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The human life vs economic loss dilemma: Relation between death rate and the output rate in Europe during the Covid 19 pandemic

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Abstract

I analyze the human life-economic loss dilemma (HELD) trade-off between saving lives ad saving economic activities during the emergency period of Covid 19 pandemic. A new concept labeled HELD Curve, not addressed in the literature so far, is proposed to model the inverse non-linear relation between loss of economic activity and death rates during the Covid 19 Pandemic in Europe, due to the lockdown policy. Econometric estimation supports this view offering to policymakers a tool to assess the impact of continuing the lockdown. The HELD curve elasticity implies a trade-off of 218 thousand EURO per saved human life.

JEL Classifications: C21; C51; E10; E32

Keywords: Human life-economic loss dilemma HELD; Covid-19 pandemic; Economic loss; Human death; Trade-off; EU lockdown

1. Introduction

Before the development of the Covid 19 pandemic, it was obvious that mortality rate due to diseases and fluctuations of the rate of economic activity were uncorrelated phenomena. At the outburst of the worldwide COVID-19 pandemic, an undisputed political consensus emerged

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worldwide, acting to limit and restrict the normal course of economic activity and individual mobility in order to contain the contagion of the pandemic disease. A new pervasive policy emerged, the so-called lockdown policy, which affected the entire social and economic life.

I postulate that the human-economic loss dilemma (HELD) poses a trade-off between saving lives and saving economic activities during the emergency period of Covid 19 pandemic. When the lockdown restrictions impeding the normal economic activity are high relative to normal levels, we expect the rate of deaths to be lower. Conversely, when the lockdown is weak, and the death rates are higher than normal we expect the economic activity to rise. It seems plausible that this principle should operate as one of the factors determining the rate of change of deaths during the Covid 19 pandemic is the stringency of the lockdown policy measures.

When the lockdown policy stringency is high and there are fewer human workers around, we should expect firms to have higher difficulties to maintain the production level, suffering a higher damage. This suggests a linear inverse relation between death rates and economic loss. On the other hand, it appears that when the lockdown policy is relaxed, the contagion continues, and the death rates fall only very slowly while the economic activity can be resumed quickly. This suggests that the relation between death rates and economic activity could, therefore, likely to be non-linear.

In analogy with the Phillips curve (Phillips, 1958), which represents the fact that when monetary policy is expansionary that brings an increase in the inflation rate, which, via the reduction of the real wage, brings about a reduction of the unemployment rate, I state that when there is a more stringent lockdown policy the immediate effect is increasing the losses of the economic activity. Subsequently, the restrictions on the human mobility should reduce contagion and hence reduce the excess mortality, in analogy with the expectation augmented long run Phillips curve, which states that when expectations are incorporated in the Phillips curve, there is a shift upward of the short run Phillips curve, therefore rendering useless the expansionary monetary policy in the long run. The Phillips curve is a vertical line on the point of the non-accelerating inflation rate unemployment.

I will label “HELD curve” the short run relation between economic loss (the reduction of economic activity) and human life loss (the mortality rate associated with the Covid pandemic) and I will label “Non-Accelerating Loss of Economic Activity Mortality rate”, “NALEM”, the point at which expectations and changes in the productive organization of firms (i.e. smart working) are incorporated in the short run HELD curve, so that the economic activity is adjusted to the zero level at a constant loss level of human deaths. It is the point that renders useless the lockdown policy in the long run, because the economy accommodates on the vertical long run curve, which is the level of mortality rate associated with zero, or non-increasing, economic loss. It is similar to the concept of Non-accelerating inflation rate of unemployment (NAIRU) (set forth by Phelps (1967); see also Ball and Mankiew (2002)).

The purpose of the present study is to see whether statistical evidence supports the hypothesis of the HELD curve, i.e., that the rate of change of economic activity due to lockdown measures can be explained by the level of excess of mortality rates with respect to normal and if so to form some quantitative estimate of the relation between the mortality rates and the economic losses, due to the effect of the lockdown policy. An indirect encouragement to deepen the research along the lines of this work is found in Chilton et al. (2020). However, note that this issue has not been analyzed in the literature so far. Acemoglu et al. (2023), Aum et al. (2021), Clemer (2020), Eichenbaum et al. (2021) address the issue of Covid pandemic with epidemiology calibrated models, hint at a trade-off relation,

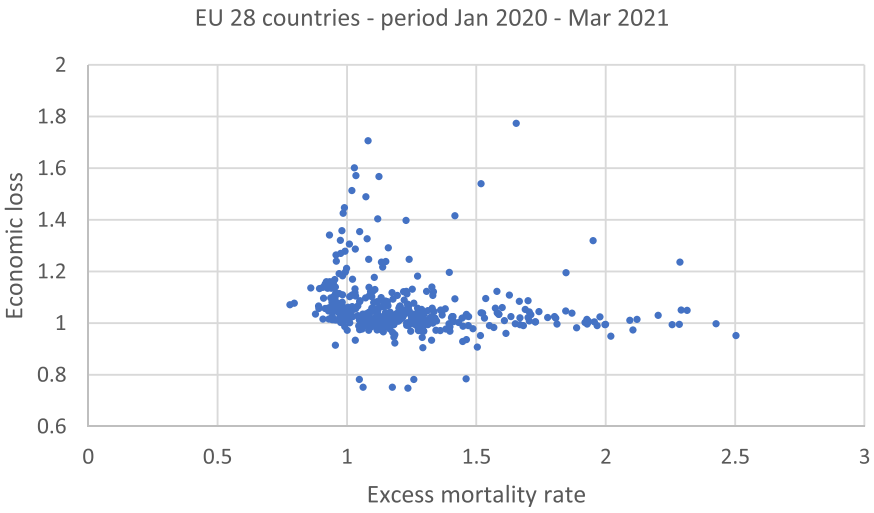

Fig. 1. Economic loss and excess mortality rates in the European Union – Jan 2020–Mar 2021.

report some methodological issues addressed in the recent literature review related to the Value of a statistical life (VSL), following the classic Ashenfelter and Greenstone (2004), Martin and Pindyck (2021) link the VSL to consumption disaster, but there is no definite empirical evidence. Ambrocio (2022) analyzed the effect of the business confidence on economic activity in soenm EU countries during the CVID-19 pandemic period. Tchatoka et al. (2022) analyzed the pattern of the stock market in seven large economies. Huertgen (2021) estimated the decline in GDP growth during the lockdown period in the Euro area.

This paper presents a novel contribution to the literature, by setting the foundations of the HELD curve and providing an empirical estimate for the European Union (EU).

I use data for the 28 EU member countries (including UK) for the 15 months from January 2020 to March 2021. (A recent Phillips curve estimation for the EU s given by Moretti et al., 2019). This particular period chosen, from the first knowledge of the COVID-19 at the beginning of Jan 2020 until the vaccination policy took over at the end of march 2021, is important and can be appreciated as follows. At the beginning of 2020 the medical knowledge about the Covid in Europe was scanty and largely unknown. The healthcare sector was facing a new disease, Covid-19, and the policy making process was uncertain. In February 2020, travel restriction policies were adopted a piecemeal fashion. As an example, the Italian Government banned the direct flights from China, forgetting the vast portion of travelling from the Far East via indirect flights. On March 11 2020 the World Health Organization declared Covid-19 a pandemic. At the beginning of March 2020 lockdown policies were enacted. Various degrees of stringency were adopted. The following swinging policies and contagion waves lasted until the massive vaccination policies were enacted at the beginning of 2021. At the end of the first quarter 2021, the vaccination policy took over the lockdown policy. A scatter diagram of the economic loss (rate of reduction of industrial production) and the percentage of excess deaths with respect to normal is shown in Fig. 1, for 420 observations, for 15 months from January 2020 to March 2021 and 28 EU countries. Detailed description of the data is in Appendix 1. The normal level for mortality rate on the horizontal is set equal to 1, while the percentage reduction in economic activity is shown on the vertical axis.

Fig. 2. Economic loss and excess mortality rates in the European Union – Jan 2020–Mar 2021.

2. Data and estimation

The model of the effects of the lockdown policy is represented by the postulated inverse relation between economic loss and excess mortality. I have chosen the logarithmic forms of the equation. Let's define y = loss of economic activity and m = excess mortality index.

The logarithmic relation is:

$$log(y_{jt}) = \phi + \theta\ log(m_{jt}) + e_{jt} \tag{1}$$

where j is the country index $j = \{1,2, ..., 28\}$ and t is the month index $t = \{1,2, ..., 15\}$.

The coefficients $\{\phi, \theta\}$ can be estimated by least squares. I used fixed factors represented by 27 country dummies D_j $j = \{2,3, ..., 28\}$ that were added to the above specifications as:

$$\phi = \Sigma\ (\phi_j\ D_j) \tag{2}$$

to get:

$$log(y_{jt}) = \Sigma\ (\phi_j\ D_j) + b\ log(m_{jt}) + e \tag{3}$$

I have then introduced a further identifying control to test for demand effects, using the EU survey of sentiment s:

$$log(y_{jt}) = \phi_0 + \Sigma\ (\ \phi j\ D_j) + b\ log(m_{jt}) + \mu\ log(s) + e \tag{4}$$

The fitted values of eq. The fitted values of Eq. (3) and the estimation results are reported in Fig. 2 and Table 1.

Table 1
Estimation results.

(1)	(2) log (y)	(3) log (y)	(4) log (y)	(5) log (y)	(6) ZMEL	(7) $NALEM_1$	(8) $NALEM_{1.05}$
RHS coeff							
φ	0.084**	0.071*	0.022**	0.011*	1.06	1.8	1.2
Θ	-0.096**	-0.091*	-0.086**	-0.083**			
ϕ2021	-0.059**	-0.060**	-0.034**	-0.035**	1.02	1.2	0.8
ϕ2	-0.023		-0.026				
ϕ3	0.006		-0.024				
ϕ4	0.015		0.009				
ϕ5	0.023		-0.002				
ϕ6	0.044	0.056**	0.063**	0.073**	1.15	4.4	2.9
ϕ7	-0.010		-0.015**				
ϕ8	-0.049		-0.015				
ϕ9	0.037	0.049**	0.048**	0.061**	1.13	3.7	2.1
ϕ10	0.075**	0.086*	0.073**	0.087*	1.16	5.0	3.2
ϕ11	-0.036		-0.040				
ϕ12	0.056	0.068**	0.063**	0.076**	1.15	4.4	2.8
ϕ13	-0.035		-0.015				
ϕ14	0.005		0.008				
ϕ15	-0.148**	-0.136**	-0.149**	-0.135**	0.93	0.4	0.2
ϕ16	0.062**	0.074**	0.051**	0.065**	1.14	3.8	2.5
ϕ17	-0.047		-0.036				
ϕ18	-0.044		-0.002				
ϕ19	0.042**	0.054**	0.090**	0.102**	1.17	6.2	3.2
ϕ20	-0.041**	-0.031**	-0.074**	-0.063**	1.00	0.84	0.56
ϕ21	-0.009		-0.004				
ϕ22	-0.041**	-0.029**	-0.077**	-0.062**	1.00	0.8	0.5
ϕ23	0.021		0.015				
ϕ24	0.036**	0.049**	0.035	0.049**	1.12	3.2	2.1
ϕ25	-0.022		-0.004				
ϕ26	0.038**	0.050*	0.049**	0.062*	1.13	3.7	2.5
ϕ27	0.005		-0.019				
ϕ28	0.021		-0.003				
μ			-0.445**	-0.443**			
Log L	442.12	430.8	533.9	521.8			
F zero slope	5.6**	11.7**	15.5**	33.6**			
r-squared	0.296	0.257	0.545	0.531			
SER	0.087	0.071	0.070	-0.070			
N. observ.	420	420	420	420			

Note: Fzero slope: F test of joint significance; SER: standard error of the regression
**coefficient significant at 1 %; * significant at 5 %.

3. Discussion

I have first estimated the unrestricted form of Eq. (3) and (4) reported in columns (2) and (4) of Table 1, respectively. In this empirical form I have introduced with a dummy variable ϕ2021 for the three months of 2021, when the vaccination campaign was announced and started. In this specification, notice that many country coefficients are not significant, thus, a restricted version is estimated in col. (3) with $\phi j = 0$ for all the non-significant coefficients. The restriction is accepted on the basis of a LR test $= -2 * (442.1 - 430.8) = 22.6$ In addition, I have tested the

significance of the sentiment control variable, which is confirmed comparing the results of cols. (4) and (5) of Table 1 against their counterparts of cols (2) and (3). In particular, the preferred estimation in col. (5) confirms the restriction $\phi j = 0$ for 16 countries on the basis of a LR test $= -2 * (533.9 - 521.8) = 24.2$ against a chi-square critical value at 1 % with 16 degrees of freedom. Notice also that the important coefficient θ that defines the elasticity of the economic loss to the excess death is remarkably stable. The sign of the coefficient of the control variable sentiment is as expected (a higher level of sentiment is associated with lower economic loss, ceteris paribus).

These results define a large group of 17 countries, which shows an average European pattern, characterized by the constant $\varphi = 0.011$ of the regression, which we label Group A: Austria, Belgium, Bulgaria, Cyprus, Czech. Rep., Denmark, Estonia, Finland, Croatia, Hungary, Luxemburg, Netherlands, Poland, Portugal, Slovakia, Sweden, United Kingdom. This is a group consisting of continental small and medium size countries plus Poland and UK. The remaining countries can be grouped according to the similarity of the specific coefficients φ_j as: Group B comprising Ireland, Malta and Poland with a negative coefficient φ; Group C comprising Greece, Romania, Slovenia with a positive $\varphi = 0.05$; Group D comprising large countries Germany, France, Italy, Spain with $\varphi = 0.7$ or above.

In detail the estimations show two main results. First, the constant is significant and lower in the first three months of 2021. This is important because the period coincide with the start of the massive vaccination campaign, even with different intensities and speed across Europe. The economic implication is clear: for a given mortality rate the implied economic loss is lower, or conversely, for a given loss of economic activity the associated mortality rate is lower. Second, there are heterogeneous responses of the HELD curve among EU countries. This reflects the different and not coordinated policies adopted by the various EU Governments. In order to appreciate such differences, I computed the estimated level of the economic loss which is implied by a zero excess mortality rate as follows.

Recalling the logarithmic transformation of Eq. (4), it is straightforward to recover:

$$y_j = [exp(\phi) * s^{\mu}]m_j^{\theta} \tag{5}$$

In Eq. (5), setting $m = 1$, i.e zero excess mortality, it can computed the zero mortality economic loss (ZMEL) as:

$$ZMEL_j = [exp(\phi) * s^{\mu}] \tag{6}$$

The values of ZMEL are reported in col. 6 of table 1, for the different groups of countries defined above (which correspond visually in Fig. 1 to the points on the vertical curve intersecting the downward sloping HELD curve). Note that there are 4 interesting groups of countries: Group A shows a ZMEL around 1.06, Group B around 1, Group C around 1.13, Group D around 1.13.

In group B we find Ireland, which showed a very robust increase of economic activity starting at the end of 2020, so it suffered no sever economic loss. In the large group A we find the bulk of the small and medium size countries. In Group C we find few other south and east countries, such as Romania, Slovenian and Greece. In group D we find the largest EU countries: Germany, France Italy and Spain with the highest level of ZMEL.

Because of the curvature of the fitted relation in the region of low death rates, there will be lower average rate of increase of economic loss, if death rates (i.e. the lockdown policy) is held constant at a given level, than there will be if death rates is allowed to fluctuate about that level.

In other words, a reduction of the death rate must be associated with a more than proportional increase in the economic loss. Consequently, the stop and go every week of the restrictions has probably proven more detrimental for the economic activity than a steady course, because the expectations of a long run steady policy will lower the economic loss.

This empirical finding (the non-linearity of the HELD curve) well explains the consequences of different policy attitudes in the EU countries. A steady and severe lockdown for a relatively limited period in countries like Germany and UK have had less impact on economic activity than in Italy, where during the whole 2020 a complicated system of graduating restrictions (yellow, orange, red zones) at the local level has been changed very frequently every week. As data shows, Italy records one of the highest ZMEL in the EU.

In addition, it is possible to estimate the level of death rate that can be associated with the zero economic loss or the NALEM, the point at which expectations and changes in the organization of the economic activity are incorporated in the short run HELD curve, so that the economic activity is adjusted to the zero level (or constant loss) level of human deaths. It is the point that renders useless the lockdown policy because the economy adjusts so that the excess mortality rate is independent of the economic loss.

Ideally, in normal situations in the long run, the NALEM should be equal to one, which means zero excess mortality, so that the fluctuations of economic activity are independent of the (pandemic related) mortality rate. In Fig. 2, the long run NALEM is represented by the red vertical line. The implied NALEM in this period of exceptional Covid 19 pandemic can estimated using Eq. (5), by setting $y = 1$:

$$NALEM_j = [1/(exp(\phi) * s^{\mu})]^{1/\theta} \quad (7)$$

This represents the mortality rate compatible with the zero economic loss in the short run. Notice that ϕ is country specific so that NALEM is country specific, as reported in columns (7) and (8) of Table 1. Precisely, col. (7) reports the computation for zero economic loss (y = 1) and col. (8) reports the computation for an hypothetical loss of 5 % (y = 1.05). It is interesting to note that, apart from Group B (with values lower than unity), the values are significantly higher than unity and reflect the grouping already defined above. Group A shows a value around 1.8 or 80 % excess mortality, Group C shows a value around 3 or 200 % excess mortality, Group D shows a value around 4 or 300 % excess mortality, to get zero economic loss, respectively. The values for a moderate loss of 5 % are consistently lower, as expected. The final interesting result of the estimated model for the policy analysis is the empirical value of the elasticity of the HELD curve. The estimated value of -.083 implies numerically that the effect of the lockdown policy could result in a 10 percent increase in the death rate, associated with an increase of economic loss, i.e. a reduction of GDP, of 0.83 percent. We recall that in the pre-Covid year 2019 in the EU there have been 5.3 million deaths and the average excess mortality in the period of estimation, as reported by the EU (2022), has been around 12%. The GDP has been in 2019 around 14017 billion EURO and 13399 in 2020, i.e with an average decrease of 4.4%. A simulation with these values, using the estimated elasticity, implies that 636,000 more deaths (increase deaths by 12%) are associated with an economic loss estimated around 139 billion EURO (0.99% of GDP) or 139 billion Euro /636 thousand deaths, which is equal to 218 thousand EURO per death. This means that the lockdown policy was implicitly tolerating one more death to save 218 thousand EURO of economic activity, or alternatively, that the lockdown policy was implicitly expected to lose 218 thousand EURO of economic activity to save one more life.

4. Conclusions

These conclusions are of course tentative. There is need for much more detailed research into the relations between lockdown effect on the death rates and effects on economic activity. This paper has investigated such relation, the HELD curve – human life economic loss dilemma - for the EU countries in the period January 2020–March 2021, when the healthcare system was caught at the beginning unprepared and the lockdown restrictions were the policy consensus, until the readiness of the vaccine made massive vaccination the main policy option.

The empirical findings of this paper point out that a new type of policy has been implemented to impact on human activity, namely the lockdown policy. The lockdown policy has had the intention to push down the mortality rate (like the expansionary monetary policy desired to push down the unemployment rate), but it had the consequential effect to push up the economic loss in the economy (like the expansionary monetary policy pushes up the inflation rate).

This empirical estimation seems a more straightforward method to empirically measure the value of life, than many computations of the VSL and the implied Value of Statistical life year (VSLY). For example, Aldy and Kip Viscusi (2007) measure VSL around 9.7 million USD, which can imply a VSLY around 250–323 thousand USD; Kniesner and Viscusi (2023) report the US Department of Health estimate of VSLY of 369 thousand USD; Herrera-Araujo and Rochaix (2020) report a VSL around 6.75 mil EURO (about VSLY equal to 225 thousand USD) Robinson et al. (2021) report a value of VSLY around 455,484 USD; Colmer (2020) report a VSLY around 465.565 USD.

Our estimate provides a direct empirical measure of the revealed trade-off induced by the lockdown policy between accepting economic loss and willingness to save human lives. In other words, the HELD curve implies that the Covid 19 pandemic contrasting policy action in the EU has had a metric of 218 thousand EURO of economic activity per saved human life. This model of the HELD curve suggests a marginal elasticity of the trade-off of roughly 1% of GDP loss against 12% of deaths increase. The historical data for 2020 show an average of 4.4% GDP loss against 12% of deaths increase. Simulating the model with a 4.4% economic loss would imply a death increase around 50%. This implies that at the margin the lockdown policy was only partially effective, because the actual economic loss, if targeted by the policy, would have been associated with a higher death increases than what has actually happened. Or alternatively, it could be argued that the policy makers were underestimating the impact on economic activity per given target of saved life. In conclusion, this suggests that in the future, should similar health situations occur, restrictive policy actions should take into due account the effects that will be generated on economic activity.

Appendix

I have collected data for EU 28 countries, included the UK, reported in Table A1. Note the ordering is according to the original name, while I have reported the international names.

I have taken from public sources of the EU two raw variables, Industrial production, monthly and death numbers, weekly from the following sources.

Industrial production. Monthly, Data taken from the Eurostat.

Production in industry - monthly data [STS_INPR_M__custom_927452].

Deaths, weekly, Data taken from the Eurostat.

Table A1
EU country list.

Number	Ctry	Country
1	AT	Austria
2	BE	Belgium
3	BG	Bulgaria
4	CY	Cyprus
5	CZ	Czech. Rep.
6	DE	Germany
7	DK	Denmark
8	EE	Estonia
9	EL	Greece
10	ES	Spain
11	FI	Finland
12	FR	France
13	HR	Croatia
14	HU	Hungary
15	IE	Ireland
16	IT	Italy
17	LT	Lithuania
18	LU	Luxemburg
19	LV	Latvia
20	MT	Malta
21	NL	Netherlands
22	PL	Poland
23	PT	Portugal
24	RO	Romania
25	SE	Sweden
26	SI	Slovenia
27	SK	Slovakia
28	UK	United Kingdom

Table A2
Main descriptive statistics.

Variable:	Mean	Std Dev	Minimum	Maximum
Excess mortality	1.24	0.30	0.78	2.50
Economic loss	1.06	0.05	0.85	1.18
Ec. Sent. indicator	0.89	0.10	0.595	1.142
Variable:	Sum	Variance	Skewness	Kurtosis
Excess mortality	520.89	0.09	1.64	2.92
Economic loss	443.53	0.00	-0.52	0.63
Ec. Sent. indicator	374.5	0.011	-0.39	-0.036
Variable:	Median	1st Qrt	3rd Qrt	IQ Range
Excess mortality	1.16	1.05	1.32	0.27
Economic loss	1.06	1.02	1.09	0.06
Ec. Sent. indicator	0.90	0.833	0.967	0.134

https://ec.europa.eu/eurostat/databrowser/view/STS_INTV_M__custom_927473/default/table?lang=e, Dataset page, Deaths by week and sex, Online data code:DEMO_R_MWK_TS.
Source of data: Eurostat, Last data update:20/05/2021 23:00.

Economic Sentiment Indicator (ESI) is calculated based on a selection of questions from industry, services, retail trade, construction and consumers at country level and at aggregate level (EU and euro area) in order to track overall economic activity.

https://ec.europa.eu/eurostat/databrowser/view/EI_BSSI_M_R2__custom_990933/default/table?lang=en.

I have supplemented some missing data with data from the following national sources.

Italy – https://www.istat.it/en/archivio/240106.

https://www.istat.it/it/files//2020/03/dataset_deaths_29Februaryo2021.zip.

UK – Deaths occurring in England and Wales are registered on the General Register Office's Registration Online system (RON).

https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/deaths/bulletins/deathsregisteredweeklyinenglandandwalesprovisional/weekending7may2021.

IRELAND – https://www.nisra.gov.uk/publications/monthly-deaths.

I have constructed for the period of analysis, January 2020–March 2021, the economic loss variable as the percentage reduction in the industrial production index of each country with respect to EU average of 2019. Thus, the economic loss variable is a positive percentage value. It is equal to one at zero loss by construction. It is stationary, as it is a difference of an I(1) variable.

I have constructed for each country the average number of deaths for the weeks in the period 2015–2019 and I have constructed for the period of analysis, January 2020 – March 2021, the excess mortality rate for each country as the ratio of the monthly deaths over the average 2015–2021. Thus, the mortality rate is in index number = 1 at the 2015–2109 value. It is stationary, as it is a difference of the trend mortality.

I have taken the economic sentiment indicator as published divided by 100.

The main descriptive statistics of the variables of Fig. 1 in the text are reported in Table A2.

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