Written evidence submitted by Philip Thomas, Professor of Risk Management, South-West Nuclear Hub, University of Bristol

Personal statement
I have developed the Judgement- or J-value (www.jvalue.co.uk ) as an objective and validated method of estimating the maximum rational expenditure on measures or systems to protect people and the environment.

The J-value was used originally to assess safety provisions in the nuclear industry, BNFL, MoD (nuclear propulsion) and EDF. It was recently applied to assess the effectiveness and rationality of the mass relocation policies adopted after the big nuclear accidents at Chernobyl and Fukushima Daiichi (www.nrefs.org ). I continue to work with Fukushima Medical University on the restoration of normal life in the Fukushima Prefecture as an Invitational Fellow of the Japan Society for the Promotion of Science (JSPS).

The J-value is a general method and so can be employed in any field to assess safety schemes designed to reduce a threat to human life.

It has been used in the present Covid-19 epidemic to link epidemiological and economic models to allow the objective worth to be assessed of countermeasures such as lockdown.

My testimony addresses three issues raised in the Call for Evidence. These fall under the heading, "Economy, public finances and monetary policy", and I shall attempt to answer the following questions:

1. What economic challenges may arise as the public health and social distancing policies are lifted and the economy begins to recover? What preparations can be made to manage these challenges?
2. Is the economy’s recovery likely to be shallow or sharp?
   - How long is the shock likely to last?
3. What are the differences and similarities between this shock and the Great Financial Recession of 2008 and also the economic demand management and demand suppression policies pursued during the Second World War? What lessons can be learnt from these past shocks and the recoveries that ensued?

Summary
With an effective vaccine not available, there are four basic options for leaving lockdown. Combining epidemiological and economic modelling using the J-value allows predictions to be made for each option of the loss of life due to Covid-19 and that caused by the coronavirus recession. This allows a ranking based on minimising the total amount of life lost. The Government's declared aim of keeping the basic reproduction number below 1.0 emerges as the worst option in terms of life preservation. Loss of life due to economic impoverishment is likely to dominate over that due to Covid-19 unless the departure from lockdown occurs quickly. A rapid but controlled exit, where the basic reproduction number is allowed to rise well above 1.0, will minimise overall loss of life and allow the economy to restart fully in 2021.
Evidence
There are four basic options for leaving lockdown which can be understood in terms of the behaviour of the basic reproduction number, $R_0$, over time.

The results will be summarised for each option, which will contain three graphs:
- the behaviour of $R_0$ with time
- the daily new cases over time, relative to the first peak of 4,000 cases
- the length and depth of the coronavirus recession.

as well as a table which shows the loss of life due to Covid-19, the loss of life caused by the economic recession and the combined total. A brief commentary is also provided.

The graphs and table are based on the methods described in:


The exceptionally sunny and dry weather that the UK has experienced since the lockdown began on 23 March 2020 may have created a seasonal effect and kept the $R_0$ value lower than otherwise. If such is the case, the infection transients associated with Options 2, 3 and 4 might be delayed until the autumn. See reference 3 and


The causal link between GDP per head and life expectancy for the average citizen is a J-value result (the 'Bristol curve') that is valid for 180 out of the 193 nations in the UN, as explained in:

5. Philip Thomas and Ian Waddington, 2017,"Validating the J-value safety assessment tool against pan-national data", *Process Safety and Environmental Protection*, Vol. 112A, 179 – 197, November. Available at: https://ac.els-cdn.com/S0957582017302896/1-s2.0-S0957582017302896-main.pdf?_tid=e4b52f78-d2e5-11e7-b19e-00000aad60&acdnat=1511713484_c1408cbb7c734eb48189e8be89fec68
Option 1. Keep the Basic Reproduction Number, $R_0$, below 1.0 (Government's currently declared policy)

- **Basic Reproduction Number, $R_0$, over time**
- **New daily cases relative to the first peak of 4,000 in April 2020**
- **Annual GDP falls by 29% in 2020 and does not recover**

**Number of average lives lost**

<table>
<thead>
<tr>
<th></th>
<th>Number of average lives lost</th>
</tr>
</thead>
<tbody>
<tr>
<td>To Covid-19</td>
<td>6,000</td>
</tr>
<tr>
<td>To national impoverishment</td>
<td>1,893,000</td>
</tr>
<tr>
<td>Total</td>
<td>1,899,000</td>
</tr>
</tbody>
</table>

An average life is 42 years, which is the length of time that UK citizens can expect, on average, to live from now.

The UK in lockdown is already close to $R_0 = 1$ so that only a small relaxation is possible under Option 1. $R_0$ rises from 0.74 under lockdown to 0.999 by the middle of June 2020. Near-lockdown conditions then persist indefinitely.

The number of cases of Covid-19 declines, but little immunity is built up. ~5% of the population will have contracted the virus after several years, so the nation is almost as vulnerable to further epidemics in 2025 as it was in January 2020.

National output declines to 71% of its pre-lockdown value and does not recover. Only a relatively small number of lives are lost to Covid-19. However life expectancy declines markedly due to serious national impoverishment. This implies that many people will die prematurely from non-Covid causes.

The loss of life is 1.9 million average human lives, almost all of which are caused by the nation's fall in economic activity as a result of lockdown and continuing near-lockdown conditions. Such a harmful option can be justified only if there is a high probability that an effective vaccine will be available and rolled out in the near future.
Option 2. Move out as quickly as possible without overstraining the health services

Basic Reproduction Number, $R_0$ over time

Daily new cases over time, relative to the first peak of 4,000 in April 2020

Annual GDP falls by 20% in 2020 and recovers over 3 years

Option 2 entails a slow move out of lockdown taken in steps. $R_0$ is allowed to rise to 1.18 by the middle of June 2020, and it is held there for about a year. It is then increased to 1.6. This level is maintained for a year, after which all restrictions are abolished, and $R_0$ rises to its unconstrained level of 1.94 in June 2022.

The health services need to cope with two peaks each of which is twice the size of that seen in early April 2020. The Nightingale field hospitals are brought into service.

The epidemic is over by June 22. Half the population has been infected in the end, meaning that the nation has herd immunity.

Gross domestic product falls by 20.2% in 2020. The economy takes until 2023 to recover.

644,000 average human lives are lost. Very roughly 10% of this loss of life is caused by Covid-19 and 90% by the nation's fall in economic activity.

![Basic Reproduction Number, R₀ over time](image1)

![Daily new cases over time, relative to the first peak of 4,000 in April 2020](image2)

![Annual GDP falls by 16% in 2020 but recovers in 2021](image3)

<table>
<thead>
<tr>
<th></th>
<th>Number of average lives lost</th>
</tr>
</thead>
<tbody>
<tr>
<td>To Covid-19</td>
<td>118,000</td>
</tr>
<tr>
<td>To national impoverishment</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Total</td>
<td>118,000</td>
</tr>
</tbody>
</table>

An average life is 42 years, which is the length of time that UK citizens can expect, on average, to live from now.

The basic reproduction number, $R_0$, is allowed to rise to 1.45 by mid-June 2020. All restrictions are removed on 1st January 2021, when $R_0$ increases to its unconstrained level of 1.94.

There is a single additional wave, the peak of which occurs in September 2020. This is about 9 times the size of that seen in April 2020. The Nightingale hospitals will be needed and even so the health services will struggle to cope. The death rate is assumed to double as a result. However, 54% of the population has been infected by the end of 2020, so that herd immunity is developed.

Gross domestic product falls by 16.1% in 2020. However, the economy recovers in 2021.

The number of average lives lost is 118,000, due entirely to Covid-19. It is assumed that no additional lives will be lost to national impoverishment because the recession is short lived.
Option 4. Move out of lockdown as fast as possible

Basic Reproduction Number, $R_0$ over time

Daily new cases over time, relative to the first peak of 4,000 in April 2020

Annual GDP falls by 7% in 2020 but recovers in 2021

Under Option 4 all restrictions are removed by 12 June 2020, when $R_0$ returns to its unconstrained value of 1.94.

There is a single additional spike of infections peaking in late July 2020, 30 times the size of that seen in April 2020. The health services are overwhelmed, and the death rate is assumed to double as a result. 77% of the population are infected by the end of 2020, so that herd immunity is assured.


The number of average lives lost is 170,000, all caused by Covid-19. It is assumed that no lives will be lost to national impoverishment because the recession is short lived.
Responses to the questions posed in the Call for Evidence

1. **What economic challenges may arise as the public health and social distancing policies are lifted and the economy begins to recover? What preparations can be made to manage these challenges?**

A 2nd wave of infections is to be expected unless the UK is to stay in semi-lockdown in perpetuity (Option 1). The possible inhibition of the virus during the summer months may mean the 2nd wave is delayed until the autumn.

It is clear that adopting Option 3 would minimise the nation's total loss of life. It is superior to the fastest possible exit of Option 4 and much better at preserving life than either Option 2 or Option 1, which offer slower routes out and have worse effects on economic activity. The greater national impoverishment over a longer period entailed by Options 1 and 2 leads to a high, consequential loss of life.

The rapid but controlled exit from lockdown required by Option 3 would, however, test the capacity of the health services even with the Nightingale hospitals brought fully into commission. These services would need to be strengthened to the point where a large second wave of cases could be managed if necessary.

Finding a way of coping with a large second wave of infections constitutes the principal challenge, both strategic and economic.

2. **Is the economy’s recovery likely to be shallow or sharp? How long is the shock likely to last?**

The length and depth of the coronavirus recession depends entirely on the strategy chosen for leaving lockdown.

Conscientious enactment of the Government's currently declared strategy of keeping the infection rate, $R_0$, below 1.0 corresponds to Option 1. It would mean an L-shaped depression, with no recovery unless and until an effective vaccine has been discovered and rolled out. Annual GDP would fall by nearly 30% and remain at that level indefinitely.

Managing the infection rate, $R_0$, to ensure that the health services as currently set up could cope corresponds to Option 2. GDP would fall by 20% in 2020, and the recession would then last until 2023.

Options 3 and 4 both offer ways of restricting the recession to 2020 only. A totally uncontrolled exit (Option 4) would lead to a smaller fall in annual GDP than the controlled exit of Option 3, but a higher total of deaths from Covid-19.
3. What are the differences and similarities between this shock and the Great Financial Recession of 2008 and also the economic demand management and demand suppression policies pursued during the Second World War? What lessons can be learnt from these past shocks and the recoveries that ensued?

In the Great Financial Recession of 2008, UK real-terms GDP per head fell by 6% between 2007 and 2009, and did not recover to its 2007 figure until 2015. The effect of the recession on life expectancy was revealed 2 – 3 years after the severe dip of 2008 – 2009. Life expectancy at birth, which had been increasing at a consistent rate of about 2½ months per year for the previous 30 years, stalled between 2011 and 2012 and has been flat-lining since that time.

The J-value-based Bristol curve suggests that a prolonged fall in GDP per head of 6.4% would cause the life expectancy of the average citizen in the UK’s population of 67 million to fall by 3 months (Ref 1). This represents a very large loss of life, which would arise from premature deaths across the age range. It would equal the maximum possible amount of life lost to Covid-19, based on epidemiological modelling.

It is clear that the UK lost at least 3 months in terms of life expectancy foregone by the average citizen as a result of the Great Financial Recession. This was the basis for reference 1 concluding that the Government needed to manage its interventions so that the coronavirus recession would not be significantly worse than that following the 2007 – 2009 financial crash. If not, its countermeasures would cause more life to be lost than gained.

All four options lead to UK annual GDP in 2020 falling by more than in the worst year of the Great Financial Recession. The only hope of averting a greater loss of life expectancy is to restrict the length of the recession. In practical terms, that means steering as close as possible to the rapid but controlled exit from lockdown exemplified in Option 3.

June 2020