
# Examining the issue of Value of Statistical Life

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# Abstract

This dissertation was written as a part of the MSc in Sustainable Development of the International Hellenic University. The paper includes information about different forms of the VSL models, ways of estimation, problems arising from the procedure. There is also a chapter concerning Greece and the implementations of the model to various activities.



Key words: Value of Statistical Life, risk reduction, willingness to pay, public preferences, cost-benefit analysis

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# Introduction

In a daily basis, individuals tend to take actions that depict in a way how they value health and the mortality risks they take. Many of these decisions are market-related and it is logical to assume that since a person decides to do/purchase something which can expose him/her to danger, this has some additional, attractive characteristics that make the individuals to defy the potential threats.

We use the term **Value of Statistical Life** (VSL) when we study the tradeoffs that occur between monetary wealth and fatal safety risks. This measure can be applied in many sectors such as environment, transportation, medicine in order to determine public policies on those. In other words it measures the willingness of people to sacrifice wealth in order to achieve lower death rates in various aspects of their daily life, as the sectors mentioned above.

The United States Environmental Protection Agency probably provides one of the most well aimed definitions of VSL along with an example to make it even clearer[1]: *In the scientific literature, these estimates of willingness to pay for small reductions in mortality risks are often referred to as the "value of a statistical life." This is because these values are typically reported in units that match the aggregate dollar amount that a large group of people would be willing to pay for a reduction in their individual risks of dying in a year, such that we would expect one fewer death among the group during that year on average. This is best explained by way of an example. Suppose each person in a sample of 100,000 people were asked how much he or she would be willing to pay for a reduction in their individual risk of dying of 1 in 100,000, or 0.001%, over the next year. Since this reduction in risk would mean that we would expect one fewer death among the sample of 100,000 people over the next year on average, this is sometimes described as "one statistical life saved." Now suppose that the average response to this hypothetical question was $100. Then the total dollar amount that the group would be willing to pay to save one statistical life in a year would be $100 per person × 100,000 people, or $10 million. This is what is meant by the "value of a statistical life." Importantly, this is not an estimate of how much money any single individual or group would be willing to pay to prevent the certain death of any particular person.*

Although we cannot set a realistic maximum limit at the estimation of a human life because everyone would be willing to give up his entire wealth to avoid the certain loss of his life, VSL helps us to compute the risks someone is willing to take, which could not be taken in exchange of time, money etc. So, every time a person chooses safety over a part of his wealth or vice versa, automatically creates, even if not aware of this, a valuation which can contribute to the general estimation of VSL for a particular aspect. Economists often estimate the VSL by looking at the risks that people are voluntarily willing to take and how much they must be paid for taking

[1] http://yosemite.epa.gov/EE%5Cepa%5Ceed.nsf/webpages/MortalityRiskValuation.html#means

them. These types of studies, which look at a person's actual choices, are known as "revealed preference" studies. A common source of such choices is the labor market, where jobs with greater risk of death are seen to correlate with higher wages.

## VSL related to traffic safety issues

The design and construction of highways is a sector that VSL is widely used for a long time. When a construction of a new highway is ongoing the public sector which is on charge for its integration has to proceed having in mind the two questions bellow:[2]

i) Within a given budget, which is the best way to allocate resources so as to reduce traffic fatalities?

ii) Is the budget sufficient to lower fatalities to the point where the typical driver would not be willing to pay more for traffic safety?

Regarding the first question let's assume that there are 2 different parts in a highway where tasks towards the improvement of safety conditions can be applied. In the first the required cost of the work that has to be done to save a life is 500 thousand $ and in the second 200 thousand $. Obviously it makes more sense to allot a portion of your budget for improvement projects to the second part of the road. By doing that, you can save a life with a cost of 60% lower in comparison with the first part. So, supposedly you are given a limited budget, the best way to allocate this is to calculate the cost it takes to prevent a fatality in various parts and then choose the less expensive.

In literature the range of VSL is between 1 and 8 million $. However, in many cases during the construction or improvement of the highways, the bottom limit is used. It can be assumed that if the VSL used is lower than the actual VSL, the safety of the highway is beyond the required level and many fatal accidents can occur because of that.

## VSL related to environmental regulations

Another sector that VSL is used to make estimations regarding the appropriate cost of various actions is the protection of the environment. In this occasion, we take account of a particular environmental problem and we are trying to estimate the VSL regarding to this. It works the same way as above, we attempt to calculate how much a person is willing to spend in order to prevent a fatality caused by an environmental issue. However there is a prominent difference between environmental regulations

[2] Measuring the Value of a Statistical Life: Problems and Prospects, Orley Ashenfelter
NBER Working Paper No. 11916, January 2006, page 7

and road safety concerning VSL. A death occurred in a car accident is much more direct and observable than a death which is caused by the environmental pollution. That is why people maybe will tend to value higher projects that enhance safety in highways, in comparison with regulations which aim to protect the environment. It is hard for anyone to consider a death that is caused by the worsening of someone's health due to environmental issues.

## VSL related to medical research and technology

As the previous categories, VSL is used in a similar way regarding medicine. In this aspect we are also using a term called *value of life year* (VLY). [3]If we take into account a 40 years old man and assume that life expectancy is 80 years, then we consider that a saved life is 40 years. So, if VSL is 2 million $ then the VLY is 2 million / 40 = 50 thousand $. Judging by this, any medical discovery or innovation that costs 50000 or less is considered to have positive value for money.

However, calculating VSL in medicine has some special characteristics because the person whose life is saved may not have a decent quality of life. In order to estimate this we use the term *quality adjusted life years* (QALY). Obviously, assessing quality of life can generate many arguments as it is a totally subjective issue. It depends by many aspects and mostly by the personality of any person separately. This metric was mainly invented in order priority to be given to patients that the saving of their life would probably result in better life years in contrast with other patients although as we mentioned above this kind of estimation has not absolute terms.

## VSL in tobacco industry

Smoking according to the writer's opinion is a field that needs investigation as it is difficult to understand why people are still choosing to smoke besides the fact that there are campaigns worldwide in daily basis which underline the literally 100% negative consequences of this habit. It is hard to find another daily routine of millions of people which is legal and nevertheless has only problems to "offer" to its consumers. The less serious problems include bad breath and annoying cough and the worst of them consist of infections of the lungs and even cancer. Not to mention that is a quite costly habit especially for the most fanatic smokers.

However the cigarette industry is a sector with billions of turnover annually. This sector first begun to "look" at the tool of VSL when in mid 80s was being accused of the cost that smoking causes on the national economy. The economic argument for increasing excise taxes on smokes was that these taxes compensated the State for a

[3] Measuring the Value of a Statistical Life: Problems and Prospects Orley Ashenfelter
NBER Working Paper No. 11916 January 2006, page 10

whole range of externalities that smoking imposed. Just to name a few of these costs we can refer to the costs of hospital and medical care for smokers and non-smokers alike, disability pensions for smoking-related diseases, welfare payments made to surviving spouses, the cost of street, home and office cleaning, the burden of home and forest fires, etc. By only naming them someone can take into account the size of the problem.

Of course the tobacco sector had to fight-back and defend its threatened position in the world market. So, in order to refute the arguments of the opposing side the industry had to recede on calculations made by a network of employed academics, who were paid to write articles in their local newspapers expressing the opinion that smokers already 'paid their way'. Of course these kinds of tactics are at least ambiguous and if their legitimacy is questionable the sure thing is that in ethical terms it is just wrong. So, instead of that they used as their main argument an assumption of Kip Viscusi (American economist born in 1949 whose primary fields of research are the economics of risk and uncertainty, risk and environmental regulation and is responsible for many literature over the VSL and tradeoffs between mortality risks and monetary values) which is known as "death benefits". According to this statement since it is widely accepted and proven the fact that smokers die earlier than non-smokers, the nation was being saved hospital, pension and nursing-home costs, and that these offset many of external costs described before. Of course this argument raised dissatisfaction and it's rather controversial as according to its general sense, the death of some people is considered a benefit for the society. It may have an apparent logic which is difficult to be confronted but again it is at least annoying. However this is the source of VSL, the attempt of estimating and putting a monetary price in human life.

## Problems with the estimation of VSL[4]

### Endogenous risks

A very important part regarding the study of a VSL is the conceptual experiment that the observer should undertake. There should be an exogenous event that affects wealth and fatality risk. The analogy between these two gives an estimation of the VSL.

The problem is that this tradeoff is difficult to be measured in practice because almost always there will be other factors that influence the whole experiment. Let's assume that higher speeds while driving could lead to higher possibilities of fatal accidents. It is a simplification that anyone can understand. So, under these circumstances we can relate higher speeds to more fatalities. However here comes a third factor, the road condition. If drivers drive in a new highway with high safety

[4] Measuring the Value of a Statistical Life: Problems and Prospects Orley Ashenfelter
NBER Working Paper No. 11916 January 2006, page 12

standards and perfect condition of the road surface then it is logical to assume that they increase their speed as they fear less of something to happen. Considering that we have two scenarios: i) the increase of speed causes more deaths ii) higher safety standards equal lower fatality risks which cause higher speeds. So, it is pretty hard to determine whether the relationship between speed and fatalities is positive or negative.

Another example of the exogenous factors that influence the metrics has to do about the wages in jobs that have higher fatality risks or are less healthy in comparison with other "regular" jobs. In this occasion we can interpret the results firstly as people want to be paid more for riskier jobs and secondly we have to take into account exogenous factors such as skills, experience, working conditions, atmosphere in the working place etc which also affect one's payment.

**Differences between people's choices**

Anyone can realize that VSL measurements can develop great divergence between different people. That can depend of numerous factors, personality, life style, income and many more. Regarding a VSL estimation we should know whose opinion is being measured and of course whose preference should be measured in order to get credible information to build a model.

Obviously when we are trying to form a VSL measurement we want our actions to be based on the preferences of the average type of person. That who does not seeks risk and does not hate risk in absolute terms. In other words we focus on measuring the preferences of an average person. Although there are some examples of successful VSL estimations that are based on people who tend to seek danger.

In conclusion we can suggest that for issues about public policy the best thing regarding VSL is to be estimated from a sample which represents the center of the distribution. In this occasion the problems which can be caused are the fact that maybe the data does not represent the average person or the people who gave their opinion are not well informed.

**Lack of appropriate information**

Another issue concerns the ability of VSL model creators to fully understand safety risks which are crucial the whole procedure. Especially in medicine and environment there are issues that even the experts face difficulties to evaluate. If the data used for a VSL estimation is not punctual then the information that the model gives back won't be punctual either so the actions taken based on that will not lead to the expected results. In another chapter of the paper there would be a presentation of one of the biggest problems that can occur through false information or through information that is not properly communicated. This includes the presentation of some facts in an optimistic and in a pessimistic way.

**Agency problems**

When it comes for a decision to be taken regarding public policies it is usual not to conduct a research which will reveal the VSL because of the procedure's cost but instead each sector relies on their experience to take the appropriate decisions.

The problem arises when the people who pay for a risk reduction are not those who take advantage of it or when a public policy is considered to be more important than the actual importance that the VSL shows. This happens often in environment relating issues where environmental groups pressure towards the fruition of their demanding.

**Valuation raising arguments and protests[5]**

Following a reduction in the VSL estimation of EPA, there have been some protesters claiming that the value of someone's life is cheaper and that governments valuate their citizens every day with less. The most confusing part of VSL is actual its name which leads many to think that is a tool with the "mission" to estimate the worth of a human life which is pretty bad. The headlines for this decrease of EPA were criticizing the federal organization that according to it the value of people's lives is not worth so much anymore.

However as we have mentioned the numbers that indicate VSL are not taken randomly but are based in surveys and in fact they present people's choices in those matters. The more accurate is the survey and the more suitable is the way for estimating VSL the more representative would be the results that would come out.

There is an example[6] provided which sorts the things out: "*Study A might have considered a one-in-a-million reduction in the risk of death (sometimes called a "micromort") and come up with an average willingness to pay of $5. Study B might have looked at a three-in-a-million risk reduction (i.e. three micromorts) and found an average willingness to pay of $21. If we convert Study B's result to the corresponding value for just one micromort, it works out to a willingness to pay of $7 per micromort. We could then say that the average across the two studies - of willingness to pay $5 in one study and $7 in the other, for the same single micromort - would be $6. If we then wanted to use this set of studies to produce a best guess about what people might be willing to pay for a two-micromort risk reduction, which wasn't specifically covered by either study, we should use twice this value, or $12.*

*Unfortunately, instead of scaling all estimates of willingness to pay for risk reductions to the corresponding willingness to pay for a single micromort (that is, a risk change of 0.000001), as was done in the example, somebody decided to use an equally arbitrary benchmark risk change of 1.00 (which means going from a death probability of one to a death probability of zero). The average willingness to pay, scaled up to this huge risk reduction, is called "the value of a statistical life." This is the number which the U.S. EPA currently reckons to be about $6.9 million. In*

[5] http://economistsview.typepad.com/economistsview/2008/07/the-value-of-a.html

[6] http://economistsview.typepad.com/economistsview/2008/07/the-value-of-a.html

*practice, however, this huge average willingness to pay is promptly scaled right back down again to be matched to the many types of small risk reductions, for each individual, that can typically be achieved by environmental regulations. The EPA number would correspond to $6.90 for one micromort."*

## VSL varied with health status, income and age differences[7]

An issue that has raised discussion and arguments regarding VSL is whether the benefit of reducing risks is more valuable to young people compared to the older ones. In fact there are examples when states or unions have adopted policies that differ from one age group to another.

i) Canada in 2000 presented a VSL which was 25% lower for over 65 year-olds in comparison with under 65 years-olds.
ii) In 2001 European commission proposed to its member to apply a model declining with age
iii) In 2002 the United States Environmental Protection Agency (which until this time was taking actions connecting monetary wealth and fatality risks regardless of the age differences) presented a plan about Clear Skies initiative that included a "discount" for the older ages. In this occasion the plan was abandoned due to the public protest.

So, is it true that the willingness to pay for "acquiring" less risk is reduced as the individuals grow? Most models tend to agree with the general thought on this matter: older people are not willing to pay as much as the youngest ones in order to have a reduced fatality risk. But why is that? That is because when an older man reduces fatality risks the life expectancy of him/her is not as long as a younger man. It makes more sense if a thirty year-old is willing to increase safety and to sacrifice for that much more in comparison with a seventy year-old because practically he buys more time than him. Theoretically a person is willing to pay the highest price for its reduced risks by the time of his birth. And this figure declines by the time.

A rather controversial approach to calculate WTP for risk-reduction efforts which influence different age groups is to perform surveys that investigate the public's preferences on conjectural regulation. In 1994 Cropper, Aydede, and Portney conducted a research. According to this, for the average person the saving of the life of a 20 year-old is equal to the saving of life of seven 60 year old. This gap is far more narrower (even non-existed) if we compare 20 to 40 year-olds. But, is there a factor in this kind of surveys that we should definitely consider? The answer is yes. There is a huge difference between interviewing people regarding their opinion on

[7] Age Differences in the Value of Statistical Life: Revealed Preference Evidence
Joseph E. Aldy and W. Kip Viscusi

public decision making in these situations and asking directly about their WTP for some regulations to be applied which are going to increase their own safety.

As far as income is concerned, again there is a lot of discussion. If all the regulations were criticized and taken into account by the public only on economic criteria then the VSL would be probably based on the average income of the individuals who would benefit from the changes. But this does not happen. Anyway, it is often more preferable the VSL to be based on cost-effectiveness instead of cost efficiency. VSL can also be adjusted in income terms and also can be based on the distribution of costs and benefits throughout the society.

**Value of a Statistical Life-Year (VSLY)**

When VSL is estimated it is convenient to assume that every year of life has the same value. These calculations can be used for example in order to find the VSLY base on the workers and how much they evaluate the years of their remaining life. However there are many factors that can change someone's evaluation about his life, including health status, making family, having a lot of wealth etc.

In[8] several environmental programs, cost-benefit analyses have been contacted where the reduction in cases of deaths in a younger than the expected age has been valued by the people who pay for this. There has been controversy whether the willingness to pay for mortality risk reduction varies and depends on the age and health status of the people whose life is actually saved. This question is meaningful to be answered in order for public policies to be determined and applied. According to several researches people of older age and people whose health has some problems are benefited more of any environmental program. There are 2 reasons that this is happening. Firstly, it has been estimated that people aged over 65 years-old compose the ¾ of the deaths in USA and Canada, so as long as the majority of the people who die are above this age it makes sense that a larger quantum of lives will be saved among them. Secondly, there are some epidemiological studies that suggest that older people face bigger changes in mortality rates in comparison with young ones and also that persons with heart or lung problems would be affected more from melioration in the quality of air that comes out from an environmental program.

There has been a common sense that aged people (because of the fact that they have fewer expected years of life) are not willing to pay as much for a possible reduction in risk of mortality in comparison with young people. There are some experts whose opinion is that VSL should not stand alone and instead it must be converted into VSLY and after that, lives saved should be valued again by multiplying the number of remaining expected life years with the VSLY. In order for this to be done it is considered that every life year has the same value regardless of the age.

[8] Does the value of a statistical life vary with age and health status? Evidence from the US and Canada$
Anna Alberini, Maureen Cropper, Alan Krupnick, and Nathalie B. Simon

Another perception is about people who face problems regarding their health. According to this perception those individuals are willing to pay less for a reduction in fatal risks because as soon as they are ill, the advantage that would gain from this reduction would not be equal to that of the other people because theoretically they are going to die sooner. We mentioned before the QALY. In QALY's literature, life years of a person in good shape worth more saving than those of a person who has a serious chronic illness. Although this is the general public thought on the subject, there are not any published surveys that certify the above. Following two surveys' results will be presented which were conducted to investigate the relationship between willingness to pay for avoiding mortality risks with age and health status.[9]

There could be two trends opposing to each other: first, an individual's willingness to pay should be higher as soon as he/she has less chances of staying alive the next years. That would result from either old age or bad health condition or the combination of these two. On the other hand, someone could mention that facing this situation, individuals would not be willing to pay much for risk reduction because of the fact that they have fewer years to live. So maybe they form a thought that it is not worth paying or in better words they won't accept the given value for money.

So, regarding people with health problems, it comes out that in general are willing to pay as much as healthy people for risk reduction matters and sometimes even more than them. As the survey had taken samples from USA and Canada, in US there is a statistically important greater willingness to pay in behalf of people with chronic diseases while in Canada wasn't recorded any significant difference. Concluding seems people with bad health status remain unaffected of their condition concerning their willingness to pay and do not become indifferent in comparison with the others. It makes sense from the point of view that people who are facing a particular problem become more sensitive about the matter.

As far as age is concerned there are indications that are in favor of the assumption that the elderly are not willing to pay the same amount as the other. However, these indications are not absolute clear and they occur only when respondents of over 70 years-old are concerned. According to the survey, participants over 70 have a 25% reduction in their WTP.

**Future earning standard: a method which failed**

This approach although it was tried in the previous years, eventually failed and the reason for that were its obvious disadvantages and the great inequality it presented. With simple words, future earnings approached valued people in terms of their future monetary earning and the ones with rather high earnings were valued much more in comparison with those with lowest expected wealth. So, having in mind that this is an estimation of VSL, if we take this method as granted it comes out that people with higher incomes are worth saving more than the other. The main argument of this at

[9] Does the value of a statistical life vary with age and health status? Evidence from the US and Canada$ Anna Alberini, Maureen Cropper, Alan Krupnick, and Nathalie B. Simon, page 780

least ambiguous method is the fact that people with low earning do not consume products and services thus do no contribute to a society based solely on monetary terms and values.

**Age-fatality Risk interactions**

The first research based on the VSL connected with age was about fatality risk and its link with age. Assuming that VSL declines with age the coefficient of the age to risk would be negative. Although if the VSL and age interaction is not that simple then it is required a more flexible model that explains their relationship.

First of all in 1975 Thaler and Rosen calculated interactions with fatality rates age of individuals of different jobs. Their findings were the same as described above. But they weren't the only. Meng in 1989, Portney in 1981 also found a negative relationship.

However, investigating the link between age and VSL we come across 3 principal caveats. Firstly, all the studies define that all the workers regardless of their age are appointed with the same fatality risk variable. Let's assume that the tasks of older workers are generally safer. If older workers have the same level of willingness to accept risks as their younger colleagues then the wage premiums for the old ones would be definitely lower. *Because the aggregate risk variable overstates their age-specific risk, the econometric evidence will indicate a declining VSL with age.* So, we may encounter an issue where lower VSL for older workers would derive from errors which biased the results by age.

Secondly, interactions between age and fatality risks impose a linear relationship between age and VSL but the actual relationship may not be absolute linear and contain ups and downs.

Lastly, worker preferences are not captured alone by hedonic estimates and supply and demand for risky jobs may differ regarding age groups. It would be ideal if the estimations could be flexible enough to handle those variations.

## Comparison of regulatory policies between different organizations[10]

In this chapter there is going to be a brief presentation of some organizations based in the USA who are using VSL in order to build models for their ventures.

**Environmental Protection Agency:** Established in 2/12/1970 EPA's goal is to preserve and protect both the public health and the environment through regulations which are based in laws voted by the congress. President Richard Nixon was the man who thought the creation of EPA and under his presidency it started operations. The agency has more than 12.000 employees in permanent basis, the majority of them

[10] Using Estimates of the Value of a Statistical Life in Evaluating Regulatory Effects
by Donald Kenkel

being scientists, engineers and specialists concerning environmental protection issues. The order establishing the EPA was ratified by committee hearings in the House and Senate. The agency is led by its administrator, who is appointed by the president and approved by Congress.

**US Department of Agriculture:** An agency with more than a century of history, USDA was formed in 15/5/1862. On May 15, 1862, Abraham Lincoln established the independent Department of Agriculture to be headed by a commissioner without Cabinet status, and the agriculturalist Issac Newton was appointed to be the first commissioner. Its assignment is to form and implement the state policy on agriculture, farming and food. More specifically USDA is concerned about food safety issues, protecting natural resources, promoting farmers rights and covering their needs, meliorating trade conditions, fostering rural communities and ending hunger worldwide

**US Food and Drug Administration:** Another organization which is active for more than 100 years as it was established in 1906. FDA's tasks include protection of public health via regulations regarding food safety, tobacco products, prescription of pharmaceutical drugs, vaccinations, medical devices, cosmetics and many others. The organization runs more than 200 field offices and in 2008 begun to post employees abroad in countries like China, India, UK and Belgium. FDA falls under the administration of the US Department of Health and Human Services. The FDA also enforces other laws, notably Section 361 of the Public health service act and associated regulations, many of which are not directly related to food or drugs. These include regulating lasers, cellular phones, condoms and control of disease on products ranging from certain household pets to sperm donation for assisted reproduction.

EPA usually is using a VSL of 4,8 million dollars with some interferences taking into account the inflation. However there are examples of regulations that used different estimations. A research about the benefits of consuming filtered water and the link between this and the reduced danger of being affected by a particular illness had been calculated with a VSL of $6 million. There are also other examples of programs implemented by the EPA that are based on other estimations of VSL.

Moving on, the USDA's approach for valuating VSL can be perceived as a hybrid one due to the fact that it is based on human capital/WTP formula. With this estimation the VSL ranges from 15000$ to $2 million (dollars in year 1996) which is related to the age group that is affected from the regulations.

On the other hand, FDA's approach is evaluating the benefits of the regulation in terms of the value of a life year. By doing this, reduces the gap between two different concepts, which are the cost-benefit and cost effectiveness analysis. The latter does not value health in monetary terms but puts into comparison the incremental cost of the intervention with the incremental benefit of the health. In that part *quality adjusted life years* again plays a role. A year of life being totally healthy is not considered to

have the same value with a year of life of someone who suffers from an illness. A ratio between the 2 years is given. So, when we put a monetary value on QALY we can transform cost effectiveness analysis to cost-benefit.

In general there is a common way of thought regarding the valuation of life-saving adjustments. However the review of the 3 organization's policies indicates that there are notable differences while each one of them calculates the VSL that is going to use for its activities. In order for this assumption to be supported, a quite extreme example will be given. According to this, the 3 agencies want to apply a regulation (each one imposes policies related to their field) that reduces mortality risks for 50 years-old.

i) EPA based on its estimations uses a VSL model of $5 million
ii) USDA uses a human capital approach and ends up in a VSL of $750.000
iii) FDA's calculations produced a VSL of $1.2 million

Especially EPA's estimation is so large that the two other VSLs are outside even from the confidence interval of the EPA.

So, we have 3 organizations with different authorities and each one of them has crafted a different measurement of VSL. As a result, an imbalanced set of regulation policies has emerged.

These agencies follow the basic principles of economics. This means that in order to increase their "production" (in our example increase of production is corresponding to additional lives saved) their marginal cost for each additional life would be increasing. So, like any other company, these organizations choose to apply regulations until their marginal benefits from life saving equals their marginal costs, even if it sounds a bit cynical. And of course they decide this based on their own estimation of VSL. The difference between the estimations means that it is possible by just reallocating the funds to create new regulatory policies which would be considered as improvement by all the agencies. This could mean either the same amount of lives is saved with less cost or at the initial cost more live are saved. In our example, EPA's estimation which is way larger gives the opportunity for the above adjustments to happen.

It is widely known that regulations linked with life-saving issues are rarely applied using only cost-benefit analyses. Very often there are pressures coming for example from political groups or activist organizations. However this occurs almost everywhere and this sector couldn't be an exception. The most crucial factor for the VSL applying agencies to become more efficient and sustainable is all of them to adopt a similar way of measuring the VSL in order to minimize the gap presented above.

Further up, there is an argument whether it is good or bad to use different measures of VSL for assessing different mortality reductions. We can assume the existence of two heterogeneities: the first heterogeneity concerns the WTP of a particular

individual in the face of different risks and the other is about the WTP of different persons related to mortality reductions.

Individuals tend to attribute different values on the reduction of the risk of death depending on the cause of this particular death. And it comes out that people's willingness to pay for avoiding a death which comes with a long period of being ill is bigger than the WTP for another cause. There are two main reasons for this phenomenon. First there is a cost for treatment when someone is ill and second and maybe most important, there is a psychological pressure for the individuals knowing that they are going to eventually die from their illness. However there are not many surveys on this issue. In 1985, Jones-Lee, Hammerton, and Philips conducted a research which ended up that individuals are willing to pay more in order to impede one hundred deaths of cancer in comparison with the same amount of deaths by car accidents and heart diseases. In fact, according to the findings of the survey people consider that preventing 100 deaths of heart failures has 2 times the worth of preventing 100 deaths in car accidents and preventing 100 deaths of cancer has 3 times the value of the deaths by car accidents. Of course the difference is obvious as a death from an accident is something totally unexpected and most of the times instant especially in contrast with the cancer which is not only painful in many cases but also long-lasting.

As mentioned above, people's willingness to pay for a particular risk reduction may have an obvious variation based on many aspects. Just to mention a few, the differences can be due to income levels, position in the society, their age etc. Also it is probably expected the fact that there is an increasing willingness to pay for a risk reduction if this has to do with children. It is obvious and absolutely justified the reason why people tend to value more the lives of the young.

Moving on, we have limited evidence that WTP for reducing fatalities varies throughout the life of an adult. According to a research held by Shepard and Zeckhauser in early 80s the connection between VSL and the age of a person has the shape of an inverted U. The peak of a hypothetical diagram would be at the age of 40 and it would decrease by an average of 40% by the age of 65. Although there are surveys like the one conducted by Jones-Less in 1985 which also has an inverted U shape but the diminution that has been recorder was only 10% of the peak results. These estimations are compatible with the patterns that come of the hybrid human capital/WTP approach mentioned before.

Going forward, in 1998 Moore and Viscusi investigated the relationship between wage and job risks and if employees of different age groups had different requirements concerning risks at their job. The results of their survey indicated notable differences between various risk-reduction projects and these divergences were mainly due to the age of the workers as well the time that the risk decrease would occur. There is a really huge difference in the value of a life among a worker who expects to live 40 more years and a senior worker who expects to live another 5. Obviously the latter evaluates that extra year much more than the younger person. After all it is a 20% increase in his life while one extra year to 40 years is just 2,5%.

Based on the above the deduction is that the estimations of life-saving/risk reduction activities should be implemented using consistent and appropriate forms of VSL. It goes without saying the fact that various organizations should use the same methods of VSL calculation when they are going to assess a certain risk for a certain community. The profits by doing this would dual, on one hand the regulations would be more effective and on the other hand the maximum cost-benefit profit would be achieved. Each agency should consider the population that their activities affect and adjust according the particularities.

## Value of Statistical Life across countries

We have presented above various factors that influence the VSL. Different agencies, different populations, age and income issues, health status and many more are taken into consideration. However environmental regulations many times affect a broader area than the expected. And that raises some question. For example consider an investment that aims to the cleaning of vehicle emissions. If this activity simultaneously affects in a negative way the global warming issue by releasing carbon dioxide, should be implemented anyway? Poor African countries should invest to fight river blindness or develop their infrastructure? What consequences would accrue from the production of goods in a country with not very strict environmental regulations? In order for someone to comprehend and answer these questions must be informed about the differences between countries in the estimation of VSL. There are cases where differences between VSL are spotted in different regions of the same country (especially the large states like) so it is easily assumed that due to cultural reasons, prosperity level, zone of climate etc. there is variation in the VSL among countries. Of course there are considerable differences of estimations even in the same country but a survey conducted by Vanaklioti and Ventouras in 2010 presented the following results (all the figures in million Euros)

New Zealand – 1.4
Austria – 2.6
Belgium – 5.6
Canada – 2.7
Denmark – 1.6
France - 1
Germany – 1.1
Netherlands – 2.4
Norway – 3.2
Singapore – 0.9
Sweden – 2.3
UK – 1.7

## Value of Statistical Life and its use in Greece

Value of statistical life is a valuable tool in the hands of states and organizations. Especially the developed countries use it in various ways in order to meliorate the life and safety of their citizens. In this chapter we are going to see the use of this tool in Greece. It is widely known that Greece faces an economic crisis for more than 10 years and that austerity policies have been applied which influence literally every aspect of the country and the daily life of its citizens. Unfortunately Greece had never the fame of a state that follows the progress and adapts to the needs of modern societies. Notwithstanding that it is one of the oldest members of the European Union Greece in many ways does not justifies this as well as the long history it has. Following there is going to be a presentation of the use of VSL in Greece in various sectors.

### Traffic safety issues[11]

According to the World Health Organization fatal accidents on the road is the cause of nearly 1,5 million deaths annually worldwide. And at the same time more than 40 million people are injured in motor accidents. Considering EU which is our main area of concern due to the fact that Greece is a part of it annually we have around 30.000 deaths. Fortunately these numbers are below world average and it is even more encouraging the fact that a reduction is being recorded year by year. Not in all countries-members but in general. What about Greece? Which is the performance of our country in this field? Unfortunately Greece is the worst country in the whole EU regarding the results of deaths occurred in car accidents. Greece's average of death per year is twice the size of European average. The good thing is that there has been a reduction in mortality rates during the last years but according to the experts this is not only due to the fact that the road were fixed and become better. Of course this plays its role but the other view of the coin indicates that due to the crisis mentioned before the exposure of the Greeks to the risks of the road is reduced as the travels through the country are also reduced. The devaluations of the citizen's economic power has influenced very much their frequency of travelling thus the fatal accidents are reduced.

It is widely accepted the fact that there is notable difference in the road safety between rural and urban areas with the former being far more dangerous. Greece couldn't be an exception. Almost 75% of accidents and 50% of deaths are taking place in the rural areas of Greece. In 2012, Theofilatos et al. analyzed the reasons that affect the hazard of the accidents in urban and rural areas. According to the finding in

[11] A contemporary estimation of Value of Avoiding Mortality in car accidents in Greece, Konstantinos Kostovasilis and Konstantinos Antoniou

urban areas the factors that influence the accidents are the young age, the crossroads and the impact in a standing barrier. On the other hand the hazard of the rural accidents depends on the climate in link with the weather conditions and to the type of the impact (the direct ones are the most deadly).

According to surveys the WTP for travelling outside urban areas is 2 times larger in comparison with the WTP for using a vehicle in urban areas. This finding can lead to the assumption that the former type of travelling is riskier than the urban travelling. However this gap drops to 1,5 times when the WTP is weighted with the traffic jam which apparently is in much higher levels for urban movements in comparison with the other.

In order for VSL to be estimated several times surveys are conducted and questionnaires are given to the people who are related to the regulations for which the VSL will be calculated. Regarding these surveys and the assumptions that could come from them Antoniou and Kostovasilis made a very interesting "experiment". This experiment shows the significance for the correspondents it receives proper information and how much over-pessimistic or over-optimistic scenarios affect them. In fact the experiment investigates the reaction of individuals in information that are real but simultaneously presented with a specific way.

The researchers build two different questionnaires. In the introduction of the first there was a picture of a highway and cars passing by. The introduction included facts such as the decrease of fatal accidents, the development of the technology, the improvement of roads and the better briefing of the drivers concerning road safety rules. All of these clues were absolutely true.

In the second one there was a picture of a destroyed car, in the middle of a street apparently taken after an accident. Following there were information which was again true as the above but in an absolutely different "mood": it was stated that car and motor accidents are the first cause worldwide for deaths in ages 15-30. It also was mentioning that every day in Greece a family with 5 members dies and calculates an estimation of the total deaths by car accidents in annual basis. It also mentions the even bigger number of injured (some of them severed) people whose injures come from fatal accidents.

The questionnaires were very similar but there were notable differences between the people given the first and the second one. In fact the population that had been given the pessimistic material presented a 75% larger WTP in contrast the correspondents of the optimistic one. These findings of course raise many questions about the probability of pressure and lobby groups to manipulate the public opinion in a specific matter by just presenting information with a particular way. This of course can happen not only in road safety issues but also in medical researches, environment issues etc.

**Value of injury and life in Greek courts**[12]

There is an economic approach for accidents occurred due to medical errors. These accidents include 3 different types of costs.

i) Primary costs: harm caused to an individual due to a medical mistake. Includes the cost of medical care after the error, the lost of earning capacity etc.
ii) Secondary costs: the cost when someone has to bear the costs that occur from the accident.
iii) Tertiary costs: this category includes administrative costs such as payment of lawyers, payment for experts in particular cases, loss of time etc.

According to the Greek legislation a medical fault that causes damage to a person is considered as a tort which obligates the individual who made the error to compensate the victim for the damage that he/she has suffered. In order the courts decide a compensation there are 4 criteria that should be matched. i) unlawful act ii) malice or negligence fault iii) occurred damage iv) proximate cause between the damage and the unlawful and faulty act

In case of personal injury covering physical or psychological harm the compensation includes the so-called *"incidental damage" (the reduction of existing fortune)* and also the *"consequential damage" (the profit that someone expects with probability in the normal course of events or the special circumstances)*. The compensation is composing of the following:

1) Medical expenses – expenses that according to the experts' opinion are necessary in order to restore patient's health. Includes hospital bills, doctors' and nurses' payments, examinations, purchase of equipment, possible sessions of physiotherapies for restoring possible damages as well as coverage of possible expenses because of travelling and treatment abroad.

2) "Incoming" damage – this kind of damage refers to the space between the time of the injury and the time the individual brought action.

3) Future losses – pretty obvious as it refers to the losses that occurred due to the fact that the person is unable to function and thus he does not takes any profit for the work he could do.

4) Future increase of expenses – possible future expenses from the victim as a result from his injury. At most times they are repeated expenses that the victims continues to experience after the time of his restitution goes. Examples of these expenses are plastic surgeries, expenses for drugs etc.

[12] Estimating the Value of Injury and Life in Greek Courts: An Economic Analysis of Liability for Medical Error – Spyros Vliamos, Aristides Hatzis – Panagiota Kapreli

Moving on, there is a presentation on the evidence that the Greek courts rely to estimate the amount of compensations. The explanation of damages would be explained in the following sections.

In case of injury we have: monetary damages to the victim for medical expenses (A1b damages), hedonic damages for pain (A2 damages) and monetary damages due to the absence of service to third parties (B1a damages)

In case of death we Greek courts render the following: monetary damages for loss of services to third parties (B1b damages), monetary damages for medical and funeral expenses (B1c damages) and hedonic damages for the family of the victim due to psychological distress (B2 damages)

A1b and B1c damages

*The court, in the case that the plaintiff asks for the compensation of medical expenses always takes into consideration the relevant receipts of hospital, doctors, exclusive nurses, physiotherapists etc. or retail receipts and invoices of pharmacists, enterprises providing nursing material, orthopedic equipment, products of individual cleanness etc. in which the provided services and the sum that was paid are certified. Furthermore, the court is always asking for medical opinions and certifications about the necessity of these expenses for the restitution of plaintiff's health (e.g. need for medication, special diet, nursing material, medical treatments etc.). In case of a third person asking for the funeral expenses, the court similarly asks for receipts and invoices of the funeral office. If these expenses are not justified by the necessary paperwork the court dismisses the claims as irrelevant.*

A1a damages

*In the case of damages causing loss of future earnings, the court examines the unfavorable consequence that the corporal or health damage had in the particular economic and professional activity of victim. The plaintiff should invoke and prove that he is unable to practice the professional activity that previously practiced which in the usual course of events he would continue practicing if the damage did not intervene and that he was thus damaged at least for the amount that he would previously gain from the same work. A complete proof it's not required; the plaintiff though should present particular real future settings on which the damage might be expected. When the damage depends on future and imponderable factors, as the victim's success in a competition, future studies etc. the relevant claim is rejected as vague or prematurely raised.*

B1a and B1b Damages

*The extent of compensation that a third person can claim because of loss of services depends on the way that the void left by the victim was covered, because of the victim's inability to offer his services. In case therefore that the victim engages paid service (e.g. house cleaning) to help him, the compensation is determined by the amount of the given wage. If no paid service is engaged or the void was covered by persons of family or with restriction of needs the compensation is calculated according to a quasi wage of a paid service.*

A2 and B2 Damages

*Hedonic damages are awarded for victim's "moral" support and not after an assessment of the affected good. The court after estimating the facts that the parties present to the court can award a "reasonable" amount as compensation if it judges that the damage caused "moral" harm to the injured or "emotional distress" to the victim's family. "Reasonable" amount, however, is one of the most awkward questions while the court should monetize damages without commercial value. In practice a great quantitative difference is usually observed on similar cases of pain and suffering. Also, there are no real efforts by the courts for establishing objective criteria for calculating hedonic damages or any solutions that would allow in a satisfactory degree uniformity on similar cases of pain and suffering. As a result the parties ask for extravagant amounts of money (for the standards awarded by the Greek courts) and the courts award a small fraction of it.*

Probably the main problem of the Greek courts is the underestimation of future earnings and hedonic damages. This happens mainly because they base their estimations to conservative methods. For example, the unpaid services of the household are not included in the calculations. It must be highlighted that the only amount which is estimated in an absolutely proper way are the restitution damages. In conclusion we see that Greek courts ought to implement modern ways of estimating the damages under the particular situations.

## Conclusion

The writer's opinion is that **Value of Statistical Life** is a powerful tool invented by humans to the service of humanity. Maybe its name is misleading and leads to assumptions that lives are treated like goods and are being attributed monetary prices but as explained before that assumption does not stand out.

Every company that bestirs in sectors related with human dynamic and especially the government related ones should definitely search, create, try and apply a VSL formula. Implementing a suitable VSL is a win-win situation for both the organization/company and the society as soon as it yields benefits for both. An appropriate VSL reflects the public's preferences and helps the company to allocate its funds to the best possible way in order not only to be effective but also to keep its customers and the general audience which addresses happy and satisfied.

I think that the biggest step towards perfection of this tool is for agencies at least in the same country to find channels of communication on order to end up in a bidirectional collusion which will allow them to form consistent models of estimation. The advantages of that would be multilateral and there would be no confusion for which approach is considering to be the best. So, the consistency between the VSL calculations used by various agencies is the biggest challenge for the experts of the sector and for the administrators of the companies.

There are many factors that influence VSL and WTP of individuals and that is why its calculation is not an easy task especially in a dynamically evolving environment. However a tool that has so many applications in such important issues of daily life (road safety, environment, medicine) could not be anything else than very important and helpful.

The sad fact for our country, Greece, is the fact that like in many other areas the state does not fully plays along with the progress. Greece besides its huge problems remains a developed country, member of the EU and it should have applied VSL in many areas of the daily life. There are some efforts towards the right direction but there is still much work to be done especially in the field of traffic safety and environmental regulations.

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