

Week 3 and 4 Notes: Economic Efficiency

ENVS 30, Fall 2025 - Anna Pede

**Note: In these notes I will focus on the math of two important concepts that were discussed in class - the Value of a Statistical Life and the Discount Rate.*

1 Value of a Statistical Life

The value of a statistical life (VSL) is used in cost-benefit analysis to calculate the benefits of an environmental policy. Imagine a regulation that will reduce air pollution, which, by consequence, reduces mortality. The VSL allows us to quantify this mortality reduction in monetary terms, which will be one of the benefits of such air pollution regulation.

The term Value of a Statistical Life makes it sound like it is the value assigned to a person's life. However, it is not the value of saving a life, but rather, the value of reducing your risk of death by a little.

The VSL is one of the *Revealed Preference Methods* used to estimate the value (benefits) of environmental policies. These methods use the “indirect” values that exist on things we already consume (pay for) to infer the value (benefits) of environmental amenities. For example, the hedonic property method infers the value of living in an area with clean air by comparing two identical houses - one in an area with polluted air and one in an area with clean air. The difference in prices between the houses should reveal how much people are willing to pay (benefit) from having clean air.

The VSL incorporates the existing difference in salaries between riskier and safer jobs. This will allow us to infer how much people are willing to reduce their salary (a kind of payment) to have a less risky job. The idea is that if you are willing to reduce your salary to reduce your likelihood of dying on the job, you would be willing to pay the same amount to reduce the likelihood of dying from pollution exposure.

1.1 Numeric Example:

Suppose you looked into the US labor market and found the following average salary and average risk associated with these two types of Jobs¹. Notice how the higher-risk job has a higher salary. In other words, people are willing to earn less to work on a job with less risk.

	Job A	Job B
Job mortality rate (Deaths per year of work)	0.0002	0.0006
Salary in the US (\$)	95,000	99,000

¹Of course, this is a huge simplification of how the VSL is calculated. But for teaching purposes, we will think about it this way. The real estimates, for example, take population demographics and labor market structure into account.

- **Calculating the VSL:**

$$VSL = \frac{\text{Change in Salary}}{\text{Change in Mortality Rate}} \quad (1)$$

$$(2)$$

Therefore, based in the US economy numbers:

$$VSL = \frac{99000 - 95000}{0.0006 - 0.0002} \quad (3)$$

$$= \frac{4000}{0.0004} \quad (4)$$

$$= 10,000,000 \quad (5)$$

Therefore, the VSL for the US is 10 million dollars. Therefore, in the US, based on labor market information (salaries), we are willing to pay 10 million dollars to reduce the risk of one fatality. Consequently, for example, if a pollution control policy avoids 100 fatalities per year in the country, the benefit from this policy would be 100×10 million.

2 Discounting

Most cost-benefit analyses have a time dimension: costs and benefits are not going to be experienced in the same period of time. Commonly, the costs of environmental policy will occur today ($T=0$) but the benefits will be felt in the future ($T>0$). Let's assume that a given policy has the following costs and benefits:

	Policy Benefits	Policy Costs
When will occur	T=30	T=0
Amount (\$)	1,000,000	300,000

The policy will bring 1,000,000 dollars in benefits in 30 years. However, getting 1,000,000 today ($T=0$) is not the same as getting 1,000,000 in 30 years ($T=30$). Suppose you have 1,000,000 today. You could buy a U.S. Treasury bond, which pays you a “guaranteed” 2% return per year . You could take the 1,000,000 and invest it. That would pay you in the future (FV):

$$FV = 1000000(1 + 0.02)^{30} \quad (6)$$

$$= 1,811,361 \quad (7)$$

Therefore, having 1,000,000 today is not the same as having 1,000,000 in 30 years. Rather, it is equivalent to having 1,811,361 in 30 years due to the guaranteed option to invest. Hence, this guaranteed return per year of 2% is the discount rate in this example. The discount rate varies depending on market conditions and the assumptions economists use when calculating it (there are thousands of investments in the economy, not just the U.S. Treasury bond). The focus here is

not on the numeric value of the discount rate or on what the correct number is to consider. The important thing to remember is that the discount rate translates future value (FV) into present value (PV) because of the alternative of investing.

- **Summary: Relating Present Value (PV) and Future Value (FV):**

$$PV = \frac{FV}{(1 + d)^T} \tag{8}$$

(9)

Rearranging we get:

$$FV = PV(1 + d)^T \tag{10}$$

Which is the equation we used to find the future value of investing 1,000,000 for 30 years. Where in the example:

Present Value: $PV = 1,000,000$

Discount Rate: $d = 0.02$ (2%)

Time periods: $T = 30$ (years)

Future Value: $FV = 1,811,361$

2.1 Numeric Example:

Lets consider again the following environmental policy costs and benefits.

	Policy Benefits	Policy Costs
When will occur	T=30	T=0
Amount (\$)	1,000,000	300,000

Considering a 2% discount rate - let's assume a group of economists figured this is the most adequate number - we can calculate the **policy net benefits** as the following:

Policy costs - occur in T=0: 300,000

Policy benefits - occur in T=30: 1,000,000

Calculating the **Present Value of the policy benefits:**

$$PV = \frac{FV}{(1 + d)^T} \quad (11)$$

$$= \frac{1,000,000}{(1 + 0.02)^{30}} \quad (12)$$

$$= \frac{1,000,000}{1.811} \quad (13)$$

$$= 552,181 \quad (14)$$

Now we have:

Policy costs - occur in T=0: 300,000

Policy benefits - measured in T=0: 552,181

Recall that:

Total Net Benefits = Total Benefits - Total Costs

$$\text{Total Net Benefits} = 552,181 - 300,000 \quad (15)$$

$$= 252,181 \quad (16)$$

Hence, the policy net benefit when considering the temporal component is 252,181 dollars. Using discounting accounts for the fact that getting 1,000,000 in 30 years is not the same as getting 1,000,000 today. Actually, it is the same as getting 552,181 dollars today. Note that if you invest 552,181 at a 2% return rate for 30 years, you will get:

$$FV = 552,181(1 + 0.02)^{30} \quad (17)$$

$$= 1,000,000 \quad (18)$$