THE COSTS AND BENEFITS OF A COVID-19 LOCKDOWN

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1. Introduction

As with most other countries, the New Zealand government recently implemented a substantial curtailment of normal activities in order to reduce the death toll from Covid-19 ("lockdown"). Since then, curtailments have been lessened but still substantial, most particularly in restricting foreign visitors. This paper attempts to estimate the cost of such a policy (especially in terms of the GDP losses) relative to the additional lives saved, so as to compare this to currently employed ratios for guiding public policy in general. It then considers whether the current policy should be maintained.

2. Analysis

To date, the New Zealand death toll from Covid-19 has been 22, and there have been no deaths since May 28.[1] The justification for the lockdown was the likelihood that the death toll would have otherwise been considerably larger. The first estimates of this type were presented for the UK by Ferguson et al (2020), who estimated that a China style "suppression" policy (which might have to be maintained for several months) would yield about 20,000 deaths in the UK (ibid, Table 4) whilst that from a much milder "mitigation" policy (involving isolation of only high risk groups and suspect cases) would yield about 250,000 deaths (ibid, page 16). Ferguson et al therefore recommended suppression, and their recommendation appears to have significantly influenced UK government policy. However, and remarkably, the paper contains no information on the costs of adopting a suppression rather than a mitigation policy. Implicitly, their goal seems to be to minimize the number of deaths regardless of the cost. This is not a rational policy, and could involve inflicting on a country a 'cure that was worse than the disease'.

[1] See https://www.worldometers.info/coronavirus/country/new-zealand/.

Turning to New Zealand, Ferguson et al's (2020) expected saving in lives from a suppression policy rather than a mitigation policy (of 230,000) would translate into 17,000 lives for New Zealand if the results here were proportional to the difference in populations (5m for NZ and 68m for the UK). These 17,000 people would be mostly old and almost all would be suffering from pre-existing conditions.[2] Ferguson et al (2020, page 7) also estimate the casualties at 510,000 from no control measures, implying a worst case saving in lives from a suppression strategy over (totally ineffective) mitigation efforts at 490,000, implying a saving in lives in New Zealand of 36,000.

Subsequent estimates for New Zealand come from Blakely et al (2020), who estimated the deaths from an "eradication" policy (akin to suppression) at 500 and those from a mitigation policy at 6,500-13,000. The expected saving in lives from eradication rather than mitigation is therefore 6,000-12,500. Blakely et al (2020) also proffered an estimate for the average residual life expectancy of the victims sans Covid-19 at five years, implying the number of life years saved at 6,000*5 = 30,000 to 12,500*5 = 62,500. By contrast, in examining the UK situation, Miles et al (2020, page 68) estimates the average residual life expectancy of the victims sans covid at 10 years by reference to mortality tables for people of the relevant ages and sexes. However, as acknowledged by Miles et al (2020, page 69), the fact that most of these people have at least one serious pre-existing condition implies that this estimate of ten years is far too high. This leads them to reduce it to about six years, and then to apply a 20% discount to reflect their less than perfect quality of life, yielding a Quality Adjusted Life Years (QALY) saved per victim of five years. For New Zealand, the saving in QALYs would then range from a lower bound of 6,000*5 = 30,000 to an upper bound of 12,500*5 = 62,500.

Since New Zealand has suffered only 22 deaths to date, and none since 28 May, Blakely et al's (2020) estimate of 500 deaths from an eradication policy would seem to be far too high. Accordingly, their estimates of 6,500 – 13,000 deaths from a mitigation policy are also likely to be too high. To better estimate this, it is desirable to locate a country otherwise identical to

[2] In respect of those dying in New York City up to May 13, 96% were at least 45, and 74% at least 65. Furthermore, in those cases where the existing medical condition of the patient was known (no underlying condition or at least one underlying condition), 99% had at least one underlying condition. See https://www.worldometers.info/coronavirus/country/new-zealand/.

New Zealand but which pursued a mitigation rather than a suppression strategy. No such country seems to exist but Sweden appears to be the best available alternative because it adopted a mitigation strategy and is similar to New Zealand is many relevant ways. In particular, both countries are largely populated by Caucasians emanating from or native to Northern Europe, with similar population density, living standards and the quality of their health care systems. To date Sweden has suffered 570 deaths per 1m of population and the increase in the rate is tailing away to zero.[3] All countries that have experienced higher death rates (Belgium, Spain, Italy, UK, and Peru) engaged in some form of lockdown, and therefore are not suitable estimators for the death rate under a mitigation strategy.[4] So, using Sweden's death rate of 570 per 1m, New Zealand's population of 5m implies 2,850 deaths under a Sweden-style mitigation policy. The QALYs saved would then be (2,850 – 22)*5 = 14,140.

Even this figure is likely to be too high because, if New Zealand suffered the same death rate as Sweden under a mitigation policy, Sweden's Nordic neighbours (Denmark, Norway and Finland, who like New Zealand all locked down) would be expected to have had the same death rate as New Zealand, but instead all have much higher rates (107, 47 and 60 versus 4 for New Zealand). A plausible explanation for this increase is the proximity of these Nordic nations to other nations with large numbers of victims coupled with land access from those other nations. So, Sweden's 570 per 1m is an upper bound. A more plausible figure is much lower, but incapable of reliable estimation.

Even this upper bound is likely to be too high because most claimed victims of Covid-19 suffered from at least one serious existing condition and some of these deaths might have occurred at the same time even in the absence of Covid-19. Similarly, if a person is shot in the heart and then the head, and then dies, one should not attribute the death to the head shot. A test for this issue would be to estimate the number of deaths that would have occurred in the absence of Covid-19 and the number truly attributable to it is then the actual deaths in 2020 less the predicted number sans Covid-19. The Euromomo Network has done so and estimated the number of deaths across 18 European countries progressively through 2020, 2019 and 2018 relative to a baseline. The excess deaths in 2020 to date relative to 2019 at the

[3] See https://www.worldometers.info/coronavirus/country/sweden/.

[4] See https://www.worldometers.info/coronavirus/ for the death rates, and Wikipedia pages for the policies pursued by their governments.

same point is about 90,000 and that relative to the 2018/2019 average at the same point is about 115,000.[5] By contrast, the deaths attributed to Covid-19 across these 18 countries were 170,457.[6] Thus, the deaths attributed to Covid-19 seem to have been in excess of the true number by 50-90%. Using the midpoint of 70%, the expected death toll for New Zealand under a mitigation policy would then be no more than 570/1.7 = 335 per 1m, which implies 1,675 deaths and the QALYs saved would then be no more than (1,675 – 22)*5 = 8,265.

Turning now to the costs of the policy, this principally takes the form of lost GDP. Shortly before the pandemic arose, in December 2019, The Treasury (2019, page 3) forecasted New Zealand's real GDP growth rates for 2020-2024 at the rates shown in the first row of Table 1. This is a lower bound on growth under the pandemic but with *no* curtailment of economic activity, because the pandemic would have increased health care expenditures. More recently, in May 2020, these forecasts have been revised as shown in the third row of the table (The Treasury, 2020, page 3). Arbitrarily designating 2019 GDP as 100, the GDP results under these two paths are as shown in Table 1.

Table 1: GDP Forecasts

	2020	2021	2022	2023	2024	Sum
Dec 2019 Forecasts	2.2%	2.8%	2.7%	2.5%	2.4%	
Implied GDP	102.2	105.1	107.9	110.6	113.3	539.1
May 2020 Forecasts	-4.6%	-1.0%	8.6%	4.6%	3.6%	
Implied GDP	95.4	94.4	102.6	107.3	111.1	510.8

The aggregate difference in these two paths is 539.1 – 510.8 = 28.3, which represents 28% of New Zealand 2019 GDP. Since New Zealand's 2019 GDP was $311b, this is $87b.[7] Even this may be too low for two reasons. Because the 2024 GDP level under the curtailment

[5] See https://www.euromomo.eu/graphs-and-maps#excess-mortality.

[6] The countries are Austria, Belgium, Denmark, Estonia, Finland, France, Greece, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the UK. For the deaths, see https://www.worldometers.info/coronavirus/.

[7] The GDP figure comes from Table M5 on the website of the RBNZ (www.rbnz.govt.nz).

scenario is below that from the no-curtailment scenario (111.1 versus 113.3) and such GDP losses relative to the counterfactual would continue until these levels were equal.

In summary, the QALYs saved by locking down rather than mitigating is estimated at no more than 8,265 whilst the GDP losses from the curtailment of economic activity are expected to be at least $87b. Some of these GDP losses would have arisen without any government-imposed restrictions, because some people would have reduced their interactions with others anyway; for example, a foreigner electing not to make a trip to New Zealand that they would otherwise have made. Further losses would have arisen due to the additional actions of foreign governments; for example, foreign governments preventing their citizens from making foreign trips. Further losses would have arisen if the New Zealand government had followed merely a mitigation strategy. Further losses would have arisen from the New Zealand government instead following a suppression strategy. It is only the last of these losses that can be attributed to the New Zealand government choosing to lockdown rather than mitigate. Estimating the proportion arising from this residue is problematic but Miles et al (2020, page 70) estimate it at 2/3. In the interests of being conservative, I halve this proportion to 1/3. So, the GDP loss from lockdown rather than mitigation would be 1/3 of $87b, i.e., $29b. The cost per QALY saved would then be $3.5m as follows:

$$\frac{\$29b}{8{,}265} = \$3.5m$$

This is a lower bound on the cost per QALY saved because the GDP loss of $87b is a lower bound and the QALYs saved of 8,265 is an upper bound. By contrast, the pre Covid-19 value of a QALY in New Zealand was about $45,000 (Kvizhinadze et al, 2015, page 3).[8] Thus, with Covid-19, the cost of adopting a suppression rather than a mitigation policy per additional QALY saved would be at least 78 times the pre Covid-19 value for a QALY. This is an extraordinary difference. Consistency would require spending at least $29b to extend the lives of 1,650 people suffering from heart disease, cancer or diabetes, which is 50% more than the entire annual government spending on health care in New Zealand.

[8] Blakely et al (2020) uses the same figure whilst Miles et al (2020, page 68) reports a similar figure of 30,000 pounds in the UK. A related concept is the "Value of a Statistical Life", which values all lost years of an average aged person's life. Such estimates are accordingly much larger than the value of a QALY. Conducting the analysis at the QALY level is superior because the likely fatalities from covid-19 have very low residual life spans.

Furthermore, the $29b loss (and likely more) may not be 'evenly' shared (through the tax system in the usual way with medical expenditures to extend lives). It may fall largely on two groups. The first own businesses and would suffer a loss in profits. The second would lose their jobs and remain unemployed for some period. By adopting a suppression rather than a mitigation policy, in order to moderately extend the lives of 1,000 largely old and sick people, these two other groups might suffer substantial financial losses. The extent to which this actually occurs will depend upon the extent to which the government compensates them for these losses. Furthermore, even if the government does intervene in an attempt to protect some vulnerable groups, other vulnerable groups may be inadvertently hurt. For example, if rent payments were suspended by government for some period, landlords will suffer and some of them will be retired people who derive a considerable proportion of their modest incomes from this source. In addition, prospective landlords will not rent out their properties, to the disadvantage of both parties.

Some of the parameters used in this analysis are very debatable. However, the values selected have been chosen to minimize the cost per QALY saved. Any reasonable alternative parameter values would increase this cost per QALY saved. For example, if the death rate under a mitigation rather than a suppression policy were halved, the cost per QALY saved would double to $7m. Alternatively, if the proportion of the $87b GDP loss attributed to lockdown versus mitigation were raised, the cost per QALY saved would also rise. Even if this proportion were instead halved from 1/3 to 1/6, this would merely halve the cost per QALY saved from $3.5m to $1.75m, but this would still be 39 times the pre-covid value. It is not conceivable that baring every non-essential worker from working who would otherwise do so, and baring every person who wishes to participate in entertainment activities within New Zealand (involving flights, visits to hotels, motels, sports events, cinemas, restaurants and cafes), would contribute less than 1/6 to the GDP loss of $87b.

This analysis omits many relevant features, some of which would reduce the cost per QALY saved by a suppression rather than a mitigation policy, but the huge excess in the cost per QALY saved from a suppression rather than a mitigation policy over currently accepted values for a QALY provides considerable scope for such additional features without changing the fundamental conclusion. Firstly, with a mitigation rather than a suppression policy, the health system may be so overwhelmed by Covid-19 cases that many other people may die

from lack of care. However, even if the number of these extra deaths were as large as those from a mitigation rather than a suppression policy (Boyd, 2020, page 4), it merely halves the cost per QALY saved in the above analysis, still leaving the cost per QALY saved well in excess of currently accepted values for a QALY. Secondly, there are direct medical costs of dealing with the demand surge from a mitigation rather than a suppression policy. However, any reasonable estimate of these costs has no material impact on the result. For example, if these extra medical costs were as much as $2b (Boyd, 2020, page 4), the cost of a suppression rather than a mitigation policy would then be $27b rather than $29b, which only trivially lowers the cost per QALY saved.

Thirdly, some Covid-19 survivors will experience significant long-term adverse consequences.[9] However neither Ferguson et al (2020), nor Blakely et al (2020) nor Miles et al (2020) comment on it, and all three teams of authors contain at least one co-author who is a medical expert; this suggests that none of them judge it to be a very significant issue. Nevertheless, this can be tested. For example, if 10 people experience serious long-term consequences from contracting Covid-19 for every death, and their quality of life is thereby reduced by 20% (consistent with the figure used earlier for people suffering from serious pre-existing conditions), this is equivalent to tripling the QALYs saved by suppression rather than mitigation, thereby reducing the cost per QALY saved from $3.5m to $1.2m; this would still be 27 times the generally used pre-covid value. So, because the cost per QALY saved from suppression relative to mitigation is so much larger than the generally used figure, even a significant allowance for this issue does not change the conclusion here.

This analysis also omits many features that would raise the cost per QALY saved. Firstly, some of the lives saved from a suppression rather than a mitigation policy would be lost anyway when the suppression policy restrictions are lifted (as they inevitably must be). So, the additional lives saved by suppression rather than mitigation are overestimated. Secondly, suppression increases unemployment and therefore leads to an increase in addiction, crime, mental health problems, and premature death. Thirdly, the normal operation of the health care system is disrupted. In respect of the UK, Miles et al (2020, page 68) notes that referrals for cancer investigations were 70% down in April 2020, and outpatient visits were 64% down

[9] See https://www.businessinsider.com.au/coronavirus-survivors-lung-damage-ards-fcim-intensive-care-research-2020-3?r=US&IR=T.

between mid March and early June. Fourthly, there are adverse consequences from students not attending school. All of these raise the cost per QALY saved.

In addition, the appropriate cost from the GDP losses is not the GDP losses themselves but the "economic surplus", which is the consumer surpluses (the aggregate amount consumers are willing to pay in excess of the amounts actually paid for all goods and services) plus the producer surpluses (the aggregate amounts received by producers less the amounts they would be willing to accept to produce at this level), and this sum could be more or less than the GDP losses. Again, there is considerable room for large adjustments before suppression involves a cost per QALY saved no higher than generally employed figures on the value of a QALY.

All of this suggests that the cost per QALY saved of a suppression rather than a mitigation approach by the New Zealand government is dramatically inconsistent with long-established views on the value of a QALY. This holds even if the actions of foreign governments, most of whom adopted some variant of temporary lockdown, are taken as given.

3. Looking Forward

The above analysis looks back at the wisdom of the New Zealand government's suppression decision earlier this year, and concludes that it was in error in light of the subsequent experience of Sweden and The Treasury's most recent GDP forecasts. This is useful but even more useful now would be to assess the cost per QALY saved from continued pursuit of a suppression strategy rather than switching now to a Sweden-type approach. Again, Sweden's death rate of 570 per 1m, reduced to 335 to deal with the evident overestimation in the deaths attributed to covid, is the upper bound on the deaths from doing so. The lower bound on the extra deaths from continued suppression is zero. So, the upper bound on the incremental deaths is 335 per 1m. Adjusted for New Zealand's population of 5m yields 1,675, and multiplying by 5 as before yields the upper bound on the QALYs saved of 8,375.

The difficult part is the incremental GDP loss from continued pursuit of suppression versus a Sweden-style approach. Inter alia, this depends upon how long the current Auckland lockdown will continue under the government's current suppression approach, and whether it will be repeated and/or extended to other parts of the country should further covid cases be

found there. Rather than trying to guess at this, I instead ask what is the smallest GDP loss consistent with continued suppression (rather than switching to mitigation) yielding a cost per QALY saved equal to the pre covid generally accepted figure of $45,000. Calling this smallest GDP loss Q, it is the solution to the following equation:

$$\frac{Q}{8{,}375} = \$45{,}000$$

The solution is Q = $377m. So, if the incremental GDP loss from continued suppression versus switching to a Sweden-style mitigation approach is more than $377m, switching to a Sweden-style approach is warranted. Given that the adoption of a suppression rather than a mitigation strategy earlier this year is estimated to cost $29b, it is inconceivable that Q could be less than $377m. Switching to a Sweden-style approach is therefore clearly warranted.

4. Conclusions

World-wide, many governments have implemented substantial curtailments of normal economic activity in order to reduce the expected death toll from Covid-19. This paper firstly considers the effect of the New Zealand government adopting a suppression policy earlier this year rather than a milder mitigation policy, with the actions of other governments taken as given. The cost per QALY saved from doing so would seem to have been at least 78 times that of the currently used value for a QALY of $45,000. Consideration of alternative parameter values and recognition of factors omitted from the analysis would not likely reverse this imbalance in cost per QALY saved versus the currently accepted figure for the value of a QALY. The suppression policy was therefore dramatically inconsistent with long-established views about the value of a QALY.

This paper then considers the merits of continued suppression versus switching now to a Sweden-style mitigation approach, and concludes that switching is clearly warranted.

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