THE VALUE OF STATISTICAL LIFE IN RUSSIA AND THE COSTS OF THE COVID-19 PANDEMIC

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Abstract - This paper presents the first estimate of the value of statistical life in Russia based on the compensating wage differential methodology. The obtained estimate of the value of statistical life in Russia (1.59 million US$2020) is comparable in magnitude to estimates from developed countries considering the difference in GDP per capita based on purchasing power parity and significantly higher than those obtained previously for Russia using survey methodology. As an application, we evaluate social costs associated with COVID-19 deaths to be 0.09 and 0.23 trillion US$2020 using the age-adjusted and age-invariant value of statistical life, respectively.

Keywords - Compensating Differential, COVID-19, Hedonic Wage Equation, Value of Statistical Life.

I. INTRODUCTION

Value of statistical life (VSL), numerically representing public preferences toward money and safety, is a crucial instrument for risk monetizing in cost-benefit analysis of government policy. Whereas the VSL is widely used in developed countries, there are no credible and methodologically comparable estimates in many developing and emerging market economies due to the lack of necessary data.

The largest group of VSL studies are based on the compensating differentials in the hedonic wage equation revealing people's willingness to accept compensation for fatal occupational risks [1]. Generally, the application of this methodology requires a wide array of reliable and high-quality data and therefore is primarily applied to a few developed high-income countries [2]. There are no such estimates for Russia, whereas current evaluations of the VSL in Russia based on stated preferences obtained by surveysrange from 1.1 to 5.2 million rubles, which is less than 0.09 million US$2017 (the average exchange rate in 2017 was 0.0172 USD for 1 ruble) [3]. These estimates represent a striking contrast to the VSL estimates for developed countries. For example, for the USA, the U.S. Department of Health and Human Services' VSL estimates range from 5.3 to 17.4 million US$2020, a central estimate reaching 11.4 million US$2020 [4].

Previously obtained estimates of the VSL in Russia based on stated preferences are also significantly lower than corresponding values for Russia provided by Viscusi and Masterman that reach 1.97 million US$2015 [2]. Viscusi and Masterman calculated VSL estimates for 189 countries using a base VSL of $9.6 million for the USA adjusted to the VSL income elasticity and difference in the GNI per capita measured by the World Bank between the country from their sample and the USA [2]. Given that the lack of data prevents them from calculating the values directly, this method provides adequate approximations, but it does not account for other factors of differences between countries, including working conditions and risk profiles.

Whereas there is no official methodology and no comparable estimates for most developing and emerging market economies, the VSL is a fundamental parameter in developed countries for governmental cost-benefit analyses in various policy areas [1], [5]. Against the backdrop of the COVID-19 pandemic, these estimates have become increasingly widely used in studies assessing the consequences of COVID-19 [6], [7].

The COVID-19 pandemic is one among many possible applications of the value of statistical life estimates. On the one hand, the events of the pandemic and the restrictive measures that followed caused severe economic and social losses, but on the other hand, quarantine measures were justified to preserve the life and health of the population. Hence, VSL estimates can be used to understand the cost of mortality from COVID-19 and the relations between economic costs of lockdown and benefits from saving lives due to the introduction of quarantine regulations.

According to the Russian Federal Service for Supervision of Consumer Rights Protection and Human Welfare, the economic costs of the COVID-19 pandemic in 2020 reach 997 billion rubles (13.86 billion US$2020) [8]. However, this amount includes only medical expenses and funds to support the population and businesses but does not include losses due to COVID-19 mortality. The current paper shows that mortality costs highly outweigh these economic losses.

The contribution of the current study is twofold. Firstly, this paper presents the first estimate, to the best of our knowledge, of the value of statistical life

in Russia. The estimate is based on an analysis of the compensating differentials for fatal risks in the hedonic wage equation as the most reliable calculation method. Secondly, we provide an application of obtained VSL estimates for calculating the costs of COVID-19 mortality in Russia.

II. DATA AND METHODS

2.1. Data description

We provide calculations using representative national survey data from the Russian Longitudinal Monitoring Survey (RLMS). This data is a series of nationally representative surveys from 1994 to 2020 and contains detailed information about individuals and households, such as gender, age, the wage rate, the level of education, the current occupation, and more. For this study, we analyzed a representative sample of 5,782 individuals for 2020.

Since there is no available data on occupational fatalities in Russia, fatal risks by industry from the Russian FederalState Statistics Service (Rosstat) are paired with fatal occupational risks from the U.S. Census of Fatal Occupational Injuries (CFOI). Both types of fatal risk were measured as the number of fatal cases per 100,000 workers employed in a particular industry or occupation.

We analyze factor variables such as gender, marital status, educational level, and region as dummies.Table 1 contains information on key data parameters.

Variable	Mean	Std. dev.	Min	Max
Wage (in rubles)	187.144	141.745	0.3	4500
Age	41.977	11.697	18	87
Cross fatal risks (industry-occupation)	2.592	6.512	0	206.523
Fatal risks in industries only	3.661	3.468	0	11.683

Table 1: Descriptive statistics

2.2. Estimation method

To determine the marginal rate of substitution between money and safety, we estimate the hedonic wage equation in the form of:

$$\ln(w_i) = \beta X_i + \gamma_1 \text{DeathRisk}_{ikj} + \gamma_2 \text{InjuryRisk}_{ikj} + \varepsilon_i \quad (1)$$

where w_i is a worker i's hourly wage rate, X_i is the vector of individual characteristics (gender, age, age squared, marital status, level of education, region), DeathRisk_{ikj} and $\text{InjuryRisk}_{ikj}$are fatal and non-fatal risks in an industry k and an occupation j where an individual i works respectively, ε_i is an error term, $\beta, \gamma_1, \gamma_2$are regression coefficients.

In equation (1), γ_1 is the parameter of interest and represents the marginal rate of substitution between money and life safety as revealed workers' preferences. As a robustness check, we compare two specifications of this model to examine if the inclusion of U.S. data on occupational risks influences the resulting estimates. In the baseline model, we calculate fatal risks as the square root of the product of risks in an industry and occupation. An alternative model is estimated utilizing Russian industry risk data only.

Based on the estimation results, we calculate the value of statistical life as:

$$\text{VSL} = \widehat{\gamma_1} * \text{Wage} * 100000 * 2000 \quad (2)$$

where $\widehat{\gamma_1}$ is an estimated regression (1) coefficient, Wage is the average wage among all individuals in the sample, 100,000 is the number of workers per which death risk was measured, 2,000 is an average working hours quantity per year.
The results of the hedonic wage equation (1) estimation are presented in Table 2.

Variable	Baseline model with cross fatal risks (industry-occupation)	Alternative model with fatal risks in industries only
Dependent variable: hourly wage rate		
Age	0.044***	0.044***
	(0.004)	(0.004)
Age^2	-0.001***	-0.001***
	(0.00004)	(0.00004)
Female	-0.334***	-0.334***
	(0.014)	(0.014)
Death risk	0.003***	0.0025*
	(0.001)	(0.0012)
Injury risk	0.001***	0.001***
	(0.0001)	(0.0002)
Dummies for the education level	yes	
Dummies for marital status	yes	
Dummies for region	yes	
Constant	3.608***	3.587***
	(0.479)	(0.479)
R^2	0.39	0.382
Observations	5782	

Table 2: Regression estimates for the hedonic wage equation *: indicates statistical significance at 1% level; **: indicates statistical significance at 5% level; *: indicates statistical significance at 10% level.**

III. RESULTS AND DISCUSSION

3.1. Estimating the value of statistical life in Russia

As shown in Table 2, in general, the values of the coefficients in both models are similar, except for the

fatal risks. Although these coefficients also do not differ much, the estimates in the baseline model appear to be more accurate since they account for risk variation among different occupations.

Substituting the coefficient for fatal risks from the baseline model (the value before rounding is 3.047e-03) into formula (2), we get a value of statistical life in Russia which equals 114.05 million rubles or 1.59 million US$2020 (the average exchange rate in 2020 was 0.0139 USD for 1 ruble).

This value is comparable with the estimates of U.S. Department of Health and Human Services estimates for the USA of 5.3 to 17.4 million US$2020 when adjusting for differences in GPD per capita based on PPP (according to the World Bank, 29,812.2 versus 63,593.4 in current international dollars for Russia and the USA, respectively).

3.2. The costs of the COVID-19 pandemic

According to Rosstat administrative statistics, 144,691 people died due to the COVID-19 pandemic in 2020 (data for 2021 is not yet available). These values for 2020 are, most likely, greatly underestimated due to the difficulties of accounting for causes of death. Registration of deaths in Russia records only one primary cause of death. If patients with COVID-19 died from concomitant diseases, their deaths would not be included in a record of COVID-19 deaths in the administrative statistics. Hence, the costs of the pandemic measured by administrative statistical data can be considered the lower bound of total costs from COVID-19 mortality.
One of the most debated questions regarding the measuring of pandemic cost using VSL arises from the differentCOVID-19 vulnerability by age [6], [7]. The distribution of COVID-19 deaths by age in Russia during 2020 is illustrated in Fig. 1.

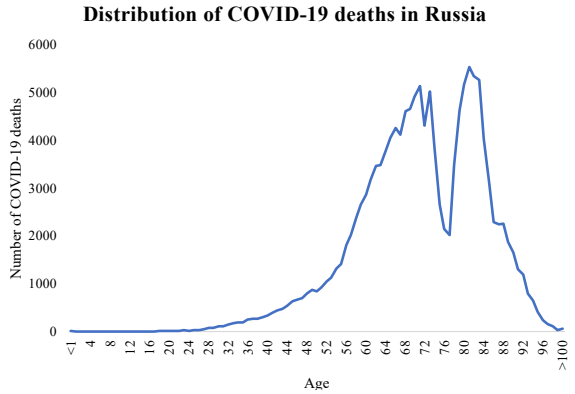

Fig. 1. The distribution of COVID-19 deaths in Russia among different ages (Rosstat administrative statistics, 2020).

Since older people are more likely to die from COVID-19, it is reasonable to place different values on people of different ages. Evidence shows that the VSL varies by age following a decreasing or inverted U-shape pattern [9], [10], [11],but using the same VSL for people of all ages is better aligned with the social equity standards [7] and can be formally justified [12]. The simplest explanation of the age variation in the VSL is connected to the life expectancy argument since older people have a lower life expectancy on average.

Considering the difference in life expectancy and vulnerability to COVID-19, we can estimate the age-adjusted costs of the pandemic according to the value of a statistical life year (VSLY). VSLY can be calculated as an average value of the VSL per year given the remaining life expectancy for the mean age among the data sample. Since the mean age in the sample is 42 (see Table 1) and the remaining life expectancy for this age in 2020 was 32.33 years (according to Rosstat data), the VSLY is:

$$\text{VSLY} = \text{VSL} \div 32.33 = 3{,}528 \text{ million rubles}$$

Using VSLY, we calculatedthe age-adjusted VSL as the product of remaining life expectancy for different ages from Rosstatadministrative statistics and the VSLY calculated above. Estimates of the VSL for different ages are presented in Fig. 2.

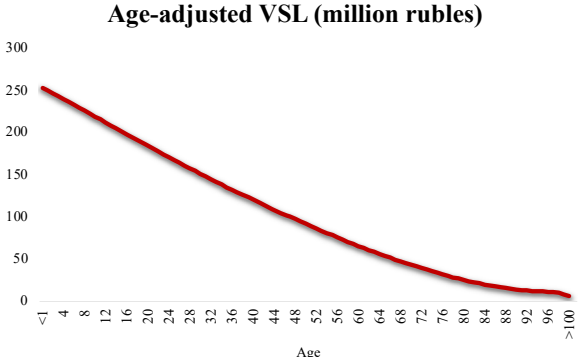

Fig. 2. The age-adjusted VSL calculated as the product of remaining life expectancy and the value of statistical life year.

Fig. 2 shows that the age-adjusted VSL falls dramatically by age since older people have a lower life expectancy. As COVID-19 mortality is higher for people in older age groups, the total costs of the pandemic utilizing age-adjusted VSL will be significantly lower than with age-invariant VSL.
Total costs of the pandemic for both age-invariant and age-adjusted value of statistical life are presented in Table 3.

Table 3: Total costs of the COVID-19 pandemic

A choice between age-invariant or age-adjusted VSL is debatable and mostly depends on the political will of those responsible for making policy decisions. Whereas the age-adjusted VSL is consistent with the premise of the difference in life expectancy, equal VSL for all ages is more likely to be politically relevant in terms of preserving social equity. In both cases, total costs of the COVID-19 pandemic in 2020 significantly exceed economic costs officially

reported by the Russian Federal Service for Supervision of Consumer Rights Protection and Human Welfare, equal to 13.86 billion US$2020. Furthermore, the estimated values indicate only costs of COVID-19 mortalities and need to be supplemented by losses from non-fatal cases of COVID-19 illnesses to represent actual total costs. Thus, the obtained results show the minimum loss estimate. Nevertheless, the magnitude of such assessments is difficult to overestimate since the primary concern during the pandemic was reducing mortality and economic concerns were secondary.

IV. CONCLUSIONS

The major conclusions of the current study are following:

1. The estimated value of statistical life in Russia equals 114.05 million rubles or 1.59 million US$2020,which is more than twenty times higher than previously obtained for Russia using survey methodology.The current results are obtained with the compensating wage differential methodology widely used in developed countries for the VSL evaluation in cost-benefit analysis.
2. Our evaluations of the total costs of the COVID-19 mortalities more than six times exceed the economic losses estimated by the Russian Federal Service for Supervision of Consumer Rights Protection and Human Welfare [8].The pandemic costs may differ depending on the type of VSL, age-adjusted or age-invariant, is used. Since older people are more vulnerable to COVID-19 and their VSLs are lower due to a lower remaining life expectancy, the age-adjusted VSL results in the lower magnitude of the pandemic costs.

These results can serve as an impetus for starting a discussion on revising the VSL in Russia. Accordingly, the revision of the estimates should help provide a more precise analysis of the COVID-19 pandemic implications and entail a more comprehensive understanding of the costs and benefits of policy programs that explicitly or implicitly involve the value of human life and health.

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