.

## 2. Principal-Agent Theory

By deriving the principle-agent theory it can be shown that attitudes towards monetary risk directly affects the optimal mixture of certain and uncertain remuneration. Thus, the hospital managers propensity to take risks are interesting to measure because it should influence the hospital's financing. Below I will derive the principle-agent theory and show the connection between optimal financing and risk aversion.

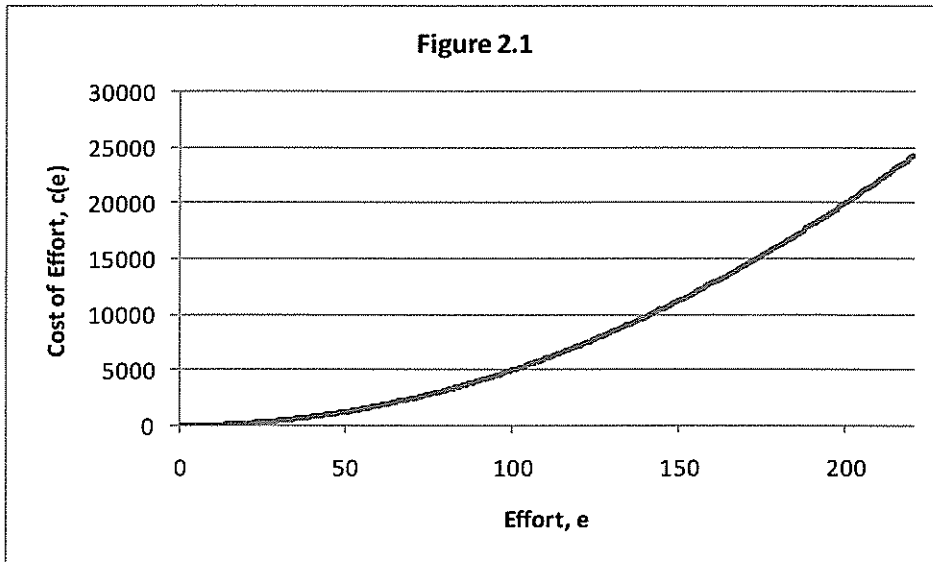
### 2.1 The Agent

Let  $x$  be output as a function of  $e$  (effort from the agent) and  $\varepsilon$  (a parameter affecting  $x$  outside the agent's control),  $E(\varepsilon) = 0$ .

$$(48) \quad x = e + \varepsilon$$

Yielding that effort is costly both physical and psychological for the agent. Assume that the cost of effort can be characterized as follows:

(49)  $c(e) = \frac{1}{2}e^2$ , where  $c'(e) > 0$  and  $c''(e) > 0$ , implying an increasing and convex function as illustrated in figure 2.1.



(50)  $y = \beta x + f$ , where  $y$  is income for the agent,  $\beta$  is the portion of income dependent of output,  $x$  is output and  $f$  is the fixed income.

Then assume that the agents expected utility of income can be characterized by the following (CARA) function:

(51)  $u(y) = -e^{-ay}$ , where  $u'(y) > 0$  and  $u''(y) < 0$ , implying diminishing marginal utility of income and  $a$  is a measure of absolute risk aversion.

$$(52) \quad \left. \begin{array}{l} \varepsilon \sim N(0, \sigma^2) \\ x \sim N(e, \sigma^2) \end{array} \right\} y \sim N(\beta e + f, \beta^2 \sigma^2)$$

$$(54) \quad \max_e Eu(y) \stackrel{def}{\Leftrightarrow} \max_e \beta e + f - \frac{a}{2} \beta^2 \sigma^2$$

Thus the agent's utility from producing effort,  $e$ , can be written as follows:

$$(55) \quad \max_e Eu(y(e, \varepsilon)) - c(e)$$

From (50) and (55) can be written as follows:

$$(56) \quad \max_e \beta e + f - \frac{a}{2} \beta^2 \sigma^2 - \frac{1}{2} e^2 = 0$$

By maximizing (57) with respect to  $e$  you get:

$$(57) \quad \beta - e = 0$$

Thus,

$$(58) \quad e^{OPT} = \beta$$

To ensure participation from the agent the fixed reimbursement must satisfy the following condition:

$$(59) \quad V(\beta) = \beta e^{OPT} + f - \frac{a}{2} \beta^2 \sigma^2 - \frac{1}{2} e^{OPT^2}$$

$$(60) \quad = \beta^2 + f - \frac{a}{2} \beta^2 \sigma^2 - \frac{1}{2} \beta^2$$

$$(61) \quad = \frac{1}{2} \beta^2 + f - \frac{a}{2} \beta^2 \sigma^2 \geq 0$$

$$(62) \quad f = -\frac{1}{2} \beta^2 + \frac{a}{2} \beta^2 \sigma^2$$

$$(63) \quad f = \frac{\beta^2}{2} (a\sigma^2 - 1)$$

## 2.2 The Principal

Let  $E\pi$  be expected profit. From (59) and (49) expected production,  $x$ , is equal to  $\beta$ . The principal then has the following profit function to maximize.

$$(64) \quad E\pi = 1 \times \beta - (\beta^2 + f)$$

$$(65) \quad = \beta - \left[ \beta^2 + \frac{\beta^2}{2} (a\sigma^2 - 1) \right]$$

$$(66) \quad = \beta - \frac{\beta^2}{2} [1 + a\sigma^2]$$

To find the optimal  $\beta$ , differentiate (67) with respect  $\beta$ :

$$(67) \quad \max_{\beta} \beta - \frac{\beta^2}{2} [1 + a\sigma^2] = 0$$

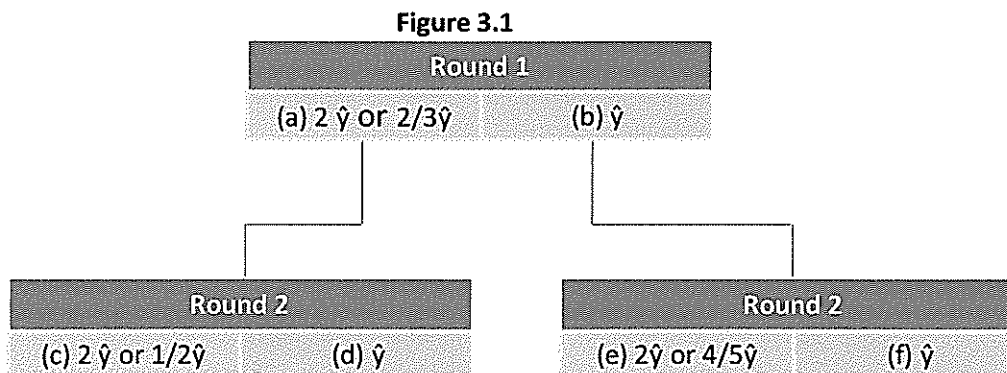
$$(68) \quad = 1 - \beta(1 + a\sigma^2)$$

$$(69) \quad \beta^{OPT} = \frac{1}{1+a\sigma^2}$$

As specified in the introduction  $\beta^{OPT}$  is dependent on  $a$ , the measure of absolute risk aversion. Even though absolute risk aversion is not calculated in this paper, the fact that the respondents propensity to take budgetary risk is of importance for the hospital funding, is not altered.

### 3. The Vesta Study

In the Vesta study  $\hat{y}$  was defined as the lifetime income of a household. The respondents were asked to presume that their income was the only income of their household and that they had to change work of reasons beyond their control. The new job offers are best characterized as gambles. The “gambles” which faced the respondents are illustrated in figure 3.1.



The questions separate the respondents into 4 different groups. Respondents who chose safe (b), safe (f) ended up in group I, and are categorized as the least willingly to take monetary risk. Person choosing safe (b), risky (e), which is the least risky gamble, ended up in group II. Group III contains persons who chose risky (a), safe (b), while the “gamblers” ended up in group IV (risky (a), risky (c)).

The Vesta study was conducted on a representative sample of the Norwegian population and obtained the following results:

**Table 3.1: "The Vesta-study"**

I	II	III	IV
40 %	37 %	14 %	9 %
<i>Max risk aversion</i>		<i>Min risk aversion</i>	

There are strong similarities between this paper and the Vesta study. We have, however, done some modifications to tailor our research design to the unique characteristics of the Health Sector. (These differences are commented in chapter 4.2.1.). Even though the design is slightly different, a qualitative comparison between the results of the two studies is interesting. Differences between these results and our study will be firmly commented and analyzed in chapter 5.

#### 4. Methodology

The methodology chapter will basically expand on the questionnaires form and its respondents. Initially, a short introduction of the structure of the National Health Service is given. This is to justify the sample of respondents. Secondly, the questionnaires will be discussed. The questionnaire contains two sets of questions, part one and two. Part one aims at categorizing the respondents after their willingness to take monetary risk, into distinct groups. The formulation of the questions will be firmly reproduced and discussed, relating "the gamble" the respondents are exposed to, to the expected utility theory presented above. The methodology is taken from Barsky et al. (1997).<sup>18</sup> Part two concentrates on background information from the respondents. The questions will be reproduced and commented, but not to such an extent as the questions in part one.

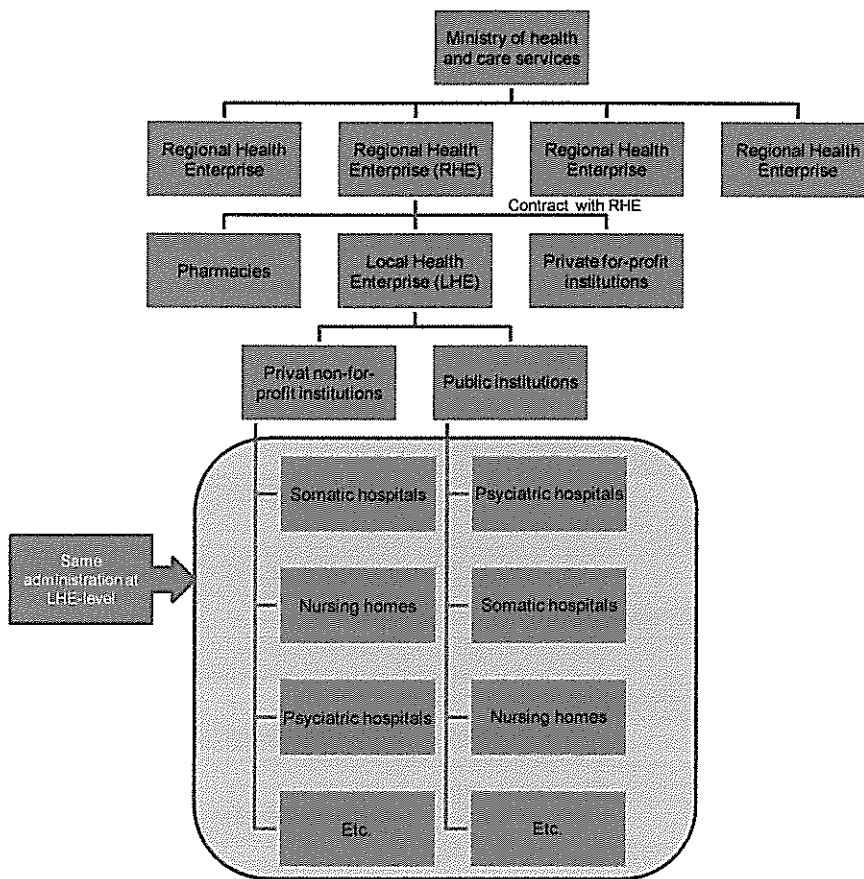
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<sup>18</sup> Barsky, Robert B., F. Thomas Juster, Miles S. Kimball and Matthew D. Shapiro (1997): "*Preferences and Behavioral Heterogeneity: An Experimental Approach in the Health and Retirement Study*".

## 4.1 The Structure of the National Health Service

The aim of the survey is to reveal risk preferences among people with budgetary responsibility within the Norwegian health care system. To be able to ask the right people, an analysis of the organizational structure within the health care sector is necessary. (The overall structure is illustrated in figure 4.1.1).

Figure 4.1.1: Organization of the Norwegian Health Services



The superior management lies with the Ministry of Health and Care services, which is led by a democratically elected politician. Currently Sylvia Brustad is the minister of the Health and Care services department. The health care institutions in the country are geographically divided into four regional enterprises, “Helse-Nord”, “Helse-Midt”, “Helse-Vest” and “Helse-Sørøst”. The different regional enterprises differ in quantity of employees and turnover, with “Helse-Sørøst” as the undisputed largest enterprise. “Helse-Sørøst” had in 2006 a turnover at 47 billion

kroner and over 69 000 employees<sup>19</sup>, placing “Helse-Sørøst” as the eleventh largest corporation in Norway<sup>20</sup>.

The four regional enterprises are again divided into approximately 50 local health enterprises (LHEs) and pharmacies. The pharmacies will however not be commented further since they are not of interest in this survey. The LHEs consist of both private for-profit and non-for-profit and public institutions. Due to the nature of the demand for health care services most hospitals have been publicly owned. However, today some private institutions have specialized themselves and typically offer different elective surgeries with the hope of making a profit. Non-for-profit organizations administer everything from somatic hospitals to nursing homes. The institutions within LHEs typically share management and administration. At the top, with the overall responsibility, is the CEO. In addition to the CEO there are department managers, who are independent of institutions/hospitals (figure 4.1.2). The department managers typically have responsibility for special fields, like medicine, surgery etc., on all hospital in the organization. While the department managers usually have studied medicine (often doctors or nurses), the CEO’s backgrounds differ (economists, lawyers, doctors or nurses). The department managers have budgetary responsibilities for their department, but not for the hospital as a whole. The person who has the greatest personal risk concerning budget deficits is the CEO. In addition the board director’ budgetary responsibility is beyond dispute. Therefore, the questionnaires are sent to all CEO’s and board directors of LHEs in Norway. (A typical organization map of a health enterprise is illustrated in figure 4.1.2.)

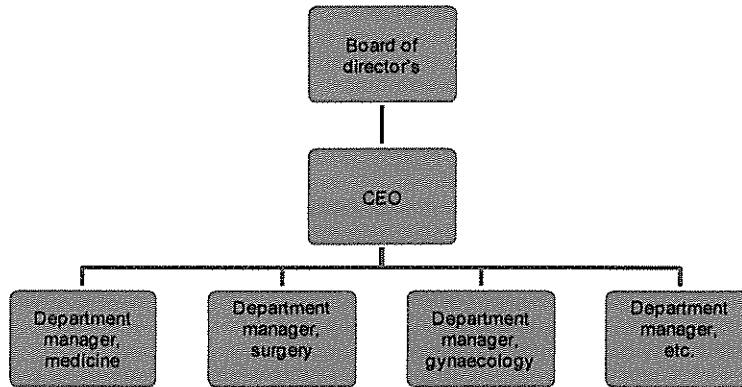
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<sup>19</sup> [http://www.helse-sorost.no/modules/module\\_123/proxy.asp?D=2&C=25&I=82&mids=a26a](http://www.helse-sorost.no/modules/module_123/proxy.asp?D=2&C=25&I=82&mids=a26a)

<sup>20</sup> [http://www.norgesstorstebedrifter.no/index.php?cmd=500&range\\_type=500&sort=driftsinntekter&listeid=0](http://www.norgesstorstebedrifter.no/index.php?cmd=500&range_type=500&sort=driftsinntekter&listeid=0)



Figure 4.1.2: Typical organization of local health enterprises



Even though the organizational structure in figure 4.1.2 is most common, a few exceptions have been discovered. In “Helse-Innland” (under “Helse-Sørøst”) and “Helse-Bergen” (under “Helse-Vest”) there are directors at each hospital which have responsibility for budgets. Even though the organization differs, to ensure comparability, questionnaires are also in these in the special cases only sent to the board director and CEO’s.<sup>21</sup>

<sup>21</sup> Sources of the organizational analyses: <http://www.helse-nord.no/>, [http://www.helse-midt.no/templates/startpage\\_70142.aspx](http://www.helse-midt.no/templates/startpage_70142.aspx), <http://www.helse-vest.no/> and <http://www.helse-sorost.no/>.

## 4.2 The Questionnaires

### 4.2.1 Part One – “the Gamble”

One of the critical challenges associated with the compilation of the questionnaires was to avoid misunderstandings or confusion about the hypothetical situation referred to in the survey. To steer clear of such unfortunate circumstances the questions were tested among the participants in the research team:

- Fred Schroyen, Professor, PhD, at the Department of Economics (NHH), project supervisor.
- Kurt Brekke, Research economist, Post Doctor, at the Department of Economics (NHH).
- Gaute Torsvik, Professor at the Department of Economics (UiB).

Additionally, members of Health Economics Bergen (HEB) were posed the questions. During this process it became obvious that the questions had to be refined. The following considerations and changes were done:

**Time horizon.** The measure of risk aversion involves gambles over the yearly fixed reimbursement. Earlier work, such as Barsky et al<sup>22</sup>, Arie Kapteyn and Federica Teppa<sup>23</sup> and Vesta<sup>24</sup>, were conducted on households. In these experiments one of the principle requirements involved gambles over lifetime income. However, the project group concluded that lifetime gambles are not relevant for the surveys sample group. CEO's and board directors in the National Health Service are presumed to have a substantially shorter time horizon than households. In addition a too short time horizon would make the gamble uninteresting since winning or losing would not change the economic situation of the health enterprise. Therefore the duration of the gamble was set to 5 years.

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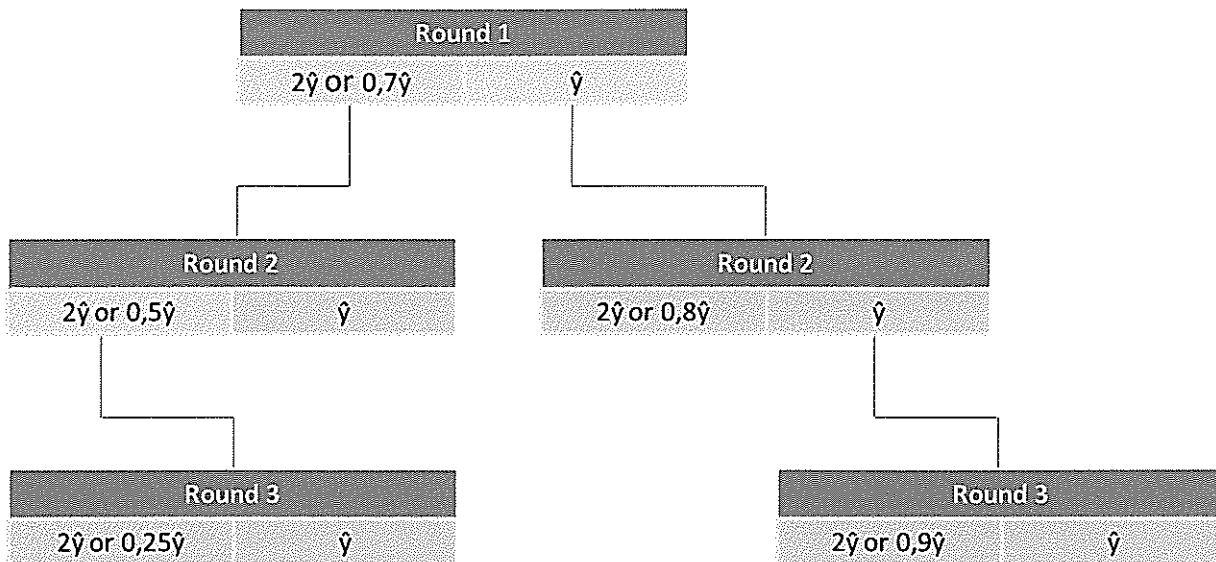
<sup>22</sup> Barsky, Robert B., F. Thomas Juster, Miles S. Kimball and Matthew D. Shapiro (1997): “*Preferences and Behavioral Heterogeneity: An Experimental Approach in the Health and Retirement Study*”.

<sup>23</sup> Kapteyn, Arie and Federica Teppa (2002): “*Subjective Measures of Risk Aversion and Portfolio Choice*”

<sup>24</sup> Vesta (2006), “*Trygghetsrapport – en analyse av nordmenns trygghet, utrygghet og risikovilje*”

**The gamble.** Previous experiments (such as those mentioned above), offered a gamble where the respondents had an opportunity to double their households lifetime income, with limited possibilities of losing. For example, the respondents in the Arie Kapteyn et al. report were exposed to the following gamble (see figure 4.2.1):

Figure 4.2.1



Arie Kapteyn et al. defined  $\hat{\gamma}$  as the respondent's self reported after tax household income. After discussions with personal within the Health Service<sup>25</sup>, the project group concluded that a doubling of the fixed reimbursement probably was a too unrealistic scenario for the respondents to be able to relate to. The upside was, for this reason, limited and the downside was limited accordingly. (By limiting the upside the downside also had to be restricted or else the critical value of risk aversion would become zero<sup>26</sup>.) Further, we found it beneficial to follow Arie Kapteyn's example with 3 rounds of gambles instead of 2 rounds, which was conducted in the Barsky et al. study. This was done since 3 rounds of gambles enabled a more fine-meshed scale of risk-aversion, with a ranking of risk aversion in six groups instead of four.

**Political motivation.** Finally, due to the actuality of the discussion about hospital funding and the obvious political interests of the respondents, politically motivated answers were important to

<sup>25</sup> Aksel Mjøs, boardmember of Haraldsplass Diakonale Sykehus

<sup>26</sup> See chapter 2.2.2 and appendix 4 for calculation and explanation of critical values for relative risk aversion.

counteract. The information enclosed with the questionnaires, was therefore carefully formulated and the potential political consequences of the results were left out.

After these considerations the respondents were posed the following questions.<sup>27</sup> (The structure of the questions is illustrated in figure 4.2.2).

*“A letter from the Regional Health Enterprise informs that the fixed reimbursement to your hospital/Health Enterprise can be allocated in two alternative ways the next five years (2008-2012):*

- (a) Today’s fixed reimbursement continues (adjusted for inflation each year)*
- (b) The yearly reimbursements in 2008-2012 are calculated on the basis of the average for 2007 oil price in 2007. If the oil price exceeds a given reference level, the reimbursements are increased with 50% relative to today’s level. By contrast, if the average oil price falls below the reference level, the future fixed reimbursement will be decreased by 29% relative to today’s level. (In other words, the reimbursement will only be 71% of today’s standard.)*

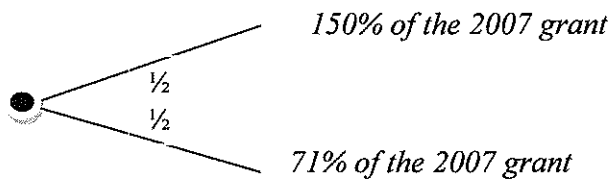
*It is generally agreed upon that the probability of the average oil price exceeding the reference level in 2007, is 50%. (Consequently, there is a 50% chance that the average oil price falls below the reference level).*

*A schematic outline of the alternatives is given below:*

- Alternative (a): the yearly fixed reimbursement in the next 5 years equals the 2007 reimbursement.*
- Alternative (b): the yearly fixed reimbursement in the next 5 years equals:*

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<sup>27</sup> Only the first question is reproduced here. The entire questionnaire is enclosed in appendix 6.

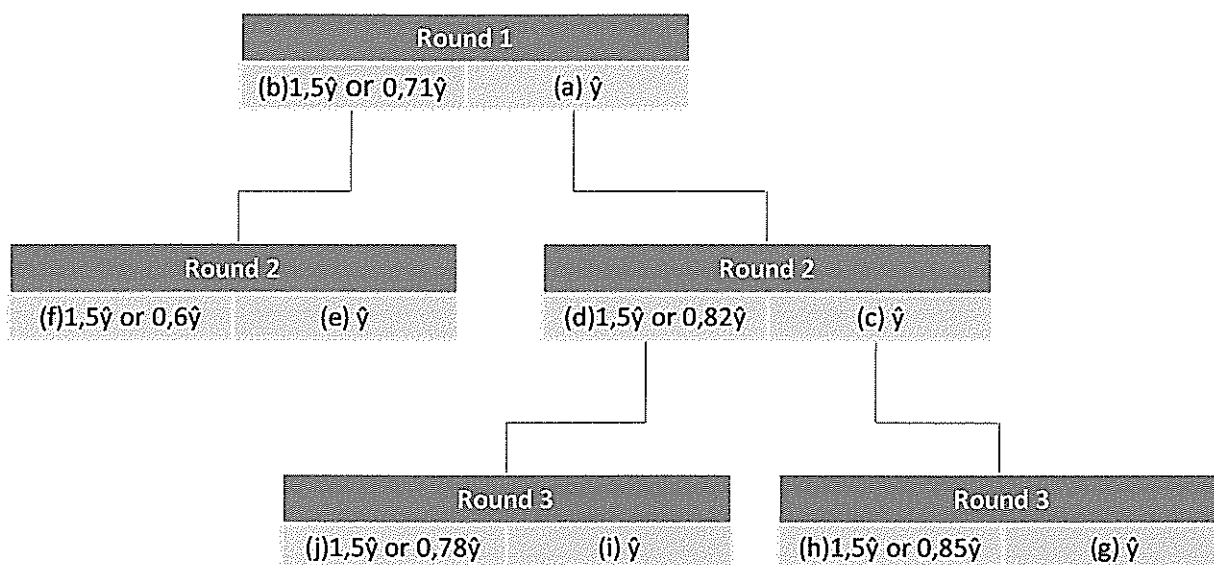


*You are asked to inform the Regional Health Enterprise about the way of allocation you, as a person with budgetary responsibility, prefer for your hospital/Health Enterprise.”*

	(a)	(b)
Answer to question 1		

Respondents who preferred a continuation of today’s fixed reimbursement, i.e. those who chose alternative (a) in figure 4.2.2, were offered an even more favorable gamble. A continuation of today’s system (alternative (c)) or a gamble where the upside still was 1,5 $\hat{y}$ , but the downside as reduced to .82 $\hat{y}$  (alternative (d)). If they still preferred today’s reimbursement ( $\hat{y}$ ), they were exposed to alternative (h) and (g), where (g) implies that the respondent will not participate in any gamble at all. However, if alternative (d) were preferred to alternative (c), they faced alternative (j) and (i). Finally, if the respondent chose alternative (b) in round one, he or she had to choose either alternative (e) or (f) in round 2.

**Figure 4.2.2: The structure of the questions**



#### 4.2.2 Expected Utility of “The Gamble”

The questions separate the respondents into six distinct risk preference groups, depending on the answer to the five questions<sup>28</sup>. The categories are labeled I, II, III, IV, V and VI. Respondents who end up in category I have chosen the least risky alternative, by not participating in any gamble with the organizations fixed grants. Thus, they are identified as the most risk averse respondents in the survey. Respondents, who select the least risky gamble, a 50% chance of increasing today’s fixed grants with 50% and a 50% chance of losing only 15% relative to today’s reimbursement, end up in category II. In a similar manner, respondents who choose the second least risky gamble end up in category III. Eventually, every respondent is categorized and ranked after his or her preferences towards risk. The categorical responses are summarized in Table 4.1.

<sup>28</sup> See appendix 6 for the entire questionnaire

**Table 4.1: Risk Preference Survey Design**

Category	Gamble	Relative Risk Aversion, $\gamma$	
		Upper bound	Lower bound
I	No change	$\infty$	4,46
II	UP: 150% DOWN: 15%	4,46	3,47
III	UP: 150% DOWN: 18%	3,47	2,53
IV	UP: 150% DOWN: 22%	2,53	1,45
V	UP: 150% DOWN: 29%	1,45	1
VI	UP: 150% DOWN: 40%	1	0

If we are willing to accept the expected utility theory the categorical responses can be thought of as a result from the following calculation. Let  $U$  be a CRRA<sup>29</sup> utility function and  $\hat{y}$  the fixed yearly grant for the next five years. The expected utility theory predicts that the respondent will choose the 50-50 gamble, that is increasing the fixed grants with 50% as opposed to having it fall by the fraction  $1-\lambda$ , if and only if:

$$(70) \quad \frac{1}{2} \times 1,5 \frac{\hat{y}^{1-\gamma}}{1-\gamma} + \frac{1}{2} \times \lambda \frac{\hat{y}^{1-\gamma}}{1-\gamma} \geq \frac{\hat{y}^{1-\gamma}}{1-\gamma}$$

Where  $\lambda$  equals the prospects illustrated in the questionnaires above, i.e the ex-post grant if the oil price falls below the reference level. By solving (48) with equality with respect to  $\gamma$  one can calculate the threshold values for each category (see Appendix 4 for complete calculation and supplementary comments). The ranges are summarized in table 4.1.

#### 4.2.3 Part Two- Background Questions

Eventually, the respondents were posed four background questions (question 6-9). Question six expanded on each respondent's willingness to build a financial reserve to cover any prospective future deficit. They were given five potential answers, from not important at all to the highest priority. In question seven the respondents were asked which austerity measures they would prioritize, given a 20% reduction in the fixed reimbursement. Six tightening actions were proposed and again each alternative had five potential answers, from not important at all to the highest priority. By contrast, in question eight, the respondents were asked what they would prioritize if the fixed remuneration was increased with 50%. Again different alternatives were

<sup>29</sup> Presented above as formula (12)

suggested and the same five potential answers were given. Depending on the response to the gamble, question 6-8 would predict what the consequences of winning or losing the gamble would be for each local health enterprise.

In question nine the respondents gave information, on which position they possessed, how their salary was calculated (result oriented or fixed), the size of their hospitals fixed remuneration and finally if they wanted to be oriented about the research results.<sup>30</sup>

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<sup>30</sup> The entire questionnaire is reproduced in appendix 6.



## **5. Results**

The questionnaires were sent to 95 respondents, out of which 37 have answered. Leading personnel within private for-profit, non-commercial- and public hospitals were contacted. Unfortunately most private hospitals tender for the services they provide, rather than receiving fixed remuneration from the government, which means that the answers from the private hospitals must be excluded. After the exclusion of private hospitals we are down to 68 respondents and 35 answers. Out of potentially 50 answers we have received feedback from 26 respondents from public hospitals, implying a response rate at 52%. We have, from the private non-for-profit providers, received 9 out of 18 answers, implying a response rate at 50%.

This chapter contains descriptive statistics of the results from the response, supplied with comments and hypotheses concerning the underlying reasons behind the answers. In addition potential implications of the results are indicated.

### 5.1 Part One – “The Gamble”

As discussed in chapter 2, the questions separate the respondents into six distinct groups based on their propensity to take risk. In table 5.1 is the distribution (in per cent) of all respondents gathered.

**Table 5.1 : In per cent distribution of the all respondents**

I	II	III	IV	V	VI	
80 %	6 %	6 %	0 %	9 %	0 %	
<i>Max risk aversion</i>				<i>Min risk aversion</i>		

As much as 79 % of all respondents chose no gamble at all, exhibiting maximum risk aversion, 6% ended up in group II (150% up and 15% down), 6% in group III (150% up and 18% down), 0% in group (150% up and 22% down), 9% in group IV (150% up and 29% down) and finally 0% in group VI (150% up and 40% down).

In table 5.2 and 5.3 are the non-for-profit hospitals separated from public local health enterprises (LHE’s). Table 5.2 summarizes the answers from the non-for-profit hospitals, while the answers from the LHE’s are given in table 5.3. The results from the two health care providers seem to coincide with each other - both parties appear to have an extensive aversion against budgetary risk.

**Table 5.2: In per cent distribution of private non-for-profit hospitals**

I	II	III	IV	V	VI	
88 %	0 %	25 %	0 %	0 %	0 %	
<i>Max risk aversion</i>				<i>Min risk aversion</i>		

75% of the respondents from private non-for-profit hospitals ended up in group I, while 25% ended up in group III. 80% of the respondents from public hospitals chose no gamble, implying

maximum risk aversion. 8% found the least risky gamble attractive and ended up in group II, 0% in group II, III and VI, 8% in group II and 12% in group V.

**Table 5.3: In per cent distribution of public hospitals**

I	II	III	IV	V	VI
84 %	8 %	0 %	0 %	12 %	0 %
<i>Max risk aversion</i>			<i>Min risk aversion</i>		

There are two statistical tests for two samples that could have been suitable to measure the difference between public and private non-for-profit hospitals with regards to risk aversion, the Chi-square test and the Kolmogorov-Smirnov test for two samples. However, these test are only applicable if the number of observations are high enough, which unfortunately is not the case here. (Only 9 observations from non-for-profit hospitals).

In table 5.4 the respondents are divided into ownership, number of beds, number of DRG-points and number of stays. The three last parameters are all measures on the size of the hospitals, and all parameters seem to signal that large hospitals are more risk averse than small. However, again the number of respondents are too small to use either the Chi-square test nor the Kolmogorov-Smirnov test to check if the difference is statistically significant. Therefore, I will not elaborate more on potential reasons behind this result.

**Table 5.4 - Risk aversion**

	I	II	III	VI	V	VI
<b>1: Ownership</b>						
-Public	81 %	8 %	0 %	0 %	12 %	0 %
-Private non for profit	78 %	0 %	22 %	0 %	0 %	0 %
Total	80 %	6 %	6 %	0 %	9 %	0 %
<b>2: #Beds</b>						
-0 to 100	83 %	0 %	17 %	0 %	0 %	0 %
-101 to 500	76 %	10 %	5 %	0 %	10 %	0 %
-Over 501	88 %	0 %	0 %	0 %	13 %	0 %
Total	80 %	6 %	6 %	0 %	9 %	0 %
<b>3: #DRG points</b>						
-0 to 15000	73 %	0 %	13 %	0 %	13 %	0 %
-15001 to 30000	78 %	22 %	0 %	0 %	0 %	0 %
-Over 30001	91 %	0 %	0 %	0 %	9 %	0 %
Total	80 %	6 %	6 %	0 %	9 %	0 %
<b>4: #Stays</b>						
-0 to 30000	72 %	6 %	11 %	0 %	11 %	0 %
-30001 to 60000	89 %	11 %	0 %	0 %	0 %	0 %
-Over 60001	88 %	0 %	0 %	0 %	13 %	0 %
Total	80 %	6 %	6 %	0 %	9 %	0 %

If we compare with previous work on individuals' propensity to take monetary risk, such as the Vesta-study<sup>31</sup>, our results clearly differ from earlier work. The Vesta-study was conducted on a representative sample of private persons in Norway. The following results were obtained (table 5.5):

**Table 5.5: "The Vesta-study"**

I	II	III	IV
40 %	37 %	14 %	9 %
<i>Max risk aversion</i>		<i>Min risk aversion</i>	

<sup>31</sup> Vesta (2006), "Trygghetsrapport – en analyse av nordmenns trygghet, utrygghet og risikovilje"

Even though the design of the two studies slightly differs, the methodology and theory in this paper is representative for the Vesta-study too. Thus, a comparison between the two surveys is informative.<sup>32</sup> While 80% of personal within the National Health Services chose no gamble, 40% of the respondents in the Vesta-study ended up on the same decision. While no one within the National Health Services went in for the most risky gamble, 9% of the respondents in the Vesta-study did. In other words, the results reveal an astonishing degree of risk aversion among leading personal within the Norwegian National Health Services. Why is this so? What can explain the resentment towards budgetary risk among the health care providers and what does this resentment mean?

In chapter 1.7 two hypotheses about risk aversion were presented. Absolute risk aversion was supposed to be a decreasing function of  $\hat{y}$ , which was defined as income or wealth. Thus, the wealthier you are the less aversion against monetary risk. If we believe this, the difference between the Vesta-study and this paper, can be explained by the respondents different interpretation of their economic situation. According to the theory presented, the respondents in this survey should only report less willingness towards risk than private households, if the households in the Vesta-study interpreted their economic situation as more comfortable than the respondents in our survey perceived their economic position. Thus, a hypothesis is that the people with budgetary responsibility within the National Health Services, perceives the economic situation as bad, which results in tremendous risk aversion. The hypothesis is supported by comments made by the respondents. A board director wrote the following when facing the gamble: *"The hospitals economy is so tight that there is no room for "gambling". It would be of great importance to build up financial reserves to cover future deficits, but it is more important to secure that the quality of the daily operations is on a reasonable level"*. Another respondent replies that he thinks *"gambling is irresponsible of him given their tight economic position"*. The two quotations support the chain of thoughts presented above.

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<sup>32</sup> See chapter 3 for an introduction/presentation of the Vesta-study.

The quotations also indicate that the respondents worry about the potential consequences of a deficit, even though it is a common fact that the public hospitals' budgetary constraints are soft. Because, if they did believe that the budgetary constraints were soft, they would not worry about maintaining a responsible quality of the daily operations. By contrast, if the public hospitals in fact face soft budgetary constraints their propensity to take budgetary risk should be higher than private non-for-profit hospitals, which to a greater extent face "hard" budgetary constraints. We find no difference between the two groups. Why? One obvious explanation can be attributed to the media's coverage of the enormous deficits in the hospitals. Media's negative focus obviously feels unpleasant and today's leaders will, at least for that reason, strive to satisfy the budgets. In addition to the media, the department for Health and Care Services has tightened their control over the spending within the hospitals, which again have put weight behind the treats about limiting the cash flow from the government in the future. One can say that in a situation with a tight economy, the hospital's loss in utility from almost any decrease in funding outweighs the potential gain of a 50% increase. The consequences of losing are simply too big.

Undisputedly, this sheds favorable light over the board directors and CEO's of the local health enterprises and the non-for-profit hospitals. And, even though, we tried to counteract it, one can never exclude the possibility of politically motivated answers. In the same way as one can never entirely exclude the possibility of misunderstandings of the questions. However, we have no indications about politically motivated answers or misunderstandings.

## **5.2 Part Two – Background Questions**

One of the main purposes with question 6-8 was to predict the consequences of winning or losing the gamble, i.e. what the respondents would prioritize given a 50% increase or 20% reduction in the fixed remuneration. Since, most respondents abstained from participating in the gamble, our findings becomes purely hypothetical. Still I will shortly go through the questions and give an overview over the answers.

The analysis below is based on the average respondent.

**Question 6**

Average priority

The respondents averagely prioritize to build up a financial reserve. This might have something to do with the fact that most local health enterprises experience tough economic conditions and consequently focus on the daily operations rather than to build up financial reserves to cover potential future deficits. There are no significant difference between private non-for-profit organization and public hospitals in question 6.

**Question 7**

a	b	c	d	e	f
High priority	High priority	Average priority	Average priority	Low priority	Average priority

In question 7 the respondents are asked to prioritize what they would do if the fixed grants were reduced with 20%. Closure of wards (a) and reduction of the number of beds (b) are given high priority, while discharging of physicians (c), discharging nurses (d) and increasing the waiting times (f) are given average priority. The measure that they prioritize least is to increase the number of “corridor-patients” (e). Thus, if the respondents, hypothetically, participate in the gamble and loose, the first thing they would do is to close wards and to reduce the number of beds. Afterwards most management would prioritize to fire nurses and physicians and to increase waiting times before they at last would increase the number of “corridor-patients”.

**Question 8**

a	b	c	d	e	f	g
Average priority	Low priority	Average priority	Average priority	Average priority	High priority	High priority

By contrast if the respondents faced an increase of the fixed remuneration on 50%, they would prioritize to decrease waiting times (f) and to purchase new technological equipment (g). While opening new wards (a), employing physicians (c), employing nurses (d) and reducing the number of “corridor-patients” (e) would be given average priority. Finally, increasing the number of beds would be given low priority.

### 5.3 Potential Implications of the Results

As proven in chapter two, the optimal mixture of fixed and variable remuneration is dependent on the respondents' willingness to take monetary risk. Our survey has revealed an extreme aversion against risk in the National Health Services. This indicates that maybe the portion of variable funding through the DRG-prices ought to be decreased to secure motivated employees. However, to provide an exact estimate of the optimal  $\beta^{33}$ , estimation on the standard deviation of the demand for health care is needed.

## 6. Summary

The Norwegian National Health Services's cost and economic situation is under constant focus in the media. Every day the hospitals are struggling to reduce costs at the same time as they are trying to obtain and improve the quality of their services. To finance the hospitals such that their motivation for doing these improvements are maximum are indeed critical.

In this paper I have presented theory that firstly explains risk aversion (chapter 1) and secondly shows the connection between risk aversion and hospital financing (chapter 2). The methodology of the survey is explained in chapter 3 and 4. The findings of the questionnaire, which was presented in chapter 5, is striking. The people with budgetary responsibility in the hospitals have an extreme reluctance to take monetary risk, which is the opposite of what the research team expected. We expected that soft budgetary constraints implied less risk aversion in the National Health Services than in the rest of the society, but this hypothesis has to be rejected. In addition to puzzle the research team the results put constraints on what statistical analyses that were meaningful to perform, since there were almost no variation in the answers. Even though only descriptive analyses were conducted, I find the results and potential explanation interesting. With such risk aversion among leading personal in the Health Services, the use of DRG-prices can be questioned. However, before making any final conclusions a new survey with a more fine grained

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<sup>33</sup> The optimal portion of DRG-funding and fixed remuneration. See appendix 2.

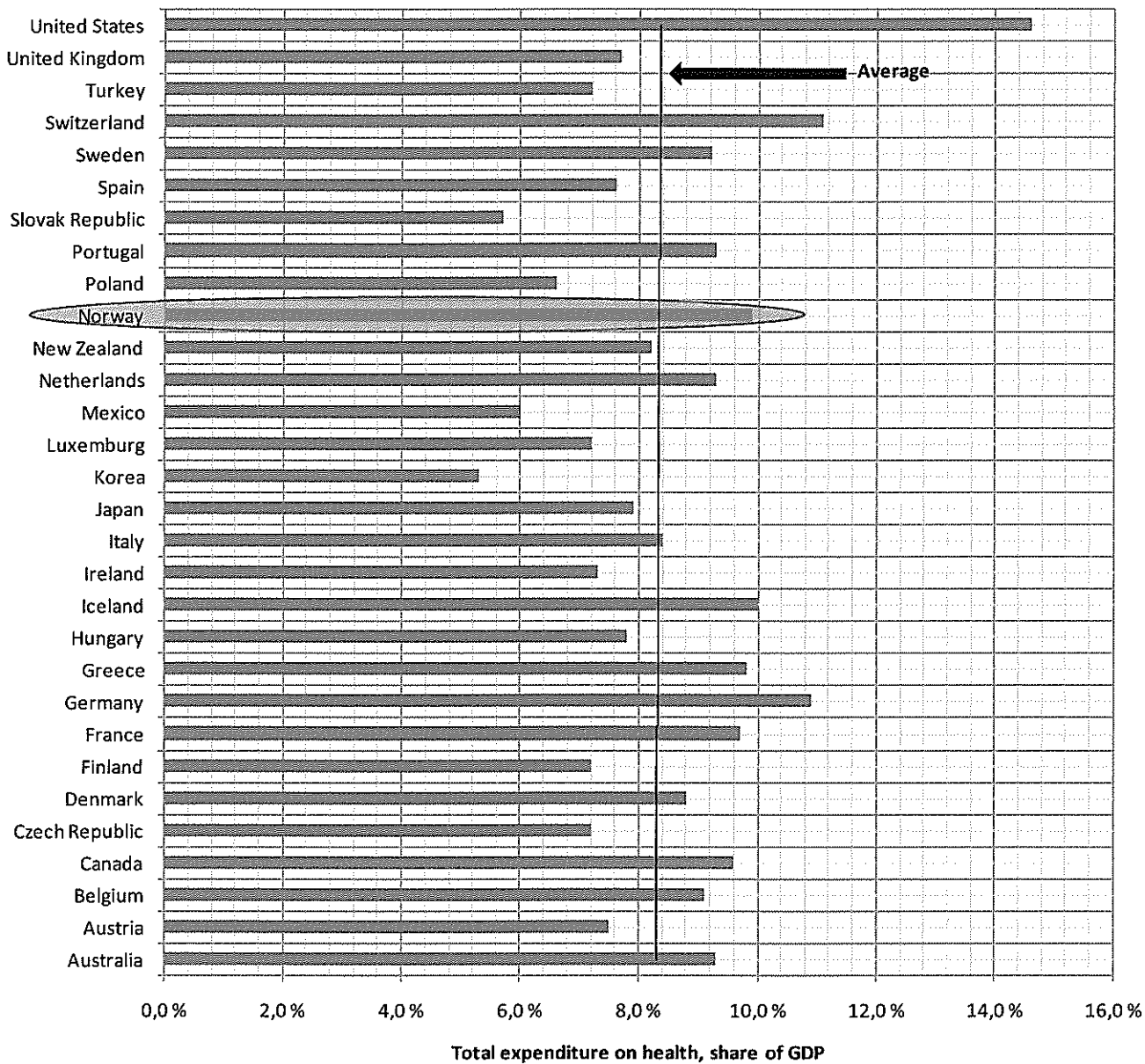


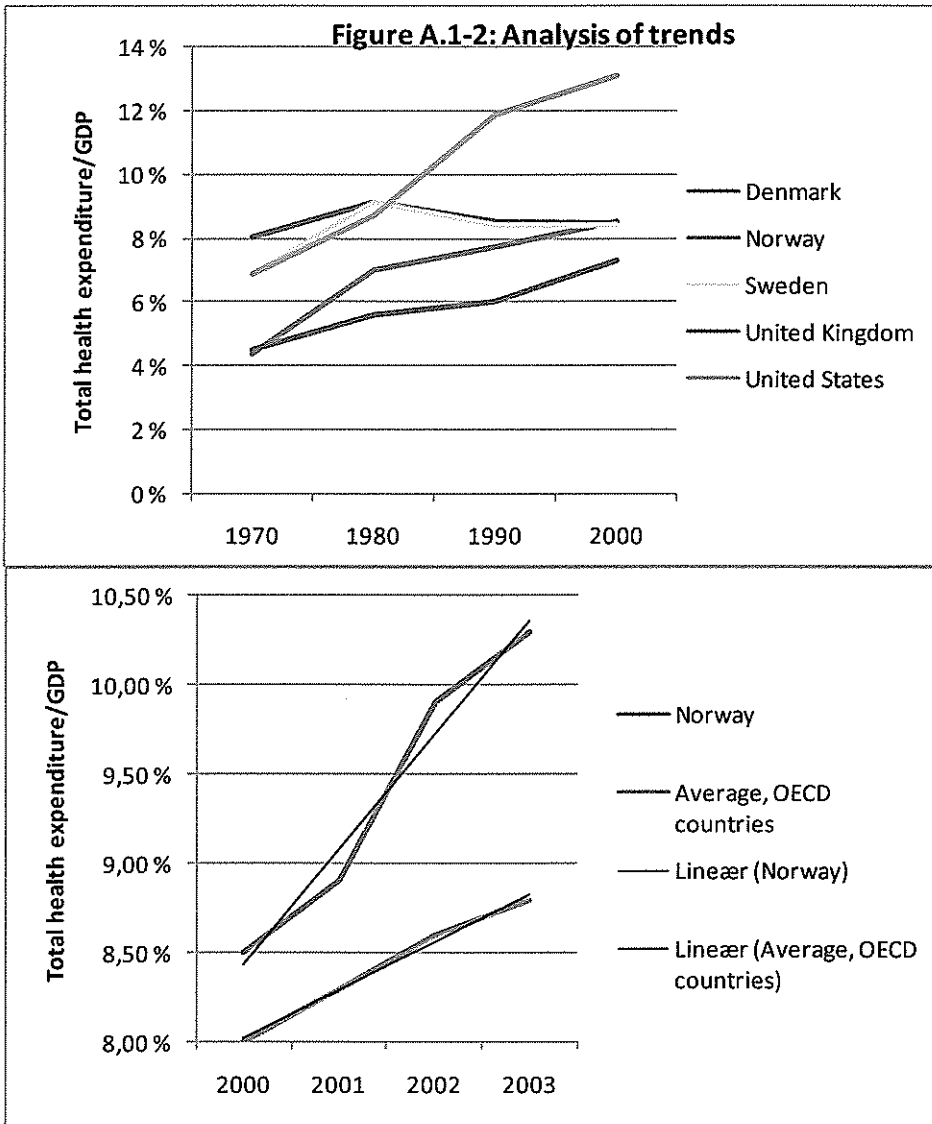
scale of risk aversion (less risky gambles) should be conducted. I would also recommend to compare private persons and the National Health Services, in order to identify potential differences.

Finally, I hope the survey can be a contribution to future debates concerning hospital funding and motivate further research on the subject of risk aversion in the health care sector.

# Appendix 1 – Health Expenditures

Figure A.1-1: Total health expenditure, share of GDP





Source: "Health at Glance – OECD Indicators 2005, statistical annex A, page 150"

## Appendix 2 – Linear and Quadratic Approximation<sup>34</sup>

### A2.1 Linear Approximation

$$(71) \quad f(x) \approx f(x_0) + f'(x_0)(x - x_0), \text{ when } x \text{ is close to } x_0.$$

The function  $g(x) \stackrel{\text{def}}{=} f(x_0) + f'(x_0)(x - x_0)$  is called the “*best linear approximation to f in  $x_0$* ”, and can be interpreted as the tangent to the graph to function  $f$  at the point  $(x_0, f(x_0))$ .

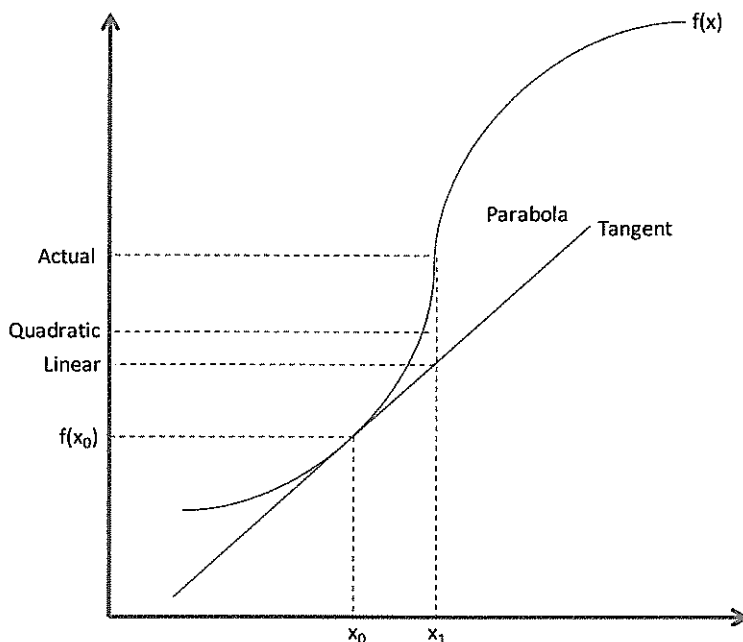
### A2.2 Quadratic Approximation

$$(72) \quad f(x) \approx f(x_0) + f'(x_0)(x - x_0) + \frac{1}{2}f''(x_0)(x - x_0)^2, \text{ when } x \text{ is close to } x_0.$$

The function  $g(x) \stackrel{\text{def}}{=} f(x_0) + f'(x_0)(x - x_0) + \frac{1}{2}f''(x_0)(x - x_0)^2$  is called the “*best quadratic approximation to f in  $x_0$* ”, and can be interpreted as the parabola to the graph to function  $f$  at the point  $(x_0, f(x_0))$ .

Both linear and quadratic approximation are illustrated in figure A.2.1. Clearly, quadratic approximation provides the most accurate estimates.

Figure A.2.1



<sup>34</sup> Knut Sydsæter (1994): *Matematisk analyse, Bind 1*. Page 133, 313, 316 and 463

### Appendix 3 – Calculation of Threshold Values

$$(73) \quad \frac{1}{2} \times 1,5 \frac{\hat{y}^{1-\gamma}}{1-\gamma} + \frac{1}{2} \times \lambda \frac{\hat{y}^{1-\gamma}}{1-\gamma} \geq \frac{\hat{y}^{1-\gamma}}{1-\gamma}$$

$$(74) \quad \frac{1}{2} \times 1,5 \hat{y}^{1-\gamma} + \frac{1}{2} \times \lambda \hat{y}^{1-\gamma} \geq \hat{y}^{1-\gamma}$$

(75)  $1,5^{1-\gamma} + \lambda^{1-\gamma} \geq 2$ , where  $\lambda$  can be either .60 (category II), .71 (category III), .78 (category IV), .82 (category V), .85 (category VI). By substituting  $\lambda$  with these values, you end up with the following values for  $\gamma$ , which defines the degree of risk aversion

among the respondents:

$$(76) \quad \gamma_1 = 1 \ (\lambda = .60)$$

$$(77) \quad \gamma_2 = 1,45 \ (\lambda = .71)$$

$$(78) \quad \gamma_3 = 2,53 \ (\lambda = .78)$$

$$(79) \quad \gamma_4 = 3,47 \ (\lambda = .82)$$

$$(80) \quad \gamma_5 = 4,46 \ (\lambda = .85)$$

These values define the following threshold values of six distinct categories, from zero to infinite risk aversion:

$$(81) \quad \text{Category I} = (0 \text{ to } 1)$$

$$(82) \quad \text{Category II} = (1 \text{ to } 1,45)$$

$$(83) \quad \text{Category III} = (1,45 \text{ to } 2,53)$$

$$(84) \quad \text{Category IV} = (2,53 \text{ to } 3,47)$$

$$(85) \quad \text{Category V} = (3,47 \text{ to } 4,46)$$

$$(86) \quad \text{Category VI} = (4,46 \text{ to } \infty)$$

No Risk Aversion



Infinite Risk Aversion

## Appendix 4 – The Questionnaire

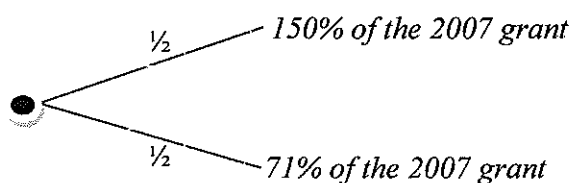
**“Question 1.** A letter from the Regional Health Enterprise informs that the fixed reimbursement to your hospital/Health Enterprise can be allocated in two alternative ways the next five years (2008-2012):

- (a) Today’s fixed reimbursement continues (adjusted for inflation each year)
- (b) The yearly reimbursements in 2008-2012 are calculated on the basis of the average oil price for 2007. If the oil price exceeds a given reference level, the reimbursements are increased with 50% relative to today’s level. By contrast, if the average oil price falls below the reference level, the future fixed reimbursement will be decreased by 29% relative to today’s level. (In other words, the reimbursement will only be 71% of today’s standard.)

It is generally agreed upon that the probability, of the average oil price exceeding the reference level in 2007, is 50%. (Consequently, there is a 50% chance that the average oil price falls below the reference level).

A schematic outline of the alternatives is given below:

- Alternative (a): the yearly fixed reimbursement in the next 5 years equals the 2007 reimbursement.
- Alternative (b): the yearly fixed reimbursement in the next 5 years equals:



You are asked to inform the Regional Health Enterprise about the way of allocation you, as a person with budgetary responsibility, prefer for your hospital/Health Enterprise.

	(a)	(b)
Answer to question 1		

If you ticked off at alternative (a), go to question 2 at page 2. If you ticked off at alternative (b), go to question 3 at page 3.

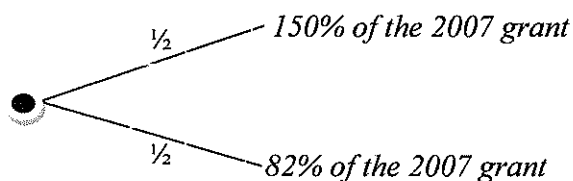
**Question 2.** Now imagine that the Regional Health Enterprise informs about the following two alternatives of funding:

- (c) Today's fixed reimbursement continues (adjusted for inflation each year)
- (d) The yearly reimbursements in 2008-2012 are calculated on the basis of the average oil price for 2007. If the oil price exceeds a given reference level, the reimbursements are increased with 50% relative to today's level. By contrast, if the average oil price falls below the reference level, the future fixed reimbursement will be decreased by 18%% relative to today's level. (In other words, the reimbursement will only be 82% of today's standard.)

It is generally agreed upon that the probability, of the average oil price exceeding the reference level in 2007, is 50%. (Consequently, there is a 50% chance that the average oil price falls below the reference level).

A schematic outline of the alternatives is given below:

- Alternative (c): the yearly fixed reimbursement in the next 5 years equals the 2007 reimbursement.
- Alternative (d): the yearly fixed reimbursement in the next 5 years equals:



You are asked to inform the Regional Health Enterprise about the way of allocation you, as a person with budgetary responsibility, prefer for your hospital/Health Enterprise.

	(c)	(d)
Answer to question 2		

If you ticked off at alternative (c), go to question 4 at page 4. If you ticked off at alternative (d), go to question 5 at page 5.

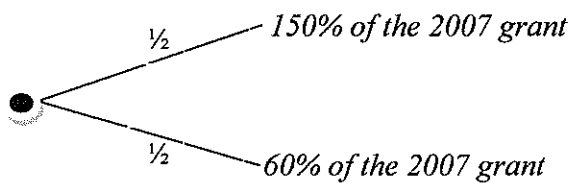
**Question 3.** Now imagine that the Regional Health Enterprise informs about the following two alternatives:

- (e) Today's fixed reimbursement continues (adjusted for inflation each year)
- (f) The yearly reimbursements in 2008-2012 are calculated on the basis of the average oil price for 2007. If the oil price exceeds a given reference level, the reimbursements are increased with 50% relative to today's level. By contrast, if the average oil price falls below the reference level, the future fixed reimbursement will be decreased by 40% relative to today's level. (In other words, the reimbursement will only be 60% of today's standard.)

It is generally agreed upon that the probability, of the average oil price exceeding the reference level in 2007, is 50%. (Consequently, there is a 50% chance that the average oil price falls below the reference level).

A schematic outline of the alternatives is given below:

- Alternative (e): the yearly fixed reimbursement in the next 5 years equals the 2007 reimbursement.
- Alternative (f): the yearly fixed reimbursement in the next 5 years equals:



You are asked to inform the Regional Health Enterprise about the way of allocation you, as a person with budgetary responsibility, prefer for your hospital/Health Enterprise.

	(e)	(f)
Answer to question 3		



Go to Part 2 of the survey at page 6.

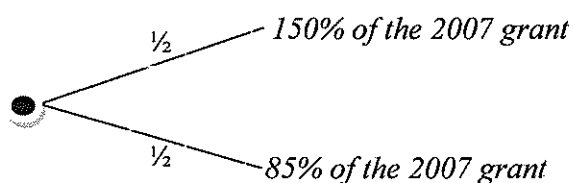
**Question 4.** Now imagine that the Regional Health Enterprise informs about the following two alternatives:

- (g) Today's fixed reimbursement continues (adjusted for inflation each year)
- (h) The yearly reimbursements in 2008-2012 are calculated on the basis of the average oil price for 2007. If the oil price exceeds a given reference level, the reimbursements are increased with 50% relative to today's level. By contrast, if the average oil price falls below the reference level, the future fixed reimbursement will be decreased by 15% relative to today's level. (In other words, the reimbursement will only be 85% of today's standard.)

It is generally agreed upon that the probability, of the average oil price exceeding the reference level in 2007, is 50%. (Consequently, there is a 50% chance that the average oil price falls below the reference level).

A schematic outline of the alternatives is given below:

- Alternative (g): the yearly fixed reimbursement in the next 5 years equals the 2007 reimbursement.
- Alternative (h): the yearly fixed reimbursement in the next 5 years equals:



You are asked to inform the Regional Health Enterprise about the way of allocation you, as a person with budgetary responsibility, prefer for your hospital/Health Enterprise.

	(g)	(h)
Answer to question 4		

Go to part 2 of the survey at page 6.

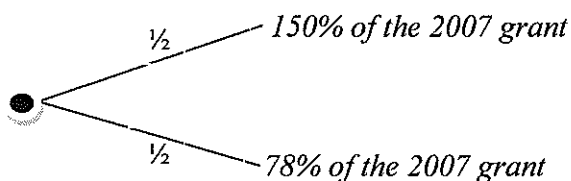
**Question 5.** Now imagine that the Regional Health Enterprise informs about the following two alternatives:

- (i) Today's fixed reimbursement continues (adjusted for inflation each year)
- (j) The yearly reimbursements in 2008-2012 are calculated on the basis of the average oil price for 2007. If the oil price exceeds a given reference level, the reimbursements are increased with 50% relative to today's level. By contrast, if the average oil price falls below the reference level, the future fixed reimbursement will be decreased by 22% relative to today's level. (In other words, the reimbursement will only be 78% of today's standard.)

It is generally agreed upon that the probability, of the average oil price exceeding the reference level in 2007, is 50%. (Consequently, there is a 50% chance that the average oil price falls below the reference level).

A schematic outline of the alternatives is given below:

- Alternative (i): the yearly fixed reimbursement in the next 5 years equals the 2007 reimbursement.
- Alternative (j): the yearly fixed reimbursement in the next 5 years equals:



You are asked to inform the Regional Health Enterprise about the way of allocation you, as a person with budgetary responsibility, prefer for your hospital/Health Enterprise.

	(i)	(j)
Answer to question 5		

Go to part 2 of the survey at page 6"

*PART 2: Background questions*

**Question 6.** *How important is it for you to build up a financial reserve to cover potential future deficits?*

*Tick off in the relevant box:*

	<i>Not important at all</i>	<i>Low priority</i>	<i>Average priority</i>	<i>High priority</i>	<i>Highest priority</i>
<i>Answer to question 6</i>					

*Go to question 7.*

*Question 7. Which tightening actions would you prioritize if your fixed reimbursement was to be reduced with 20%?*

*Tick off in the relevant box:*

	<i>Not important at all</i>	<i>Low priority</i>	<i>Average priority</i>	<i>High priority</i>	<i>Highest priority</i>
<i>Closure of wards</i>					
<i>Reduction of the number of beds</i>					
<i>Discharge physicians</i>					
<i>Discharge nurses</i>					
<i>Increase the number of "corridor" patients</i>					
<i>Increase the waiting times</i>					

*Go to question 8.*

**Question 8.** Which measure of actions would be prioritized if the fixed reimbursements were increased with 50%?

Tick off in the relevant box:

	<i>Not important at all</i>	<i>Low priority</i>	<i>Average priority</i>	<i>High priority</i>	<i>Highest priority</i>
<i>Opening of new ward(s)</i>					
<i>Increase in the number of beds</i>					
<i>Employ physicians</i>					
<i>Employ nurses</i>					
<i>Reduce the number of "corridor" patients</i>					
<i>Decrease the waiting times</i>					
<i>Purchase of new technological equipment</i>					

Go to question 9.

**Question 9.**

*(a) What is the name of the health enterprise/hospital?*

*(b1) Which position do you possess?*

<i>CEO</i>	<i>Board director</i>	<i>Other (specify)</i>

*(b2) Is your salary.....*

<i>...fixed</i>	<i>...linked to total yearly income</i>	<i>...linked to the annual results</i>	<i>...linked to other dimensions? (specify)</i>

*(c) How large is the 2007 fixed reimbursement to the health enterprise/hospital?*

*(d) Do you wish to be oriented about the results of this project?*

*Thank you!*

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