




Revisiting the value of a statistical life: an international approach during COVID-19

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Abstract

Although the employment of the value of a statistical life (VSL) is a cornerstone of USA governmental risk analysis, many argue that the VSL is flawed when evaluating proposed regulations. The VSL is only an estimate of the willingness to accept wage versus risk, which may be inaccurate for policies that mitigate large risks in pandemics, such as COVID-19. The VSL is revisited using a different approach and utilized in measuring the total value of loss from deaths caused by COVID-19 for 48 selected countries. The modified theory of the demand for health by Gary Becker is utilized to measure the VSL resulting from consumer optimization of utility, subject to constraints and investments in health made to change their survivorship at different ages. Estimates show that the VSL for an average American is around \$7.2 million compared to the world VSL of about \$1.3 million. Switzerland has the highest VSL of approximately \$9.4 million. The total value of loss from deaths caused by COVID-19 is around 6.1% of the USA GDP, compared to the global loss of 1.2% of the world's GDP, while Belgium has the highest value of loss with 9.7% of its GDP. The best possible data and procedures are necessary to make robust and reliable public health decisions while responding to the COVID-19 pandemic. The VSL measure introduced here can be applied to a specific individual, group, or population. It is comprehensive, straightforward, generalizable, and provides a consistent measure with the most popular methods. More importantly, it provides an added value to the existing methods that enable us to break down the VSL into two main components, one that accounts for working time. The other accounts for leisure time and different diminishing consumption and discount rates.

Keywords The value of a statistical life · COVID-19 · Health · Economic policy

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Introduction

The role of economics in understanding the potential and possible impacts of COVID-19 is vital at this point, especially in the value of life and death.

The COVID-19 pandemic will have long-term implications for most, if not all, populations, and its impact on economic sectors will surely be the media's focus over the next years.

Governments worldwide face a considerable challenge of when and how their respective economies can be safely reopened. Countries took mitigative measures to lower the risk of ICU bed shortages, such as closing public facilities and regulating the number of people allowed in gatherings or workplaces. While these measures allotted a lower short-term loss of life, they also stunted much of the economic growth seen over the past decade. The longer these measures last, the deeper the trenches become that economies will need to dig themselves out of over the next decade.

The COVID-19 pandemic has brought a flood of research papers where the value of a statistical life (VSL) is used to estimate the benefits of government actions from lockdowns, social distancing, and distance learning, amongst many other COVID-19 mitigations.

Best defined by Viscusi, the VSL is the monetary tradeoff amount—or in simpler terms, the wage—that a worker accepts when there is an increase of workplace fatality risks (Viscusi 2018a, b). The VSL is the calculation that the USA government uses to assess their health, safety, and environmental regulations. It is the most popular calculation that researchers depend on when evaluating workplace risks; however, the statistic comes with its own controversies. Many argue that the VSL is insufficient for being the basis in evaluating regulations since it is only an estimate of the willingness to accept wage versus risk, which may be inaccurate for policies that mitigate large risks in pandemics such as COVID-19 (Adler 2020; Adler 2019; Adler et al., 2021; Alvarez et al. 2020; Blackorby et al. 2005). Others posit that the measure is affected by biases and is not accurate when foregoing the difference in occupation, industry, age, and cohort group (Aldy and Viscusi 2008; Viscusi 2004; Viscusi 2018a, b). Although these concerns were addressed recently by Viscusi (2020) and more specifically when attempting to personalize the VSL levels to the circumstances of the individuals under study, Viscusi argues that the adoption of an average VSL that does not account for differences in age and income using the adjustments proposed in his paper represents a departure from strict efficiency guidelines in that it incorporates equity concerns (Viscusi 2020).

Even though the literature on the VSL is rich, and differences in occupation, industry, age, and cohort group have been addressed by scholars, there are several fundamental concerns with respect to these valuations and how accurate, individual-specific, and internationally applicable and comparable these valuations are.

In this paper, our objective is to provide a different method to estimate the VSL of total deaths caused by COVID-19 that account for differences in age and income, incorporate the value of lost utility, the value of leisure time,



individual-specific. It can be applied on an international level that enables policymakers to balance the benefits of the health risk reductions and the costs of economic dislocations.

The value of a statistical life (VSL)

The dominant policy approach to monetizing mortality risk reductions is the VSL. The VSL represents the monetary amount people need to be paid to accept additional risk in their lives. However, the ease and regularity of the VSL usage come with the disadvantages of biases in the publication process, lack of recognition of the differences between occupation and industry as well as the ambiguity of the effect age and cohort group have on the value (Aldy and Viscusi 2008; Kip Viscusi 2004; Viscusi 2018a, b). This paper will present the theoretical research behind the VSL then the numerical analysis before introducing a new method of calculating the VSL based on Gary Becker's method found in his paper "Health as Human Capital: Synthesis and Extensions" (Becker 2007).

In a 2018 paper, Viscusi states that when publishing research, it is possible for researchers to have publication selection bias and best-estimate selection bias when choosing VSL values. These biases cover the possibility that researchers may use estimates that are most likely to be published or choose the value from their preferred model. Fortunately, Viscusi states that the biases are only moderate when studying data from the Bureau of Labor Statistics Census of Fatal Occupational Injuries (CFOI). Viscusi offers solutions such as undertaking meta-regression studies, focusing on characteristics associated with studies with the least biases, and having government agencies work with researchers to identify reliable estimates (Aldy and Viscusi 2008; Viscusi 2015).

Viscusi details in 2004 how the current ways of measuring VSL do not differentiate between occupation and industry. Viscusi argues that this disadvantage creates four deficiencies: (1) erroneous variables; (2) failure of significant full-sample estimates; (3) failure in the analysis of nonfatal job risks; and (4) grouping all workers in the same industry or occupation under the same value of job risk. These deficiencies dilute and deviate the actual job risk, dampening the credibility of the VSL. Viscusi calls for a more robust database of evidence, concluding that VSLs can differ significantly once measurements are disaggregated (Viscusi 2004).

Lastly, a 2008 study by Aldy and Viscusi argues that the effect of age and cohort is not analyzed accurately during wage-risk tradeoffs. The ambiguity behind these factors maybe for a good reason. The authors state that the relationship age and cohort have with VSL is incredibly complex; however, they end up finding the relationship to be an inverted U-shape, signaling that the VSL rises and then falls with age. Aldy and Viscusi state that age and VSL are linked through factors such as "life cycle consumption pattern" while arguing that VSLs vary per age cohort (Aldy and Viscusi 2008; Viscusi 2019).

Many studies have utilized the VSL to make significant and costly efforts to reduce mortality by comparing the anticipated economic costs to the accumulation of saved VSLs. The VSL reported in the reviewed studies was between



\$1 million to \$10.3 million for an average American, and these values are not adjusted for publication selection effects (Bethune and Korinek 2020; Goldstein and Lee 2020; Hammitt 2019, 2020; Pindyck 2020; Robinson et al. 2021). In 2003, Viscusi and Aldy estimated the USA's VSL to be \$10 million, based on estimates of the extra wages that workers received to accept increased fatality risk at work (Viscusi and Aldy, 2003). The USA government uses an average VSL for the population (Hammitt 2019; Johansson, 2019; Viscusi 2020). When the VSL was estimated based on age across the 35 cohorts (weighted for the different proportions of the age groups), the value ranged approximately between \$300,000 to \$37 million with an average VSL of \$8,635,355 (Adler 2020).

A comparison by Robinson et al. (2021) between the VSL estimates based on three different approaches: (1) an invariant population-average VSL; (2) a constant value per statistical life-year (VSLY); and (3) a VSL that follows an inverse-U pattern, found that the average VSL estimates were \$10.63 million, \$4.47 million, and \$8.31 million, respectively, when applied to the USA COVID-19 deaths. However, despite the importance of these estimates, the analysis does not address other factors such as income level, change in risk, or uncertainty, among many other factors (Robinson et al., 2020).

Viscusi (2020) addressed the international differences by using income elasticity to estimate an international VSL derived from the USA VSL to provide country-specific global mortality cost estimates. He pointed out the need for both comprehensive and individual-specific estimates of the VSL to reflect the measure's heterogeneity and address the personal valuations of risk besides age and income adjustments.

Therefore, deficiencies exist in the VSL when using the traditional cost-benefit analysis method. The vast majority of the cost-benefit analysis value comes from foregone earnings and does not account for leisure time and utility loss nor preferences for risk reductions. Personalizing the VSL to a particular individual, or even to specific countries, is becoming a primary focus of public health officials during the COVID-19 pandemic.

The VSL can be revisited and measured using the modifications to the theory of the demand for health done by Becker in "Health as Human Capital: Synthesis and Extensions," where Becker presents the theory of human capital and integrated various contributions previously relevant yet ignored ideas into the model. Becker uses the results of the consumer optimization analysis to their utility over time, subject to constraints in budgeting and to investments in health made to change their survivorship at different ages (Becker 2007).

Becker's contributions enable us to calculate the VSL, now definable as the tradeoff between wage and risk, while also accounting for the loss of leisure, differences between average and marginal utilities in combination with losses from foregone earnings.

A more formal representation of the model is presented in his paper by using the expected utility function that is homogeneous of degree γ , simplified to a two-period model, and maximized subject to a budget constraint, as indicated below in the maximization problem:



$$\text{Maximize } u_0(x_0, l_0) + BS_1(h)u_1(x_1, l_1)$$

$$\text{Subject to: } x_0 + \frac{S_1x_1}{1+r} + g(h) = w_0(1-l_0) + \frac{S_1w_1(1-l_1)}{1+r}$$

where, u_0 : Utility in the current period zero ; u_1 : Utility in period one ; x_i : are consumption goods at period i ; l_i : is leisure at period i ; B : is the time discount rate (time preference) that depends on age. Diseases, and many other factors S_i : is the probability of survival to age i ; $g(h)$: is the expenditure function for health ; $g(h)$: is the expenditure function for health; w_i : is wage rate at period i ; r : is the interest rate.

The maximization problem above, with respect to the x 's, l 's, and h subject to the constraint, will yield the first-order conditions (1), (2), (3), and (4):

$$u_{0x} = B(1+r)u_{1x} \tag{1}$$

$$\frac{u_{0l}}{u_{0x}} = w_{0x} \tag{2}$$

$$\frac{u_{1l}}{u_{1x}} = w_{1x} \tag{3}$$

$$\frac{1}{1+r}(d \log S_1/dh)S_1u_1/u_{1x} = g'(h) + w_0(1-l_0) + \frac{1}{1+r}(dS_1/dh)(x_1-w_1(1-l_1)) \tag{4}$$

In the above first-order condition with respect to investment in health (h) represented in Eq. (4), the willingness to pay is given by the right-hand side of the equation, and the change in the probability of survival (ds) is explicitly on the left-hand side. Therefore, the maximization problem developed by Becker concerning consumption goods, leisure, and investments in health, along with the concavity of the utility function, results in the formula (5) as below that gives an estimate of the value of a statistical life life that basically equals full wealth, adjusted upwards for the degree of concavity in the single period utility function $1/\gamma$ (Eq. (14) in Becker's paper p. 385):

$$V = \frac{1}{(1+r)\gamma} \frac{1}{\gamma}(x_1 + l_1w_1) = \frac{1}{(1+r)} \frac{1}{\gamma} C_1 \tag{5}$$

where C_1 is full consumption in period 1.

Therefore, the VSL is the value calculated in Becker's Eq. (5) above discounted at an interest rate r as shown in Eq. 6 below:

$$\text{VSL} = V/r \tag{6}$$



The VSL developed by Becker; represents the tradeoff between wage and risk is given by the marginal costs for investments in longevity and equals full wealth, including the value of leisure weighted by the parameter that indicates the extent of the concavity of the utility function (i.e., the extent of the diminishing marginal utility of consumption that is equal to γ (Details on pp. 382–385, Becker 2007).

The investments in health are made because the increase in life adds to lifetime wealth; however, there is a diminishing marginal utility of consumption when the homogeneity degree is less than one ($\gamma < 1$) and investments in health are greater than investments made to maximize wealth. Investments are made because additional spending on consumption adds marginal utility while spending on health adds years to life and average utility; since average utility is greater than marginal utility, total utility increases. A greater utility function's concavity causes a smaller γ , and thus more benefits to invest in health and survive longer.

Using the above VSL formula, the calculations differ for people with different wealth, age, survival probability, and other factors. These factors are embodied in the utility function and reflected in γ that appears in the formula derived for calculating the VSL. The VSL measured by using the formula above depends on the following parameters:

1. The interest rate r
2. The extent of the diminishing marginal utility of consumption that is equal to γ which is between 0 and 1.
3. The full wealth that depends on the wage rate and the total amount of available time for work and leisure.

The novelty of the VSL formula is that the willingness to pay to reduce the chances of dying considers not just the foregone income, but the lost utility that also includes the value of leisure time, as Beker (2007) indicated and that most of the statistical value of life comes not from foregone earnings, but from the loss of leisure time, and differences between average and marginal utilities.

Moreover, the above formula can be used to represent a single individual VSL with his (her) own time preferences, wage rate, interest rate, the extent of the diminishing marginal utility of consumption that is equal to γ , and most important, leisure time, which all depends on the individual's age, occupation, gender, and many other factors reflected in γ .

The introduced VSL formula can be used with averages for individuals or a specific group of people, gender, ethnicity, or population. Hence, a more accurate and valid judgments can be made by comparing the VSL across different groups or even for a specific individual over time.

The VSL developed by Becker (2007) is consistent with values measured by other methods, is believed to solve most, if not all, the deficiencies in the traditional VSL, as Becker's formula does not deviate from the recommendations of a utilitarian or social welfare function. Economists must consider both functions when calculating VSL regarding COVID-19, as suggested by previous research



(Adler et al. 2020). A study of the optimal lockdown policy to control fatalities in a pandemic found that the intensity of the lockdown should depend on the fatality rate and the VSL assumed and measured by the cost–benefit analysis in previous literature (Alvarez et al. 2020).

Data

Data on the number of COVID-19 associated deaths for countries were obtained from the World Health Organization (WHO) COVID-19 situation report (World Health Organization 2020). In addition, data on Gross Domestic Product and Gross National Income per Capita for 2019 was obtained from the World Bank (2019a, b). Only countries with more than a thousand deaths recorded by August 31st, 2020, will be considered in calculating the VSL.

We will use the same assumptions by Becker (2007) that the total time available for work and leisure is approximately 5200 h per year (excluding sleep of roughly 68 h per week). The total time used by Becker is somehow similar to the total time reported by American Time Survey (2021). Therefore, the annual hours for work and leisure per year are 1900 and 3300, respectively. The marginal utility of consumption is diminishing and $\gamma=0.5$ while the interest rate equals 5%.

The interest rate of 5% is the average between the two rates, 7 and 3 percent, used by the US government to evaluate policies mainly because of divergent views about whether a before-tax investment rate or an after-tax consumption rate is preferable. This, in turn, relates to whether a policy affects capital or consumption, particularly in terms of its costs. Besides, these values were similar to the ones used by Becker. Again, this VSL formula enables us to change these parameters as needed to calculate a specific VSL (Discounting for Public Benefit–Cost Analysis, 2021).

To calculate the VSL for countries with more than a thousand deaths attributed to COVID-19, wages per hour are estimated by dividing the Gross National Income per capita by the total annual working hours (1900 h). Then, the results are multiplied by the total hours available for work and leisure (excluding sleep), weighted by $\gamma=0.5$ at an interest rate of 5%.

We have also considered the case when the marginal utility of consumption is constant ($\gamma=1$) and when the marginal utility of consumption is very high ($\gamma=0.1$) to estimate a range for the VSL in the selected countries.

The value of lives lost during COVID-19 equals total deaths multiplied by the discounted VSL.

We will consider different values of γ between 0.1 and 1 to provide a range of estimates for the VSL and account for people with varying levels of benefits to investing in health and surviving longer.



Table 1 Value of deaths from COVID-19 as of 8/31/2020 as a percentage of gross domestic product

Country	Cumulative deaths until 31/8/2020	GNIPC (Gross National Income/ Capita in 2019) (\$)	Hourly earnings (\$)=GNIPC/1900	VSL ($\gamma=0.1$, $r=5\%$) in millions \$	VSL ($\gamma=1$, $r=5\%$) in millions \$	VSL ($\gamma=0.5$, $r=5\%$) in millions \$	Value of loss from COVID-19 in billions \$ (using $\gamma=0.5$)	GDP in millions \$	Cost of death (% of GDP)
USA	181,689	65,760	34.61	36.1	3.6	7.2	1311.57414	21,427,700.00	6.12
Brazil	120,462	9,130	4.81	5.0	0.5	1.0	120.732238	1,839,758.04	6.56
India	64,469	2,130	1.12	1.2	0.1	0.2	15.0741538	2,875,142.31	0.52
Mexico	63,819	9,430	4.96	5.2	0.5	1.0	66.0638824	1,258,286.72	5.25
UK	41,499	42,370	22.3	23.3	2.3	4.7	193.018306	2,827,113.18	6.83
Italy	35,477	34,460	18.14	18.9	1.9	3.8	134.203724	2,001,244.39	6.71
France	30,467	42,400	22.32	23.3	2.3	4.7	141.807093	2,715,518.27	5.22
Spain	29,119	30,390	15.99	16.7	1.7	3.3	97.1425638	1,394,116.31	6.97
Peru	28,607	6,740	3.55	3.7	0.4	0.7	21.1657965	226,848.051	9.33
Iran	21,462	5,420	2.85	2.9	0.3	0.6	12.7694409	445,345.282	2.87
Colombia	19,064	6,510	3.43	3.6	0.4	0.7	13.6237737	323,802.808	4.21
Russian Federation	17,176	11,260	5.93	6.2	0.6	1.2	21.2306273	1,699,876.58	1.25
South Africa	14,028	6,040	3.18	3.3	0.3	0.7	9.30111685	351,431.649	2.65
Chile	11,244	15,010	7.9	8.2	0.8	1.6	18.5269502	282,318.16	6.56
Belgium	9,891	47,350	24.92	26.0	2.6	5.2	51.411774	529,606.71	9.71
Germany	9,298	48,520	25.54	26.6	2.7	5.3	49.5236606	3,845,630.03	1.29
Canada	9,113	46,370	24.41	25.5	2.5	5.1	46.3874897	1,736,425.63	2.67
Argentina	8,401	11,200	5.89	6.1	0.6	1.2	10.3288367	449,663.447	2.29
Indonesia	7,343	4,050	2.13	2.2	0.2	0.4	3.26460737	1,119,190.78	0.29
Iraq	6,959	5,740	3.02	3.2	0.3	0.6	4.38491454	234,094.043	1.87
Ecuador	6,555	6,080	3.20	3.3	0.3	0.7	4.37500627	107,435.665	4.07
Turkey	6,326	9,610	5.058	5.3	0.5	1.1	6.67352021	754,411.708	0.884
Pakistan	6,294	1,530	0.81	0.8	0.1	0.2	1.05711096	278,221.906	0.38



Table 1 (continued)

Country	Cumulative deaths until 31/8/2020	GNIPC (Gross National Income/ Capita in 2019) (\$)	Hourly earnings (\$)=GNIPC/1900	VSL ($\gamma=0.1$, $r=5\%$) in millions \$	VSL ($\gamma=1$, $r=5\%$) in millions \$	VSL ($\gamma=0.5$, $r=5\%$) in millions \$	Value of loss from COVID-19 in billions \$ (using $\gamma=0.5$)	GDP in millions \$	Cost of death (% of GDP)
Netherlands	6,215	53,200	28.00	29.2	3.0	5.8	36.2956994	909,070.395	3.99
Sweden	5,832	55,840	29.39	30.6	3.1	6.1	35.7491179	530,832.909	6.73
Egypt	5,399	2,690	1.42	1.5	0.1	0.3	1.59429253	303,175.128	0.53
Bolivia	4,938	3,530	1.86	1.9	0.2	0.4	1.91349881	40,895.3229	4.68
China	4,729	10,410	5.47	5.7	0.6	1.1	5.404088445	14,342,902.8	0.04
Bangladesh	4,248	1,940	1.02	1.1	0.1	2.2	0.90466678	302,571.254	0.29
Saudi Arabia	3,870	22,850	12.03	12.5	1.3	2.5	9.70732509	792,966.838	1.22
Romania	3,578	12,630	6.65	6.9	0.7	1.4	4.96073573	250,077.444	1.98
Philippines	3,520	3,850	2.03	2.1	0.2	0.4	1.48766723	376,795.509	0.39
Guatemala	2,740	4,610	2.43	2.5	0.3	0.5	1.38660861	76,710.3859	1.81
Ukraine	2,557	3,370	1.77	1.8	0.2	0.4	0.94593879	153,781.069	0.62
Poland	2,033	15,200	8.00	8.3	0.8	1.7	3.39221501	592,164.401	0.57
Panama	1,983	14,950	7.87	8.2	0.8	1.6	3.25436538	66,800.8	4.87
Honduras	1,842	2,390	1.26	1.3	0.1	0.3	0.48327011	25,095.3955	1.93
Portugal	1,819	23,080	12.15	12.7	1.3	2.5	4.60862008	237,686.076	1.94
Kazakhstan	1,781	8,810	4.64	4.8	0.5	0.9	1.72243258	180,161.741	0.96
Ireland	1,777	62,210	32.74	34.1	3.4	6.8	12.1352865	388,698.711	3.12
Switzerland	1,724	85,500	45.00	46.9	4.7	9.4	16.1810158	703,082.435	2.30
Dominican Republic	1,681	8,090	4.26	4.4	0.4	0.9	1.49285848	88,941.2983	1.68
Algeria	1,501	3,970	2.09	2.2	0.2	0.4	0.65414436	169,988.236	0.38
Afghanistan	1,402	540	0.28	0.3	0.03	0.06	0.08310826	19,101.3538	0.44



Table 1 (continued)

Country	Cumulative deaths until 31/8/2020	GNIPC (Gross National Income/ Capita in 2019) (\$)	Hourly earnings (\$)=GNIPC/1900	VSL ($\gamma=0.1$, $r=5\%$) in millions \$	VSL ($\gamma=1$, $r=5\%$) in millions \$	VSL ($\gamma=0.5$, $r=5\%$) in millions \$	Value of loss from COVID-19 in billions \$ (using $\gamma=0.5$)	GDP in millions \$	Cost of death (% of GDP)
Japan	1,279	41,690	21.94	22.9	2.3	4.6	5.85335473	5,081,769.54	0.12
Morocco	1,111	3,190	1.68	1.8	0.2	0.4	0.38905155	118,725.28	0.33
Kyrgyzstan	1,059	1,240	0.65	0.7	0.07	0.1	0.14415179	8454.61961	1.71
Nigeria	1,013	2,030	1.07	1.1	0.1	0.2	0.22573967	448,120.429	0.05
World	844,474	11,570	6.09	6.4	0.6	1.3	1072.56111	87,751,540.8	1.22



Results

Data on the number of COVID-19 associated deaths shows that the world's total deaths as of August 31st, 2020, equals 844,474. Using the formula suggested by Becker, the world VSL equals \$1.3 million. The value of loss from COVID-19 is approximately \$1.1 billion, representing 1.22% of the world's total GDP, as shown in Table 1.

Among all countries with more than a thousand total deaths as of August 31st, 2020, the USA has the highest total deaths of 65,760. The VSL estimate for the USA is \$7.2 million, with a total loss from deaths caused by COVID-19 comprising around 6.1% of the USA's 2019 GDP. Using the Becker formula, the estimated VSL for the USA represents the full wealth, adjusted to the concavity of the utility function ($1/0.5$). The full wealth represented by $(x_1 + l_1w_1)$ and equivalent to C_1 as represented in the VSL formula above is measured by the average hourly earnings multiplied by the total time available for work and leisure weighted and discounted by γ and r .

The VSL when using Becker's formula is slightly lower than the VSL estimated by Matthew (2020) of \$8.6 million, though the value is within the range of Viscusi's estimates.

When comparing the calculations of VSL across the three different levels of γ , the world's VSL ranges from \$600,000 to \$6.4 million, with Switzerland having the highest value of \$4.7 million to \$46.9 million. When the marginal utility of consumption is diminishing and $\gamma=0.5$, Switzerland has the highest VSL of about \$9.4 million. Belgium has the highest loss value from deaths as a percentage of GDP of about 9.71%. The United Kingdom (UK) has a similar value to the USA, with total loss from deaths caused by COVID-19 being around 6.8% of its GDP.

Our estimates for the VSL for each country calculated by the three values of γ of 0.1, 0.5, and 1 as shown in Table 1, columns 5–7, are consistent with the VSL values estimated by Viscusi, where the later values lie between our ranges of the estimated VSL (Viscusi 2020).

Discussion

Becker's formula to calculate the VSL is comprehensive, easy, generalizable, provide a consistent measure with the most popular methods, and more importantly, provide an added value to the existing methods that this formula enables us to break down the VSL into two main components, the first one is the VSL accounting for working time, and the second one the VSL accounting for the leisure time. More importantly, people who sleep less than or greater than the average sleeping hours of a typical person might have different VSL even when holding other parameters constant.

It also enables countries to estimate the VSL with different levels of discount rates, different degrees of concavity of the utility function, and, most importantly,



different average annual income levels per individual in a specific age group and different occupations given their different total time of work and leisure.

To assess the value of any coronavirus policies, data of the expected number of lives saved by the VSL, the suitable discount rate, and the concavity parameter must be used. In addition, evaluating policies that reduce mortality risk may provide better judgments when utilitarian and prioritarian functions are used (Hammitt 2020).

For example, vaccinating patients of ages 20 to 64 who are not high-risk would produce higher net returns than vaccinating patients of ages 65 and older who are at high-risk (Lurie et al. 2020; Meltzer et al. 1999). Decisions for agents who most decide to take the risk might deviate from the preferences of the central agent, who is neither the agent who takes the most risk nor the agent who avoids risk the most (Ashenfelter 2006.)

Conclusions

The Beker's VSL formula reintroduced here represents a comprehensive, generalizable, and easy method to measure the VSL and provides a consistent measure with the most popular methods. More importantly, this method accounts for leisure time in estimating the VSL. Estimates can be broken-down by values for both work and leisure times. Nevertheless, this formula enables us to consider variations in the estimates of the VSL when the total time of work and leisure varies across different individuals or groups were given that sleep duration varies among different occupation populations.

This method enables policymakers and researchers to differentiate between ages, occupations, countries, races, and even groups or individuals with different discount rates for the future, especially during this period of time where each one has his case and his VSL that deviates from the average estimates used by policymakers.

The fact that everyone is vulnerable to COVID-19 should inspire collective action, internationalism, and an urge to begin thinking big, as advised by other (Lurie, 2020; Koven 2020).

As time goes on, and as health standards begin to be globally recognized as a human right, it should be expected that health will start to be seen as an indispensable and relevant part of domestic and global economies, provoking a greater investment in and awareness of the crucial nature of health as human capital and its role in economic development.

Policymakers must decide how to reconcile the number of lives lost to sickness with the negative economic impact that preventive measures cause. There is no right answer to this question nor a magic solution to this pandemic. Nevertheless, responses to the COVID-19 pandemic should utilize the best possible data and procedures to make robust and reliable public health decisions without ignoring the individual and the population's systematic welfarist approach to normative reasoning.

The employment of the VSL is expected since the VSL is a cornerstone of USA governmental risk analysis. However, using more general, widely applicable, and



easy estimates of the VSL introduced here should not deviate from the recommended utilitarian approach.

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