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The Monetary Value of Human Life

- Examining the differences between sectors

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Abstract

Economic evaluation has become an important tool in health and transport economics. To evaluate decisions, thresholds and benchmark values are required. These thresholds can include valuating lives in monetary form. To ensure an efficient distribution of resources the value of human life should be approximately the same between the sectors. In transport economics value of statistical life (VSL) is frequently used and in health economics the value of a quality-adjusted life-year (QALY) is frequently used to compare costs and benefits. I calculate and create a confidence interval (CI) for the transformed VSL in ten countries using official data. In order to see if there is coherence between the sectors the transformed VSL is compared to the threshold QALY values used in the health sector. In addition, using EuroVaQ data, I also explore for four of these countries if the threshold values reflect individuals willingness-to-pay (WTP). Last, the relationship between GDP per capita and the QALY thresholds are analyzed. I conclude that there is little coherence between the sectors, only one country report similar value. In addition the WTP presented in EuroVaQ is lower than both the transformed VSL and the QALY thresholds. The GDP per capita has a positive effect on the thresholds. The results imply that the two sectors value human life differently.

Keywords: VSL, QALY, Threshold, Health, Transport

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1. Introduction

1.1 Background

How much is a man or woman's life worth? Most would perhaps instinctively argue that a life is priceless and that it is impossible to quantify in monetary terms. But reality shows that we are often not prepared to do whatever it takes to save a life. Resources in society are scarce and it is important to plan and evaluate how to best use the resources. There is a need of knowing how much we should spend in order to save a person and to maximizing individual's utility. In the wake of scarcity of resources, economic evaluation has become an increasingly important part of economics and a powerful tool for governments and policymakers.

Indirectly, economic evaluation is something individuals have done for ages; however the use of economic evaluation as an official tool is a recent development. Comparing costs and benefits and the use of cost-benefits analysis (CBA) was primarily initiated in the 80s by Ronald Reagan who in 1981 required a regulatory impact analysis (RIA) for all major economic decision in the American government (Boardman et al 2014). RIA is a type of CBA and with the CBA the policymakers could justify its decisions. After the Reagan's initiative the use of economic evaluation and CBA has become praxis in many countries for almost all major economic decision (Boardman et al 2014).

To enable the state to redistribute resources efficiently across sectors the use of economic evaluation is good in theory; decisions will be made on the same basis in all sectors creating an efficient distribution of resources. The purpose of economic evaluation is to choose the best decision on a monetary basis that balances the resources available against the need. It is a common view that the responsibility of the state is to distribute the resources efficiently (Hindriks et.al 2013). Assuming that the state should strive for an equal efficient distribution of resources it is crucial that all sectors within the state value human life in a similar manner.

However, measuring costs and benefits is complex, especially measuring the value of a human life and assigning a monetary value to a human life. Assigning monetary value or putting a price on a person is not only complex, it is also considered as a moral problem. Hansson (2007) argues that human lives and money are incommensurability; assigning values to human life should be for calculative purposes only (Hansson 2007). However, in practice this is not always the case. In many countries there is monetary value on human lives that is used to evaluate decisions.

Two sectors where this phenomenon is present in is the transport and health sector (KCE 2008, Cost-Benefit Analysis 2012, Baguelin et al 2010, SafetyNet 2009 and Influensan A(H1N1) 2009). In this thesis I will focus on these two sectors and their valuation of human lives.

In transport economics it is common to use value of statistical life (VSL) to monetize human lives. The VSL is a value of an average person and what that person's full life is worth (Boardman et al 2014, Hultkrantz et al 2008, and Andersson et al 2011). How to monetize the VSL has varied through time. In the 70s the human capital method was primarily used (Hultkrantz et al 2008 and Andersson et al 2011). The increasing use of CBA following Reagan's initiative also developed the ways of monetizing VSL and Stated preference (SP) methods became frequently used and especially the contingent valuation (CV) (Boardman et al 2014, Andersson et al 2011 and Hultkrantz et al 2008)..

VSL can be linked to Quality-Adjusted Life-Year (QALY) which is the most common measure in health economics. QALY measures both morbidity and mortality and is designed as a utility measure where the quality of life is viewed in a scale ranging from 0-1 (Boardman et al 2014, Burström et al 2013, Sassi, 2006 and Hultkrantz et al 2012). However, following the boom in CBAs, a need of monetizing QALY, like the VSL, emerged. Medical spending accounts for a substantial portion of the government spending, so it has become seen as increasingly important to economically evaluate the decisions in the health sector. To monetize QALY, Willingness-To-Pay (WTP) is commonly used. The first attempts to estimate the monetary value of a QALY using WTP was made in the 70s. Since then, countless other studies have been conducted resulting in a wide range of answers (OECD 2012). One of the most recent and biggest projects so far was the EuroVaQ project. The project was an EU funded project aiming to develop robust methods to analyze the WTP for several European countries with a sample of over 40 000 individuals (EuroVaQ 2010). Even though there seems to be an uncertainty coming to estimate the value of a QALY, threshold is being used in many countries. The thresholds are not official in all countries (KCE 2008), but are still used as a tool to evaluate decisions (A(H1N1) 2009, KCE 2008 and Cost-Benefit Analysis 2012).

QALYs can also be calculated from the VSL (Abelson 2003 and Boardman et al 2014). The transport sector and the health sector are two important sectors handling and evaluating major projects and who uses two different measures in order to put a price on a human life. The value of a human life should be the same within a country since it should represent the preferences in that country (Loomes 2002). Since it is possible to calculate the value of a QALY value from the VSL it is also possible to compare the value of human life set in the transport sector to the value set in the health sector.

1.2 Purpose

I take my departure from the assumption that the purpose of economic evaluation is to enable the state to distribute its resources in an efficient manner. The aim of the thesis is to compare the values used by official authorities in the transport and health sector in order to see if there is coherence between the sectors. If it turns out to be a different valuation between the sectors the implication could be that the economic evaluation is not an efficient tool. Using data for VSL from the SafetyNet (2009) project and threshold values for QALYs the comparison will be done for 10 countries using an approach suggested by Boardman et al (2014) and Abelson (2003). Four of these countries were also a part of the EuroVaQ (2010) project. In the four countries there is a possibility to compare the WTP from EuroVaQ project to the values used in the transport sector as well as the health sector. The WTP could give a hint if the values used in practice for economic evaluation is reflected in the preferences of the population. Lastly an analysis of the wealth, measured as GDP per capita, and QALY threshold will be conducted to see if higher wealth gives a higher threshold.

The thesis will answer the following questions:

- Is the value of human life the same in transport and health sector?
- Does the value of the human life reflect the preferences in the population?
- Does higher wealth result in a higher value of a QALY threshold?

While the main body of the literature within health economics focuses on the WTP for a QALY and the methodological problems concerning the measurement, little attention has been directed towards the differences between the health sector and the transport sector and their ways of measuring human life. Differences in the value of a human life between the two sectors could potentially lead to an inefficient distribution of resources in the society.

1.3 Disposition

The thesis is organized in the following g way; in section 2 the theory will be presented. An introduction the concept of VSL and QALY as well as the approach used in order to transform the VSL into value comparable to the value of a QALY will be presented. Section 3 presents the method used in the thesis, the data will also be discussed under section 3 where focus will lie on the references used for the VSL and QALY thresholds, since there is a presence of uncertainty. In Section 4 the results will be presented. Following section 4, section 5 is the discussions of the results. The discussion will deal with the implications of the results and the validity. Lastly a shorter conclusion will be presented.

2. Theory

In order for policymakers to make correct decisions one must first ask, how do we decide what is the correct decision. To evaluate economics decisions there is several cost analysis tools at hand. The three mostly used are CBA, Cost-Effectiveness Analysis (CEA) and Cost-Utility Analysis (CUA). CBA measures all cost and benefits and assigns it monetary values. The basic decision rule is if the benefits are greater than the costs then there is motivation for the policy. CEA is used when the objective is clear and the state seeks the most effective way to accomplish the objective. The use of cost-effectiveness ratio is common and will be more thoroughly introduced in section 2.4. Lastly the CUA is a way to analyze impacts without assigning monetary values to them. It could be due to the fact that it is difficult to assign monetary values to all impacts. Consequently the costs of the policy is compared to the utility gains, here the use of QALY is common. QALY is used without a monetary value and it is the gain in quality of life that is important (Boardman et al 2014). These three methods are the most common in economic evaluation. The focus for the thesis is however not to investigate these method but instead the monetizing of VSL and QALY. To be able to do that an introduction of the two concepts are necessary and also how they can be monetized.

2.1 Value of Statistical life

The VSL is a theoretical concept trying to estimate the benefit from saving a person's life through an intervention (Boardman et al, 2014). If a policymaker is planning to build a road for bicycles and cars they have to decide if they should have separate lanes for the two. The benefits from building two separate lanes could be measured in how many lives it will save from fatal accidents. These lives saved must be put in monetary form in order to perform a cost-benefit analysis of building the two separate lanes. One way of doing this is to estimate the VSL. The VSL monetizes the benefits from the lives it will save. A high VSL will enable more expensive policies in order to save lives and hence a low VSL will lead to less financing. VSL is often used in order to evaluate infrastructure project, roads and railways and is a common feature in transport economics (Andersson et al, 2011).

2.2 Quality-adjusted life-years

In CUA it is common to use the measure of QALY or DALY (disability-adjusted life-years. This thesis will focus only on the QALY measure. The strength of this measure is that it reflects both mortality and the morbidity. In other words it reflects the quantity (mortality) of life, which can be the life-expectancy, but it also reflects the quality (morbidity) of life. The morbidity is the quality of the remaining life-years measured in a scale from 0-1 where 0 refers to death and 1 refers to a state with perfect health. Where on the scale 0-1 a certain health state ends up in is calculated by assessing health-related quality of life (HRQoL) (Boardman et al, 2014). HRQoL reflects the quality part of QALY and can be measured with different methods. One of the most common is the EQ-5D method which is a questionnaire reflecting five dimensions. These five dimensions are: mobility, self-care, usual activity, pain and anxiety. The use of this questionnaire is widely accepted but can be criticized for a lack of coherence on what values that should be used on the scale. Hypothetical values used by NICE in Great Britain seems to be a high estimate compared to Swedish data based on a health survey (Burström et al, 2013). The EQ-5D method is closely linked to the health index method (HR) (Boardman et al, 2014). Boardman et al (2014) identify three other methods used to estimate the HRQoL value. These methods are: the time trade-off (TTO), standard gamble (SG) and health rating (HR). In the TTO method respondents are asked to compare and chose between different bundles of remaining life-years and the quality of those life-years. One alternative is living fewer years but with high quality and the other is living longer but with lower quality. The SG method respondents are presented with different alternative with different outcomes and probabilities. It can be compared with having a surgery that will fully restore the health but there is a risk of complications from the surgery. In the last method, the HR method, respondents are asked to rate health states. Estimating the HRQoL is complex and the results from the methods vary a lot creating uncertainty for the QALY as well (Burström et al 2013). Also earlier studies has found that age and sex has a significant importance on the HRQoL suggesting that men have higher estimates than women and that older people value their health less than young (Dolan et al 1996).

2.3 Monetizing VSL and QALY

The VSL varies between countries and in studies. Exactly how it should be measured is not standardized. One of the most common ways to measure the VSL is using WTP for the VSL. The WTP can be estimated through different SP methods, which is a direct estimation. There is also revealed-preference (RP) method which is an indirect estimation method where you analyze preference revealed in other markets (Hultkrantz et al 2008). CV method is one of the SP methods and also the most common in transport economics (Hultkrantz et al 2008). CV method is based on survey studies where the researchers present individuals with hypothetical questions and scenarios where the respondent are asked to state his or hers WTP or WTA (willingness-to-accept) for the scenario (Boardman et al, 2011).

Methods used in order to estimate the value of a QALY is similar to the ones mentioned above. CV and WTP are most frequent used but other SP and RP method could also be used. It is also possible to discount the VSL to estimate the value of a QALY. The method of discounting VSL will be discussed in detail in section 2.3.3. A combination of CV approaches is used in order to estimate the WTP for a QALY in the EuroVaQ project, further discussed in the method section.

2.3.1 Contingent valuation

The CV methods are divided into three approaches; Direct elicitation, dichotomous-choice and discrete choice experiment.

The direct elicitation, also called non-referendum, is straight forward and respondents are asked directly their WTP. However there are three ways it could be used in practice; open-ended, close-ended and contingent ranking method. The open-ended is only stating the WTP. Close-ended include a specified amount presented to the respondent. The respondents are asked a specified amount until he or she agree on amount (if no, the specified amount goes down until yes, if yes the specified amount goes up until no). The procedure resembles to negotiations over price. The close-end way has a weakness in the first amount presented since it could affect the respondent. The third way, contingent ranking, is based on a ranking of good presented in monetary values. The WTP is then estimated from the ranking. The contingent ranking is sensitive to what alternatives are given and in what order since it can affect the respondent (Boardman et al, 2011).

Dichotomous-choice method, referred to the referendum method, is similar to the close-end way of direct elicitation. The respondents are asked if they are willing to pay a specific amount chosen by the researchers. Several amounts are presented and the fraction of respondents who agree is presented in a histogram, the answers being the respondents that agree on the specific amount. From the histogram the demand curve can be estimated and the area under the curve is the estimate of the WTP (Boardman et al, 2011).

A discrete choice method focuses on the attributes of a certain good. Then the attributes of the good is changed with a price level attached (both good and bad changes) and the respondent is asked to select the preferred bundle of attribute. Usually implemented by multiple choice questions, note that the good can be abstract and referring to a health state. In that case the method is similar to the EQ-5D method which will be described in the QALY section (Boardman et al, 2011).

Even tough CV method is the most common method today it still faces some critique. First there is the difference of WTP and WTA where WTA usually gives a higher estimate compared to WTP. WTA reflect an individual's willingness to separate from something he or she already possesses. Individuals tend to value goods in their possession higher than goods they do not possess, which is reflected in the WTP. However, since WTP is the most used concept this is not an issue that I will focus on in this thesis. Other issues with CV that could give rise to bias results are Hypothetic bias, warm glow, strategic response, framing and embedding effects. The best solution is simply to devote a lot of time and effort to create a good survey, understandable for the respondents (Kling et al 2012 and Boardman et al, 2011). How the structure of the questionnaire is built up is important, especially how risk and uncertainty is presented. Kahneman et al (1979) presented the concept of prospect theory in 1979. What they found is that individuals are risk-seeking when it comes to avoiding losses and risk-averse for gains. Using this theory can explain some differences in the WTP from different studies since individuals can be willing to pay differently for health gain compared to avoid health losses.

There have been attempts to standardize the SP methods; one example is after the oil catastrophe in Alaska in 1989 when the oil tanker Exxon Valdez ran aground. There was a need of monetizing the impacts on the environment following the accident, SP methods where used but came under heavy criticism. Because of this the National Oceanic and Atmospheric Administration (NOAA) formed a panel in 1992 whose main task was to put up guidelines in order to standardize the SP methods. In this panel well known economists where represented, such as Arrow, Solow and Leamer, to name a few (Kling et al, 2012). Despite these guidelines recent studies still finds a wide range of values of the WTP for the VSL suggesting that there is still some issues of valuating with WTP and SP methods (Boardman et al, 2013).

2.3.2 Revealed Preferences and Human Capital method

Another method based on surveys is a wage-risk approach. The wage-risk is a RP method. The approach focuses on scenarios which are easier to grasp for individuals than other WTP questions. Instead of stating the WTP ones is asked to state how much more wage they demand in order to increase their job related risks. Then one can use these preferences in order to calculate their WTP for a VSL or the value of a QALY (Boardman et al 2014).

It is also possible to use the human capital method to estimate the VSL value. However the method is becoming less popular. The method is based on calculating the expected earnings for individuals. The problem with the method is its shortages in explaining individuals' preferences (Andersson et al, 2011 and Hultkrantz et al 2008). While it is becoming less popular used by itself it is sometimes used in combination with WTP. By incorporating the human capital method with WTP one can also analyze the production loss for the state when a person dies as well as WTP (Andersson et al 2011). In the transport sector material and medical costs can also be added in association with accidents to the VSL (Trawén et al, 2002). Sweden is one of the countries that add these features to its VSL. The VSL for Sweden contains both an aspect of the WTP and the loss of production for an average person as well as the material cost. The US and Great Britain also add an amount for the material cost as well as the medical cost (Andersson et al, 2011). Norway uses the loss of production value in their VSL (Cost-Benefit Analysis 2012).

Using SP method and the RP method can give a wide range of answers. The variation between studies can hence be explained through different methods and not necessarily different preferences. For a more detailed overview of differences and how to use SP and RP in a correct manner, see Harrison (2006).

2.3.3 Discounting VSL and the concept of VLY

Another way of estimating the monetary value of a QALY is to use the VSL. Using an approach presented by Abelson (2003) and Boardman et al (2014) gives the opportunity to use the VSL and discount it to create the value of QALY. First the concept value of a life-year (VLY or VOLY) need to be introduced. VLY is a constant value reflecting the value of one year based on the VSL value. The VSL is discounted by an annuity factor which gives the VLY. VLY is denoted in equation 1 below:

$$VLY = \frac{V\hat{S}L}{A(T-a,r)}$$

Equation 1: Value of a life-year (VLY), **Source:** Boardman et al (2014) and Abelson (2003)

Assumptions needed are that the VSL need to be constant for the remaining life-expectancy, denoted by $V\hat{S}L$. $A(T-a,r)$ is the annuity factor where r is the discount rate and T-a is the remaining life years. VLY can be assigned weights in order to widen what it can measure. Health weights denoted by w_t can be applied; making the VLY comparable to the QALY relationship is shown in equation 2 below:

$$QALY_t = w_t VLY$$

Equation 2: Quality-adjusted life-year (QALY), **Source:** Boardman et al (2014)

The strength of the QALY measure compared to the VLY is the quite high probability that not all years are spent in the same health state (Boardman et al, 2014). Also your health stock is likely to decline over time (Grossman. 1972). When the health stock declines the QALY value will also decline. To evaluate interventions and policies it is important to note the declining health stock and compare the expected discounted QALY over time (Boardman et al, 2014). However, since economic evaluation focuses on a specific point in time the declining health stock is not an issue.

2.4 Incremental Cost Effectiveness Ratio

CEA is a common valuation method in health economics. CEA is useful when the target for a policy is clear and well defined and what is left to decide is which alternative to chose. The main difference between CEA and CBA is that in CEA the benefits are not monetized. Instead focus lie on measuring the cost and the effectiveness of the policy. The effectiveness can be lives saved form vaccination, or in education it might be test results. The costs and effectiveness are then compared in a ratio; the ratio is called ICER or Incremental Cost Effectiveness Ratio which is shown in equation 3 below:

$$ICER_{ij} = \frac{C_i - C_j}{E_i - E_j}$$

Equation 3: Incremental Cost Effectiveness Ratio (ICER), **Source:** Boardman et al 2014

ICER is the ratio used where C denotes costs and E denote effectiveness. The sub indexes of i and j denote the different options (Boardman et al, 2014).

However, if one would look only at the cost-effectiveness ratio (CE) where one focus on the cost and effectiveness it is possible to estimate the cost per life, if the effectiveness is measured in saved lives (Boardman et al, 2014). It could also be the case that policies within the health sector look at saved QALYs, if there is a threshold value or benchmark of the QALY we can in theory measure the benefit in monetary form. This was done in the CBA of the swine flu vaccination in Sweden 2009 conducted by Socialstyrelsen and MSB (Influensan A(H1N1), 2009). In Great Britain a similar study was made by Baguelin et al (2010). In analysis like the ones mentioned above with QALY as an effectiveness measure, we are moving from CEA towards CBA. In CBAs, threshold values become an important decision tool in the health sector when it comes to measure befits. In the CBAs the effectiveness can be measured as QALYs gained, that is how many QALY with the score 1 was gained by the intervention. This reflects a weight of 1 in equation 2.

2.5 Health care expenditure and GDP

Medical expense has risen dramatically the last decades as a share of GDP (Jones 2002). Williams (2004) argued that the use of GDP should be given more importance in the estimation of QALY thresholds because the threshold should reflect the average wealth of the population. Wealth, measured as GDP per capita, and health expenditure has been found to have a strong relationship in earlier studies (Gerdtham et al 1991) so it is likely to be a relationship between the value of a QALY and GDP as well. Since the threshold values are used in the decision process within the health sector it is likely that an increase in the health care expenditure is reflected in the threshold values. Also, when it comes to income and health there is a large literature on which way the causality goes. The demand for health is likely to increase as income goes up. The income increases as the health level increase (Rivera et al 1999 and Devlin et al 2001). However, discussion regarding the causality is beyond this thesis.

3. Method

The aim of the thesis is to compare the valuation of human life in two important sectors of the society, the health sector and the transport sector. Both are crucial for a modern welfare society. As mentioned in the theory section health sector use the value of a QALY as a measure for life and transport use VSL. These measures cannot be compared directly since VSL is a measure for all remaining life years and the value of a QALY only reflect one year. However, it is possible to discount the VSL value and transform it, making it is possible to make a comparison. However, some assumptions are necessary regarding discount rate, life expectancy and weights. The base for the calculations is the one presented in the theory section by Boardman et al (2014) and Abelson (2003) (see equation1 and 2). Note that the thesis is not a test of the approach presented in the theory section. It is assumed that the approach is correct. With the assumptions, however, comes a certain degree of uncertainty which could alter the results and make it difficult to interpret. A short discussion of the uncertainty and how it is dealt with is presented below. Discussion regarding the data will is presented in section 3.4, where the discussion of the VSL and the thresholds values of a QALY will be dealt with.

To follow Boardman et al (2014) and Abelson (2003) approach to calculate a value from the VSL that is comparable to the value of a QALY, there is a need to discount the VSL. The VSL is discounted with an annuity factor containing life expectancy and the discount rate. Discounting the VSL will lead to the VLY, which can be assigned weights. The weights can be from 0 to1 where 0 is comparable to death and 1 is perfect health state. Assigning these weights to the VLY make it comparable to the value of a QALY (see equation 2). For the reminder of the thesis the discounted VSL is called the transformed VSL. The transformed VSL is the value used in order to compare the value of a QALY and the VSL. In the two following section a detailed discussion about the life expectancy and the discount rate.

3.1 Discounting VSL: Life expectancy

The life expectancy is the expected remaining life years an individual have from birth. However VSL is calculated for an average person. The average person’s age is not defined but is recommended to be 40 year by EU (Cost-Benefit Analysis, 2012) and it is also most commonly used (Abelson 2003). Also later research has also found an inverted U-shaped relationship for valuation of VSL and age. There are some differences in different age categories and it seems to increase up to the age o around 40. After the peak it decreases suggesting it has a peak at around 40 (OECD, 2012 and EuroVaQ, 2010). The results of the peak around 40 also support the usages of an age of 40 as average person since it is the max VSL that is interesting to capture. For the first calculations made in this thesis the average person will therefore be at the age of 40. But, as mentioned, there is no standard value and even though research and recommendations suggest the use of 40 it is not certain that all the countries in this study use that age. To deal with problem of the average person several calculations will be made for different age of average person, ranging from 30 up to 40. These calculations will be used to construct a confidence interval. The calculations will be integrated with the uncertainty of the discount rate; this will be discussed later.

There is also another issue with discounting VSL with life expectancy. The main goal is the end up with a value of a QALY, one can argue for the use of quality-adjusted-life-expectancy (QALE) (Sassi, 2006). However such data is not available for the countries and the data that is available is not calculated in the same manner in different countries, so regular life expectancy will work as a proxy. If data was available for QALE it could give other results than using the remaining life years.

3.2 Discounting VSL: Discount rate

What discount rate to use has an influence on the results and it is not straight forward to what rate one should use. A study by Bonneux et al (2001) regarding cardiovascular diseases found that a discount rate increasing from 0 % rate to 3 % could decrease the cost for an intervention with almost 9 times, when comparing the cost-effectiveness. It is clear that the discount rate matter, however using 0 % is not realistic. Boardman et al (2014) uses 3.5 % and Abelson (2003) use 3 % but there is no standard level of discount rate, there is a clear difference between the countries (EuroVaQ 2010). According to EuroVaQ (2010) data, which contain four of the countries also investigated in this thesis, the discount rate varies from 1.5 % to 4 %. Great Britain use 1.5 %, Netherlands have 2.5 %, Sweden has 3 % and Norway has 4 %. With that said, Baguelin et al (2010) used 3.5 % for a CBA in Britain for the swine flu, so there is uncertainty about the discount rates presented in EuroVaQ. The discount rate also varies between the sectors. Hultkrantz et al (2012) findings suggest that the Swedish health sector uses 3 % where the transport and traffic sector uses 4 %. The calculation in the thesis made in order to transform VSL to value comparable to the value of a QALY uses two different values of the discount rate in order to deal with the uncertainty. The values are 3 %

and 4 %; this is motivated by the fact that Boardman et al (2014) uses 3.5 % and Abelson (2003) use 3 %. Also Norway uses 4 % which motivate the high value of 4. I will be using 3 % since having a wider range of different discount rate can actually cause more problem than it solve. Netherlands and Great Britain have according to EuroVaQ rates below 3 %, but I cannot be certain that they actually use those rates, which are evident in Baguelin et al (2010), and there is a lack of information of the other countries. Hence, it would be like shooting in the dark in order to estimate the discount rates for the other countries. Therefore only the two values will be used. Note that the use of two values only deal with the issue to a certain extent, it will not solve the problem.

3.3 Comparison method

To be able to compare the VSL and value of a QALY a 95 % confidence interval will be used. The interval of the transformed VSLs will then be compared to the threshold values from the health sector. If the QALY threshold lies within the 95 % interval then it implies that the VSL and QALY and hence, a human life, is worth equally in the two sectors. The confidence interval acts as a sensitivity factor as well, there is uncertainty in the discount rate and how the life expectancy should be used. To some extent solve the issue two discount rates will be used, 3 % and 4 %. Also a life expectancy with a 11 years span is introduced starting with an average person with the age 30 going up to 40, as has been identified as the age where the values is the highest (OECD 2012 and EuroVaQ 2010). The procedure gives a total of 22 observations for each country and the CI is constructed from these 22 observations. The 22 observation comes from 11 observations with 3 % and 11 with 4 % discount rate. The procedure gives more credibility to the approach suggested in the theory as how to discount the VSL (see equations 1 and 2). A calculation with the base year of 40 and the discount rate of 3 % for all countries is also presented. Using the results from the EuroVaQ project for the countries that are available, the WTP for a QALY is also compared to the threshold values as well as the transformed VSL.

In addition a regression is performed to analyze the relation between GDP per capita and the QALY thresholds. Both the QALY threshold and the GDP per capita are in logarithmic form. Following the regression a linear prediction is conducted of the threshold values. Note however that there are only 10 observations, which is the number of countries in the dataset. This makes the conclusion of the results weak, the results will be interesting but in order to do significant interpretations of them there is a need of a larger dataset. As for the causality problem with health and wealth I cannot conclude in which direction it may go. That is beyond the thesis. However, with the results it is still possible to analyze if the threshold values are too high or low compared to the wealth level.

3.4 Data

The data used in this thesis comes from various sources and must be handled with care. In this section the data will be presented, where it is from and also its limitations and shortcomings. As the reader will note, some of the data is not the most trustworthy, however the access to data is limited which must be kept in mind. The countries in the data set are Australia, Canada, Finland, Great Britain, Ireland, Netherlands, New Zeeland, Norway, Sweden and United States. The reason for choosing these countries is the access of QALY thresholds and VSL used in practice in economic evaluation. The year for used as base year in this study is 2008. This is motivated by the fact that the VSL values where collected at that point (SafetyNet, 2009). There is a need for a reference year in order to have the same price level and calculate the life expectancy. However, it is not clear when the VSL value are calculated. Also it is not certain when the QALY thresholds were calculated.

3.4.1 Life expectancy and PPP adjusted GDP per capita

The calculations are based on the average person with the age of 40, and a range calculation between 30 and 40. The remaining life years are hence the expected life expectancy from the age of 40 to the death. The data on life expectancy is collected from the World Bank (World Bank, 2014). The year used as base year is 2008. An overview of the life expectancy and the data used for calculations are available in the appendix, table 5.

As 2008 is used as the base year the currency must be in 2008 years currency and it has to be the same for all countries. The VSL values were presented in Euros and most of the QALY threshold value is presented in domestic currency. In the calculations all values are converted to PPP adjusted US dollar for 2008 making it easy to interpret the results. Exchange rates and GDP per capita was taken from OECD data (OECD, 2014). GDP per capita for all countries is presented in the table 6, available in the appendix.

3.4.2 VSL

Official data on VSL is scarce and the data that do exist is limited in the way it has been calculated. The data used in this thesis is from the SafetyNet (2009) project. The report was funded by the European Commission, Directorate-General Transport and Energy. The project gathered information on official values from 23 countries. Unfortunately there is no information on how the values were estimated and which methods used. The countries investigated in this thesis are among those 23. The uncertainty of the data and the methods used to estimate the VSL is a problem but as mentioned there are few other sources of VSL and these values are official according to SafetyNet (2009). As long as it is the official values it serves the purpose of the thesis. However it is worth to note that there is likely to be a difference in how to estimate between the countries. Also, who is responsible for the official values differs between the countries. In several countries it is the road or traffic administrations that are responsible for the official VSL value (Andersson et al, 2011, SafetyNet, 2009 and Cost-Benefit Analysis, 2012). The lack of data is also showed by Trawén et al (2002); they conducted a survey in order to establish the official VSL values, only 11 countries responded. The VSL values for the ten countries of interest are available in table 7.

3.4.3 QALY Thresholds

The access to VSL values is limited although official. The data for QALY thresholds are also scarce and are in addition often not official. In some of the countries the threshold is from official sources like government institution, however, the threshold is not an official recommendation. With that said, it is clear in many cases that even though it is not official it is still being used in comparisons in CBA by official institutions. One example is the Swedish value of 600 000 SEK which is not official, still it is being used by official institutions (Influensan A(H1N1), 2009). In Norway it is the same scenario, there is no official threshold but a figure of 500 000 NOK is commonly used (Cost-Benefit Analysis, 2012). Due to the lack of data and lack of official thresholds the data set consists of 10 countries. Some of the threshold values are in intervals, since the focus of the thesis is to investigate the value of a human life I only present the top value. One can argue for an average number of the interval, however, the top value should indicate that some policies have been accepted at that threshold which means that a life could be valued at those levels. It is interesting to investigate what is the maximum we are willing to pay for a life.

The thresholds number is presented in table 11 in the appendix. In table 11 the source for every threshold number is also presented and comments on the values as well as the source.

3.4.4 EuroVaQ

The EuroVaQ project was initiated 2007 and lasted until 2010. It was an EU funded project consisting of 10 countries and approximately 40 000 individuals. The main goal of the project was "to develop robust methods to determine monetary value of a QALY across a number of European member states" (EuroVaQ 2010, p.7). In the process the WTP was also calculated for these 10 countries using SP method based on surveys. Two main approaches was used, namely a chained approach and a direct approach, individuals from the sample of 40 000 where randomly assigned to one of the two approaches.

The direct approach is straight forward and the survey questions simply asked how much are an individual willing to pay in order to avoid a health problem. Note that all health problems presented in the questions lasted for at least one year, also, little risk were assigned to the health problems. The advantages with the direct approach are that it is straight forward, making it easy for the respondents to grasp the questions. However, some critique may be put forward regarding the range of answer with some very high and some very low and in some cases zero, indicating that respondents has not fully understand the magnitude of the question. Some respondents also stated zero as their WTP as they argued that it was the state's role to pay for treatment, these values were recorded as missing values in the sample.

The chained approach was done in two steps. The motivation behind the chained approach is to keep health changes at a minimum to decrease the chance of a budget constraint bias, likely to be present in the direct approach where the health problems were substantial. However, in order to make the method work, one need to assume that the WTP for a QALY is linear since the small health increase is multiplied up to a full QALY. Hence there is a need to assume linearity. In the first step two health states were presented, green and yellow, to the respondent. The green health state dominated the yellow but both health states have small changes in QALY. The health states are presented in the EQ-5D form (see section 2.2) and the respondent's utility for the two health states are determined. The utilities were determined by the TTO method or the SG method, which method used was randomized through 8 different versions where half of the 8 were determined by SG method and half by the TTO method. Then risks are introduced together with probabilities of being in the health state for a certain amount of time (six scenarios). The WTP is based on the respondents WTP to avoid the risk of being at the health state. The respondents were given 15 different amounts in random order then order these amounts in the following categories: definitely would pay, definitely would not pay and unsure. The highest amount order in the category, definitely would pay was taken as the WTP. However if the respondent were willing to pay more than they were asked to state that specific sum, then the specific sum was used as the WTP for the QALY. Again, respondents who argue that the state should pay were removed from the data.

EuroVaQ was an internet based survey and has the problem, like many surveys based project, of a low response rate. In the four countries analyzed in the thesis, none have a response rate over 20 % of the invitations sent out. The low response rate creates a problem of bias and the results should be handled with care. In the thesis the results from the chained approach will be used due to the strength of the method. The means from the two health states (green and yellow) and the risk-variant questions will be added and a mean for all will be calculated representing WTP for a QALY. I will use the trimmed data where the top 1 % outliers are removed. The respondents who stated their WTP to be zero is also removed in the trimmed results. In the appendix the WTP is presented as well as the response rate. Also, the six scenarios and the changes in QALY are presented. In table 8 the health states are presented, in table 9 the WTP and response rates are presented and in table 10 a more detailed overview of the WTP is presented.

4. Results

The following section presents the results in four tables. In connection to each table there is a short summary of the findings.

In table 1 the value of human life is presented. For the transport sector the VSL has been transformed using 3 % as a discount rate and 40 year as the average person. The last column present the QALY threshold value used in the health sector.

Table 1: Value of Human life

Country	VSL	Annuity	Transformed VSL	QALY Threshold
Australia	1147568	23.53	48775	51384
Canada	1354557	23.28	58192	64809
Finland	1224491	22.98	53277	76284
Great Britain	2026118	22.99	88118	33706
Ireland	1125755	22.85	49263	47292
Netherlands	1674168	23.19	72192	94975
New Zeeland	1638714	23.22	70572	13416
Norway	2603086	23.29	111758	57129
Sweden	1878992	23.44	80156	68389
United States	3066584	22.47	136457	100000

All numbers are in US dollar, the average person's age is 40 years, discount rate is 3%

As can be seen in table 1 there is substantial differences between the transformed VSL and the QALY thresholds in several countries. Australia, Canada and Ireland have quite similar values. Looking at New Zeeland the transformed VSL is five times as big as the QALY; this is the country with the largest difference. Note the wide range of results with countries both being substantially above and below. Note that the United States has both the highest transformed VSL and the highest QALY threshold.

In table 2 the confidence interval from the different approaches of discounting the VSL and creating the transformed VSL is presented, the confidence interval level is 95 %. The seventh column presents the QALY threshold values. The third column presents the mean of the transformed VSL from the 22 observations.

Table 2: Confidence Interval, QALY threshold and WTP

Country	Observations	Mean	Standard error	95 % CI Lower	95 % CI Upper	QALY Threshold	WTP per QALY
Australia	22	56867	1051	54680	59054	51384	-
Canada	22	67125	1241	64543	69707	64809	-
Finland	22	60680	1122	58346	63013	76284	23525
Great Britain	22	100404	1856	96542	104266	33706	-
Ireland	22	55787	1031	53641	57932	47292	-
Netherlands	22	82963	1534	79772	86154	94975	25295
New Zeeland	22	81206	1501	78083	84330	13416	-
Norway	22	128996	2385	124034	133957	57129	41455
Sweden	22	93113	1722	89532	96694	68389	30130
United States	22	15196	2810	146120	157809	100000	-

All numbers are in US dollar, the confidence interval based on an average person ranging from 30-40 years old and two different discount rates 3 and 4 %

The results from table 2 support the results from table 1 when it comes to Canada, which is the only country which has a QALY threshold value that falls within the transformed VSL confidence interval. For the two other countries in table 1 that showed promising results, Australia and Ireland, the results now indicate that there is a lack of coherence between the sectors. Again, New Zeeland is the country with the biggest differences between the sectors; also Great Britain shows indication of substantial differences. Even though results from the QALY thresholds are both under and over the CI it seems to be a tendency that the QALY threshold value is lower than the transformed VSL. Of the ten countries, seven has lower threshold values, one is within the CI and two have higher values, namely Netherlands and Finland.

The last column present the results from the EuroVaQ report. The results only cover four of the ten countries, Great Britain, Netherlands, Norway and Sweden. Further details about the numbers from the EuroVaQ report are available in the data section and the appendix. Interestingly the results from the EuroVaQ for all the countries have values that are lower than both the QALY threshold and the CI lower bound. Norway presents the highest WTP whereas it only reports the third highest QALY threshold. Netherlands who reports the highest QALY threshold of the four have the second lowest WTP. Excluding Netherlands from the results, suggest that transformed VSL has the highest value followed by the QALY threshold and the WTP for a QALY has the lowest monetary value in all countries.

In table 3 a simple regression of the logged value of QALY thresholds and the logged GDP per capita is presented. As has been mentioned before there are only 10 observations, so the statistical interpretations of the results are limited. From the regression the elasticity is estimated and it is above 1, which means that 1 percent increase in GDP per capita increases the QALY threshold more than 1 percent. From the regression a linear prediction of the QALY threshold values is estimated which is displayed in table 4.

Table 3: Regression

Variable	
loggdp	1.933** (0.834)
constant	-9.644 (8.859)
R-squared	0.40
Observations	10

Standard error in parenthesis, ** P < 0.05,
Estimations made in STATA 10

As can be seen in table 4 the prediction of the QALY thresholds is presented. The fifth column presents the real threshold values. Several of the threshold values falls within the predicted confidence interval estimated from the GDP per capita (Australia, Canada, Great Britain, Ireland, New Zeeland, Norway Sweden and United States).

Table 4: Prediction of QALY threshold

Country	Linear Prediction	95 % CI Lower	95 % CI Upper	QALY Threshold
Australia	49155	34238	70573	51384
Canada	51256	35983	73014	64809
Finland	46556	31882	67989	76284
Great Britain	43095	28490	65186	33706
Ireland	56612	39724	80684	47292
Netherlands	58697	40901	84246	94975
New Zeeland	27649	13079	58448	13416
Norway	116996	50046	273512	57129
Sweden	50248	35164	71804	68389
United States	73829	46065	118326	100000

All values are in US dollar, Prediction made in STATA 10

5. Discussion

In this section a discussion of the results and their implication is presented. The validity and to what extent the results are meaningful is in focus, including the problems with uncertain sources and methods. The discussion will take it starting point from the data since that is a crucial part of the thesis.

Dealing with human life is complex in many ways. Ignoring the moral aspect of assigning monetary value to human lives, there still remain obstacles. In transport and health economics the use of monetary values of human lives is used in economic evaluation but it is used in different ways. Transport use the VSL and health use QALY. The VSL data used in this thesis is from the EU funded project SafetyNet (2009), where they present the official values used within the transport and traffic sector. Exactly how the data is extracted from the individual countries and how it has been estimated in the individual countries is not detailed. Neither is it obvious if the VSL is actually used in practice. However, some confirmation of its practical use is made by the Norwegian ministry of finance for some countries (Cost-Benefit Analysis 2012), indicating that the values presented in SafetyNet (2009) are actually the VSL used in practice. The origin of the data is however likely to differ from country to country. In Norway the numbers is said to origin from the 1980s and the human capital method, the same can be said for Sweden (Cost-Benefit Analysis 2012 and Andersson et al 2011). Even though the values and method differs between countries they seem to be integrated to a certain degree since it appears to be common to make reviews of other countries values in order to make own estimations (Trawén et al 2002). To sort out the VSL complexity would require a research project by itself and it is not within the scope of this thesis. I assume the values from SafetyNet (2009) as the ones used in practice for all the 10 countries used in the data set. This of course affects the validity of the results in a negative way but it is necessary in order to reach a conclusion.

So, there is reason to question the data on the VSL, however, there is even more issues with the QALY values. In the health sector there is clear lack of transparency when it comes to assigning monetary values to human life. This viewed is shared by Abelson (2003), which is why he introduced the approach used in this thesis. It is clear that it is an area that requires delicacy as to how economic evaluation is performed. Unfortunately the development has created a situation where there is a lack of official values in almost all countries. In Sweden, for example, official reports refer to a value of the QALY which is estimated through unofficial interviews with the Swedish dental and pharmaceutical benefits Agency, TLV (Influensan A(H1N1) 2009). As KCE (2008) highlight, it seems to only be Great Britain and NICE who has explicit value of a QALY threshold. Norway's ministry of finance says that "Health services will often compare the estimated cost per QALY to a threshold of NOK 500 000 per QALY" (Cost-Benefit Analysis 2012, p.163). The terms "often" and "usually" is to a large extent accompanied with QALY threshold. With exclusion from NICE, no health service agency seems to have the accountability that comes with assigning a threshold value to the QALY. Despites this fact it is constantly used in economic evaluation concerning health policies (Influensan A(H1N1) 2009, Baguelin et al 2010, KCE 2008 and Cost-benefit Analysis et al). The origin of the "unofficial" values is as a result unclear. Since no health agency takes responsibility of the threshold and since there is no official values, it is also difficult to determine if the numbers are realistic and reflects the WTP of the population. Which has been noted by Braithwaite et al (2008) who finds that the value of a QALY thresholds used in United States are probably too low, they also question the lack of scientific proof and methods used in order to estimate the US threshold.

There is also the issue regarding how the threshold values should be used. In Great Britain the threshold value is not used as a basis for budget decisions. NICE use the threshold value to allocate within a fixed budget. Then there is a need to evaluate both the health gained and the health forgone by redistributing. Introducing WTP does not take the health forgone into consideration (Claxton et al 2013). As the thresholds takes into account the loss of QALYs as well as the gain it is not certain it reflects the public WTP (McCabe et al 2008). The scenario in Britain might apply in other countries as well and be a part of the explanation of the results. However, the threshold set by NICE is used in CBAs, as can be seen in Baguelin et al (2010), so it is still motivated to analyze the threshold. Also, even in Britain voices has been raised to have a wider transferability of the monetary value of life between sectors (Loomes 2002). Although, as McCabe et al (2008) and Claxton et al (2013) note, transferability should in that case be used in the setting of the budget, not when the budget is fixed as it is within the NICE. The way NICE uses the threshold values could be the same for other countries. If all threshold values are used in a similar manner as by NICE, then the differences between the two sectors could be explained by the different practical use of the value of a human life.

The WTP of the population was a task that EuroVaQ tried to solve. Even though their main goal was to develop strong and robust method of estimating the WTP of a QALY, the project also estimated the WTP for several countries, including four that is analyzed in this thesis. The new methods used in the EuroVaQ may very well be superior to earlier studies, however the low response rates of the survey is a problem. “The goal of most empirical economic research is to overcome selection bias, and therefore to say something about the causal effect” (Angrist and Pischke 2009, p. 15). A way to solve the issue with selection bias, which can alter the results, is to have randomization (Angrist and Pischke 2009). In the EuroVaQ project the survey was issued in a standard procedure, namely with the use of an internet survey provider, in this case the SSI (Survey sampling international). Their method might be random, but as noted, the low response rate (see table 9 for details) is likely to interfere with the randomization. Since there is a low response rate one must ask: who is answering the survey? And more importantly, who is not? Due to the low response rate there is a risk that the EuroVaQ result suffers from selection bias. The use of WTP is, in theory, a powerful tool but it is complex in practice, which is clear from the EuroVaQ project. This confirms the image of WTP raised by Olsen and Smith (2001), who points out the gap between theory and practice when it comes to WTP studies. Further on, the EuroVaQ is an open and transparent project but still suffers from issues, which raises questions on what problems might be present in the QALY thresholds values, as well as in the VSL results since those are considerable less transparent in their estimation and use. So, it is clear there is a problem with the data presented in this thesis; however, it is important to note that this is data used in practice and it plays an important role in economic evaluation in health and transport sector.

The results presented in section 4 had some interesting features. There seemed to be little coherence between the health sector and transport sector. It was only Canada that showed similar results for the two sectors in both the comparison with average persons aged 40 with 3 % discount rate and in the CI. The overall results suggest that the transformed VSL seems to have higher values. Also, introducing the WTP from the EuroVaQ their results is below both the QALY thresholds and the transformed VSL. If these results are valid then there might be an issue regarding the allocation of resources in the society. However, there are some uncertainties with both the data and the calculations that affect the validity of the result. First, as has been mentioned, the QALY thresholds are to a large extent, unofficial values. So it is not certain that the thresholds are actually used. Second, the handle of the discount rate and the age of the average person are not perfect. It is a strong assumption that the average person in all countries is 40. Also, using life expectancy could give biased result. Thirdly, the discount rate is a similar problem as the age. The discount rate is probably around 3 % in most countries but it is likely to differ between the countries, which might also affect the results.

For countries like Australia, Canada and Ireland, where the transformed VSL is reasonable close to the QALY threshold level it is impossible to say if there is a difference between the sectors. But for countries like Norway, Great Britain, New Zeeland and the United States it is likely to be a difference between the sectors since the values differ to such a large extent that it is not reasonable to explain the gap due to uncertainty of the calculations. For the four countries that were included in EuroVaQ it seems to be the case that the WTP for a QALY is lower than what is actually being used by the sectors. The issues with EuroVaQ have already been brought up and validity of those results is questionable.

The implication of the results is that it is likely there is not an efficient distribution of resources. With a higher value of human life in the transport sector, it could be the case that the transport sector is able to spend more money on project than the health sector, holding everything else equal. In the long run this could be a problem with a skew distribution of resources. If the WTP from the EuroVaQ is close to the real WTP it is also the case that the true preferences of the population are not reflected in the value of human life. Leading to possibilities for the two sectors to spend more resources than what they should. The issues with different value of human life have not passed unnoticed. In Norway they are aware of the problem and the problems associated. Their solution, presented by the ministry of finance, is to recommend a standard VSL of NOK 30 million that should be applied to all sectors. The solution to use VSL to calculate the QALY is the same solution proposed by Abelson (2003). In the United States the new patient protection and affordable care act even prohibited the use of QALY threshold within the health sector (Neumann et al 2010). However, Neumann et al (2010) criticized the same decision, “The use of explicit, standard metrics such as cost-per-QALY ratios has the advantage of transparency and can help direct our resources toward the greatest health gains” (Neumann et al 2010, p.1496). While Neumann might be right that standard metrics might be a good tool for distributing resources efficiently, it is also clear that in reality there is little transparency in the use of QALY thresholds. So, the use of QALY remains debatable. Cleemput et al (2011) stress that threshold is insufficient as a measure for interventions and that an increase of transparency is desirable.

In addition to the comparison between sectors the relation between QALY threshold values and GDP per capita is analyzed. There is a large literature investigating the connection between health care expenditure and income levels as well as health and growth. The question of causality is however an issue, the direction of the relationship is debated. The analysis performed in this thesis will not provide a conclusive answer for this debate; however, it seems to be the case that higher wealth will lead to a higher value of a QALY. The elasticity is found to be over one, consistent with earlier research (Gerdtham et al 1991). If Williams (2004) argumentation of a threshold value corresponding to the wealth level is solid, then it follows that some countries have a too high threshold value and some too low (see table 4). However, a majority of the countries have a threshold value that lies within the predicted confidence interval (see table 4). The results suggest that it seems to be the case that GDP has a significant role when it comes to explaining the threshold values. It is important to note the limitation on the QALY thresholds and wealth analysis due to limited dataset. The results are however consistent with earlier research and the results are in line with what is expected.

VSL and value of a QALY are important tools in economic evaluation in order to divide resources in an efficient manner. However, as has been shown, there is little transparency of the values and it seems that the values do not match each other between sectors.

Conclusion

The main goal of the thesis is to compare the value of human life in the transport sector and the health sector. Valuating human life in a similar matter is a foundation for efficient distribution. This thesis show that when it comes to statistical life, the distribution might not work as desired. The results indicate a difference in the valuation of human life between the two sectors. Further on, the EuroVaQ results on the WTP for a QALY show that it is lower than the transformed VSL and the QALY thresholds, indicating that the value of a human life in the sector is not shared by the individual's preferences. The results also indicate that wealth has a positive relationship with the QALY thresholds, suggesting that higher GDP per capita increase the QALY threshold. Also, there is indications that GDP per capita is possible to use in order to predict the QALY threshold. The limited dataset however makes the results unreliable and further research should focus on expanding the dataset and clarify how the VSL and QALY thresholds are actually used and how they are estimated.

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Appendix

1. Life expectancy

Table 5: Life expectancy

Country	Life expectancy 2008	Life expectancy from 40
Australia	81	41
Canada	81	41
Finland	80	40
Great Britain	80	40
Ireland	79	39
Netherlands	80	40
New Zeeland	80	40
Norway	81	41
Sweden	81	41
United States	78	38

Source: The World Bank (2014)

2. GDP per capita

Table 6: GDP per capita

Country	PPP adjusted GDP per capita
Australia	39165
Canada	40022
Finland	38080
Great Britain	36588
Ireland	42133
Netherlands	42929
New Zeeland	29083
Norway	61332
Sweden	39613
United States	48336

In US dollar, **Source:** The World Bank (2014)

3. Value of statistical life

Table 7: VSL

Country	VSL
Australia	1193378
Canada	1408630
Finland	1273372
Great Britain	2107000
Ireland	1170695
Netherlands	1741000
New Zeeland	1704131
Norway	2707000
Sweden	1954000
United States	3189000

In Euros (2002 PPP adjusted rates), **Source:** SafetyNet (2009)

4. EuroVaQ

Table 8: EuroVaQ health states

QALY change	Scenario	Notation - Green health state	Notation - Yellow health state2
0.05	100 % time	Gm	Yq
0.05	1 year risk	Gj	Yh
0.10	100 % time	Gn	Yr
0.10	1 year risk	Gd	Yi
0.10	10 year risk	Gf	
Varies	1 year with certainty	Ga	Yb
Varies	1 year with certainty - annual payment for 4 years		Ye

Source: Figure 3.13a EuroVaQ (2010)

Table 9: WTP and response rates from EuroVaQ

	Great Britain	Netherlands	Norway	Sweden
WTP	23526	25296	41456	30131
Response rate (SSI)	5.6%	15.5 %	7.7 %	12 %
Response rate (Partner)	6 %	15 %	10 %	8 %
Invites	87312	61773	29618	45752
Starters	4932	9544	2288	5492

Source: EuroVaQ (2010)

Means for the two different health states, green and yellow, and the WTP for every scenario is available in table 10 below.

Table 10: WTP for a QALY

Notation - Green health state	Notation - Yellow health state	Great Britain		Netherlands		Norway		Sweden	
		Green Mean WTP	Yellow Mean WTP	Green Mean WTP	Yellow Mean WTP	Green Mean WTP	Yellow Mean WTP	Green Mean WTP	Yellow Mean WTP
Ga	Yb	12421 (894)	22762 (914)	12862 (1038)	22951 (1058)	45518 (846)	43438 (831)	23261 (1104)	33555 (1099)
Gj	Yh	23267 (459)	23285 (394)	24892 (504)	23133 (439)	37427 (365)	29474 (288)	35200 (500)	27696 (428)
Gd	Yi	21182 (882)	14848 (646)	22211 (1017)	16819 (759)	33685 (760)	21602 (523)	34824 (1056)	16908 (767)
Gm	Yq	29308 (953)	20525 (960)	27418 (1119)	27345 (1124)	41298 (807)	41003 (801)	28805 (1107)	33142 (1100)
Gn	Yr	15897 (954)	13228 (942)	18623 (1111)	15738 (1089)	26399 (818)	24757 (794)	19287 (1122)	18292 (1095)
Gf	Ye	25245 (421)	60342 (523)	22911 (475)	68643 (575)	39136 (413)	113730 (418)	27471 (542)	63128 (569)
Average Mean WTP	-	**23526**	**-**	**25296**	**-**	**41456**	**-**	**30131**	**-**

All values in US Dollar, Number of respondents in parenthesis, **Source:** EuroVaQ (2010)

5. QALY Thresholds

Table 11: QALY Thresholds

Country	QALY Threshold value (US Dollar)	Source(s):	Comments
Australia	51384	George et al (2001)	The numbers are the top value where the Australian government would approve for policy according to an investigation of the Australian government. The source and the values old but the numbers are confirmed by the KCE (2008) who report a value close to the number used in the thesis
Canada	64809	KCE (2008)	The threshold value is from a report by the Belgian KCE which is a federal research centre in Belgium, KCE refers the numbers as implicit, in other word not official.
Finland	76284	Hallinen et al (2011)	In Finland there is no official threshold, in many cases twice the GNP per capita has worked as a guideline. That number is around 70 000 Euros. The figure of 50 000 has also been mentioned but again I chose to use the higher threshold since it could be as high as 70 000.
Great Britain	33706	NICE (2009)	Official numbers from NICE (National Institute for Health and Care Excellence). The numbers are frequently mentioned in the literature and are treated with respect, the values ranges from 20 000- 30 000 in domestic currency.
Ireland	47292	HIQA (2014)	No official number but historical references. HIQA (Health Information and Quality Authority) in Ireland has that the interval between 20 000-45 000 Euros is usually used. Again, the upper bound has been selected as a reference for Ireland
Netherlands	94975	KCE (2008)	The threshold value is from a report by the Belgian KCE which is a federal research centre in Belgium, KCE refers the numbers as implicit, in other word no official.
New Zeeland	13416	KCE (2008)	The threshold value is from a report by the Belgian KCE which is a federal research centre in Belgium, KCE refers the numbers as implicit, in other word no official.
Norway	57129	Cost-Benefit analysis, (2012)	The threshold value is from a report by the Norwegian Ministry of Finance. The report states that Norwegian health sector usually uses a value of NOK 500 000. However the same report also suggests the use of VSL for all sectors. Again the values are not official but the threshold stated seems to be used in economic evaluation in Norway
Sweden	68389	Influensan A(H1N1), (2009)	The threshold value is from a CBA regarding the swine flu in 2009. The authors refer to unofficial interviews with TLV. The CBA was conducted by Swedish authorities and they refer to TLV, so even if the numbers are not official it seems that the threshold is actually used by policymakers
United States	100000	Shiroiwa et al (2010)	The threshold for United Sates is in a major interval ranging between 50 000-100 000, the numbers are mentioned in the literature and seems to be accepted even though they are not official. I have chosen 100 000 as it is the upper bound, however, other argues for the use of 50 000 (see Weinstein 2008)