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Applying the precautionary principle to pandemics

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Author's note: The pragmatic analysis of proportionality outlined here is superseded by the one in my book *The Edge of Sentience: Risk and Precaution in Humans, Other Animals, and AI* (OUP, 2024). I will at some point aim to apply the book's analysis of proportionality to the pandemic case.

Abstract

When faced with an urgent and credible threat of grave harm, we should take proportionate precautions. This maxim captures the core commitments of the "precautionary principle". But what is it for a precaution to be "proportionate"? I construct an account of proportionality (the "ARCANE" account) that consists of five fundamental conditions (absolute rights compatibility, reasonable compensation, consistency, adequacy and non-excessiveness) and a tie-breaker (efficiency). I apply this account to two examples from the COVID-19 pandemic (border closures and school closures), arguing that my account captures the key questions on which it is both feasible and important to integrate expert input with democratic input. I close by considering how we might try to manage the risk of future pandemics in a proportionate way.

The COVID-19 pandemic has been a global public health catastrophe. At the time of writing, over 4 million deaths from COVID-19 have been reported (Worldometer 2021). In my own country, the UK, there have been over 150,000 deaths (UK Government 2021). How can humanity manage the risk of pandemics better in the future? Two major challenges are combined in this question: the challenge of *responding* to new pathogens when they emerge, and the challenge of *preventing* them from emerging. My aim is to set out the core elements of a precautionary approach to both challenges.

1. Limitations of cost-benefit analysis

In a cost-benefit analysis, the costs and benefits of a policy in different scenarios are weighted by their probabilities and valued in a common currency. This is often regarded as a gold standard for policy evaluation. Responses to COVID-19 have not generally been guided by cost-benefit analysis, leading to debate about whether such analyses should be, or should have been, carried out (Appleby 2020; Wilkes 2020). I am myself sceptical of the idea that cost-benefit analysis is the right tool for pandemic risk management, for three main reasons.

The first is the problem of *excessively wide probability ranges*. In the early stages of the pandemic, scientific advisers to the UK government avoided terms such as "forecast", "prediction", or "central projection". They instead modelled a "reasonable worst-case scenario" without assigning a probability to this or any other scenario (see, for example, MRC-CGIDA 2020). They did not think the data available supported the assignment of probabilities. By contrast, cost-benefit analysis inherently involves assigning probabilities to possible outcomes (Bradley & Bright 2020). If you cannot impose a reasonable degree of precision on the probabilities, you are unlikely to obtain unambiguous recommendations. You can generate artificial precision by encouraging scientists to go *beyond* what their evidence objectively supports and instead report their subjective degrees of belief, but scientists are right to be reluctant to do this. When evidence is scant, the scientists' subjective degrees of belief will be heavily influenced by their prior probabilities, and there is no good reason to allow the priors of scientists (which are likely to reflect their own values and biases) to set policy on momentous issues.

The second is the problem of *varying attitudes towards risk*. Suppose you have constructed a common currency for weighing outcomes, such as the "quality-adjusted life year" or QALY (Whitehead & Ali 2010). People may still be risk-averse or risk-seeking with respect to that currency. For example, a risk-averse person might prefer a guarantee of 4 QALYs to a gamble with a 50% chance of delivering 10 QALYs and a 50% chance of delivering 0 QALYS. Cost-benefit analysis normally involves an assumption of risk-neutrality: it assumes that to be risk-averse or risk-seeking is irrational. But pandemics are a context in which departures from risk neutrality are both widespread and, at face value, reasonable. Suppose you are faced with a choice between 12 weeks of self-isolation or a chance of being exposed to the SARS-CoV-2 virus, and suppose the chance is such that the expected utility for you is the same for both options. Some people might well choose the risk-averse option of the 12 weeks of self-isolation; others might well choose the risk-seeking option. Speaking for myself, I find both attitudes reasonable.

Departures from risk-neutrality can be incorporated into cost-benefit analysis in technically complicated ways, provided data on citizens' attitudes towards risk is available, but at present this is a significant evidence gap (Lakdawalla and Phelps 2020). Yet even if we had copious data on attitudes towards risk, a deeper problem would remain: in a cost-benefit analysis there is no way to avoid introducing controversial *normative* judgements about which attitudes towards risk are *worthy of consideration* and which are not. To dismiss all non-neutral attitudes towards risk as unworthy of consideration is clearly a normative judgement. However, one does not avoid normative judgements simply by allowing departures from risk-neutrality, for one immediately runs into the question of whether all departures are equally worthy of consideration. If some people are risk-averse and others risk-seeking, should we give departures from risk-neutrality in both directions the same weight, or should we give greater weight to the risk-averse? Should we incorporate departures *within a reasonable range*, while discounting extreme risk-aversion and extreme risk-seeking, or should we regard everyone's attitude towards risk as equally reasonable? I suggest that, in a democratic society, we should look for ways of settling a fundamental normative issue like this democratically, rather than leaving it in the hands of experts.

The third problem is that of *value conflict and incommensurability*. We assumed above that a common evaluative currency, such as the QALY, could be constructed, but pandemics cause such a diverse array of harms that any such currency will be placed under severe strain. For example, I am sceptical of the idea that there is a normatively justified common currency in which one can weigh the disvalue of educational losses to children from sustained school closures against the value of human lives that might be saved by closing schools. Reduce everything to maximizing expected QALYs and you miss morally important considerations, such as the injustice arguably involved in forcing children to make large and long-term sacrifices for the sake of older generations. A similar problem arises if we try to compare the cultural loss of the devastation to the arts sector wrought by lockdowns against lives saved. As with attitudes towards risk, these value conflicts should not be hidden or assumed away. In a democratic society, they should ideally be resolved through open, inclusive, democratic procedures, as Nordheim et al. (2021) have argued.

2. A precautionary framework for managing major risks

These problems point to the need for an alternative framework for managing major risks. An attractive initial thought is that perhaps the "precautionary principle" can provide the framework we need. It is tempting to think that we should, in some sense, "err on the side of caution" in our responses to pandemics, just as we often do in environmental policy, where the precautionary principle has been discussed a great deal.[1] However, a lot of actions may count as "erring on the side of caution", and the precautionary principle has been a great source of unclarity and confusion for policy-makers. This has led to a huge body of case law,

[1] For entry points to the existing literature on the interpretation of the "precautionary principle", mainly in the context of environmental policy and technology policy, see O'Riordan & Cameron 1994; O'Riordan et al. 2001; John 2010, 2019; Munthe 2011; Steel 2015; Stirling 2016; Science for Environmental Policy 2017.

jurisprudence and policy literature concerning how to interpret the precautionary principle in specific contexts. The context of pandemics has been somewhat neglected, at least relative to its new importance in light of COVID-19.

My aim here is to put forward one way of applying the precautionary principle to the context of setting public policy in response to major risks, such as pandemics. Many possible frameworks could be described as "precautionary" in various senses of that word, so I do not claim that what I am proposing is the *only* way to apply precautionary thinking to major risk management. But I do think it as an attractive way, in so far as it captures what I take to be the fundamental commitments of a precautionary attitude to risk.

I propose we think of the "precautionary principle" as a combination of a *high-level maxim* that does not aim to deliver specific policy recommendations and a *procedural framework* for implementing that maxim in a democratic way to generate specific recommendations.

2.1 One maxim, four fundamental commitments
Here is my proposed high-level maxim:

> When there is an **urgent** and **credible** threat of **grave harm**, **proportionate** precautions should be taken.

This aims to improve on previous general maxims, such as that in the 1998 Wingspread Statement (Montague 1998). The Wingspread slogan was that "when an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically". My proposal aims to captures the same general idea without unnecessarily limiting its scope. There is no reason to limit the scope of a precautionary framework to threats caused by "activities". A virus, for example, is not an activity, even though some human activities do increase the risk of new pathogens emerging. Nor should we limit its scope to threats to "human health or the environment" unless these are understood very broadly since, for example, threats to human well-being and threats to democracy may also warrant precautions. And scientific uncertainty need not be limited to "cause-effect relationships". Consider, for example, the R_0 parameter for a new respiratory virus: its reproductive rate in the absence of any attempts at mitigation or suppression. This is a dispositional property of the virus, not a "cause-effect relationship".

The high level of generality of the maxim leads to a corresponding limitation: the maxim does not imply any concrete policy recommendations. No one could mistake this maxim for an algorithm or decision rule that could be applied in a technocratic manner. Clearly, it does not specify any particular policy response to any particular threat. What it aims to do is crystallize what I take to be the four fundamental commitments of a precautionary approach to risk management.

The first commitment is that some harms are sufficiently *grave* that the state is obligated to try to guard against them: to make no attempt to do so is an unacceptable violation of the

duty of protection owed by the state to its citizens. Governments often draw a distinction between military risks and civil risks (such as risks to public health), and have separate frameworks for the two types of risk, the former involving much higher levels of secrecy. My focus here will on civil risks, but we need not write this distinction into the general maxim.

The second commitment is that some threats of grave harm are *urgent*, in the sense that the state is obligated to act immediately to protect its citizens against them rather than waiting for the threat to develop further. It is often very tempting, when faced with a major risk, to take no action and wait for more evidence to emerge. A precautionary approach is committed to the idea that, for a special class of urgent risks, a watching-and-waiting approach cannot be justified.

The third commitment is that, in order to justify precautions, the evidence for an urgent threat of grave harm need not be conclusive but must still be *credible*. There must be enough evidence to support taking the threat seriously. This deliberately sets an evidential bar that is lower than certainty, high probability or high confidence, while at the same time insisting that substantial evidence is needed to warrant the special treatment reserved for exceptionally urgent, exceptionally grave risks.

The fourth commitment is that the precautions taken must be *proportionate*. In very broad terms, to be elaborated upon later, this means that they should do just enough, without being excessive.

These four commitments—*gravity*, *urgency*, *credibility*, *proportionality*—have three important things in common. First, they describe imprecise, qualitative thresholds. There is no precise numerical threshold that separates a grave harm from a tolerable one, an urgent situation from a non-urgent one, a credible threat from a non-credible one, or a proportionate response from a disproportionate one. However, these are still real and important distinctions. Like the distinction between "bald" and "not bald", they are real but imprecise. Imprecision does not imply arbitrariness. We can construct procedures to rule on these questions in a principled, non-arbitrary way.

Second, the four commitments highlight questions that call for *mixed judgements*: judgements that combine both epistemic (i.e. relating to evidence and knowledge) and evaluative (i.e. ethical, social, political) considerations, with no clean way to separate out the two types of consideration (Plutynski 2017; Alexandrova 2018). The urgency of a risk may sound like a purely epistemic matter, but it depends on whether the risk of waiting for more evidence is *unacceptable* given what is at stake, and this is an evaluative question. In a similar vein, it may seem like a purely epistemic matter whether a risk is credible or not, but I take the bar for credibility to be properly sensitive to the stakes. When a risk threatens the whole of humanity, it is appropriate to take it seriously even if the evidence is quite thin, because what is at stake has so much value (a point that is often made in the context of "AI safety", e.g. by Ord 2021). The judgement about where to set the evidential bar in relation to

the stakes is an evaluative one. The judgement about whether the evidence reaches that bar is epistemic. The overall assessment of credibility is a mixed epistemic-evaluative judgement.

Third, and most importantly, the four commitments point to questions regarding which *it is both feasible and important to integrate expert input with democratic input*. Due to their partly scientific character, these are judgments that should not be entirely made without expert input. But due to their partly evaluative character, they are judgements that should not, in a democratic society, be entirely left entirely in the hands of experts. They point towards the need for a procedural framework that provides a mechanism for integrating expert and democratic input on the questions of urgency, gravity, credibility and proportionality.

2.2 Outline of a procedural framework

What sort of procedural framework is needed? A full answer would be the work of a book, not a single article. In very broad terms, I am in favour of involving citizens' assemblies—assemblies of 100-1000 randomly selected citizens—in these decisions, as suggested briefly by Norheim et al. (2021). The technically complicated, scientifically-involved nature of a pandemic response is not a good reason to discount the value of public input. Kitcher (2002, 2011) has long argued for a role for citizens' assemblies in science policy, particularly in the context of priority setting and funding. We just need to distinguish the technical issues on which ordinary citizens are not well placed to contribute from the normative/evaluative questions on which they *are* well placed to contribute.

It is true that the challenge of responding to a pandemic calls not only for scientifically-informed policy but also for *rapid* policy decisions. Citizens' assemblies are usually called upon to discuss relatively non-urgent questions, such as new constitutions (Landemore 2020). They have also been used to consider possible responses to climate change (Climate Assembly UK 2020), which is an undoubtedly urgent problem, but the timescale is nowhere near as compressed as that of the response to a pandemic, where a delay of even a single day can have terrible consequences. Given this, perhaps we should not be surprised that such assemblies have not been a major feature of policy responses to COVID-19, although the French government established a citizens' panel to advise on vaccine confidence (see Casassus 2021). Yet I think the general idea of a citizens' assembly is one that *can* be tailored to urgent questions demanding rapid action. We just need to ensure that the questions posed to the assembly are clear, few in number, specific to the threat at hand, and answerable without high-level expertise—and we need to set the assembly a strict timetable for deliberating and voting on its answers.

In outline, a pool of around 6,000 randomly selected citizens (constructed through stratified sampling to resemble society as a whole) could be created, with frequent rotation and a term limit of about 1 year. This pool would be on standby in case of a major emergency. If a threat were detected by surveillance processes, such as surveillance for new respiratory viruses, an assembly of 300 would be drawn from this pool. They would meet online at short notice and initially be tasked with evaluating the urgency, gravity and credibility of the threat, with the ability to question scientific advisers and with the support of a secretariat. They would hear

evidence as a single group, break into smaller grounds for deliberations, and then reassemble to vote. The question posed to them would simply be: *Is there an urgent and credible threat of grave harm?* If the assembly decides that there is, the assembly would shift to evaluating the proportionality of shortlisted policy responses. Alternatively, this second task could be taken on by a second assembly drawn from the same pool. As the crisis unfolds, they would meet regularly (e.g. weekly) to evaluate the proportionality of what the government is doing at any given time and to make recommendations.

I imagine this proposal will lead to a variety of reasonable concerns: concerns about whether this process could really be carried out fast enough to allow a timely response; concerns about the democratic credentials of such an assembly, since the members are unelected (though see Landemore 2020 on this); concerns about the assembly's relationship to the executive and legislature; concerns arising from the possibility that the assembly could be badly misaligned with, and/or completely unresponsive to, public opinion (cf. Pettit 2010; Lafont 2019); concerns about accountability for the assembly's decisions, particularly if they turn out to lead to disaster; concerns about the independence of the assembly from its scientific advisers and secretariat; and concerns about the competence of randomly selected citizens with no scientific training to make the mixed judgements required of them (though see Fishkin 2018).

These concerns are too big to address fully in one article. The overall framework, then, has to be considered a work in progress. What I want to do here is zoom in on the specific issue of *proportionality*. What is it for a response to be proportionate to the threat, and how is this to be evaluated? What specific questions would be posed to the assembly? By giving an account of proportionality, I hope to partially defuse some of the above concerns by showing that, on this specific issue, it is desirable and feasible to integrate democratic input with expert input. The same work is needed for gravity, urgency and credibility, but this must await another occasion.

3. Five pillars of proportionality

My proposed framework for assessing proportionality involves five fundamental conditions (or "pillars"), plus a tie-breaker. I envisage this primarily as a framework that could be used to structure deliberation in public decision-making body such as a citizens' assembly. It is not intended to be applied by courts, though I do not rule out the idea that it could be adapted for this purpose.

The first pillar is ***absolute rights compatibility***. In contrast to the other tests, this is intended as a legal test, and it places a basic constraint on the options that should be taken forward for detailed discussion. A proportionate response must avoid infringing the absolute rights of those affected. Many rights are qualified in the sense that it is legal for a public authority to restrict them as a proportionate means to a legitimate aim, and epidemics are generally recognised as a possible context in which restrictions can be justified. The question of whether the suspension of a qualified right is excessive is one to be considered later, under

"non-excessiveness". By contrast, an absolute (or "non-derogable") right is a right that cannot be appropriately restricted in any circumstance, no matter how exceptional.

The International Covenant on Civil and Political Rights (ICCPR) (UN General Assembly 1966) recognizes several such rights: the right to life; freedom from torture or cruel, inhuman and degrading treatment or punishment; freedom from medical or scientific experimentation without consent; freedom from slavery and servitude; freedom from imprisonment for inability to fulfil a contractual obligation; freedom from the retrospective operation of criminal laws; the right to recognition as a person before the law; and freedom of thought, conscience and religion. I propose that any precaution that violates any of these rights for any person is ipso facto disproportionate.

An important not about "freedom of conscience" is that the ICCPR distinguishes between the freedom to *hold* a belief (including a belief that vaccines are ineffective, that lockdowns are immoral, etc.) and the freedom to *manifest* that belief. Only the former is absolute. The freedom to manifest one's beliefs can be restricted, and public health is recognised as a possible basis for restrictions.

The "right to life" is a source of complications, since national laws tend to make room for exceptions: in particular, the intentional killing of a person by the police or armed forces in the course of their duties is not always deemed a human rights violation. Moreover, pandemics can put decision-makers in a situation where, whatever they decide, some people will foreseeably die. There may be intentional allowing of a certain level of death, albeit without intentional killing.

I take it that the right to life does *not* compel decision-makers to handle emergencies in a way that minimizes expected deaths. I interpret the requirement as a more minimal one: the requirement is that no one shall be intentionally killed in the course of an emergency response except for reasons that would be justifiable in normal times. Clearly, though, this is a point where legal expertise needs to be on hand in any deliberative process. Some options should simply be screened out immediately for being incompatible with absolute rights. For example, the idea of carrying out challenge trials of potential vaccines *without* the subjects' informed consent should be screened out immediately, whereas the idea of doing this *with* informed consent should not (Jemrosik & Selgelid 2020).

The second pillar is ***reasonable compensation***: those that are harmed by a response to a threat will be compensated where this is reasonable. Sometimes it may not be reasonable. For example, consider the EU's 2013 ban on neonicotinoid pesticides as a precautionary measure to protect against the collapse of bee colonies (Carrington 2013). It is not clear that the pharmaceutical companies affected deserve compensation, since we might well feel that they were also culpable for creating the risk and profited from creating it. Yet sometimes people affected by precautions are not culpable for creating that risk. Think here of school children affected by school closures. In these cases, reasonable compensation should be part of the response.

The third pillar is ***consistency***. Care is needed when specifying what consistency requires in this context. The EU takes "consistency" to mean "consistency with precedent": a precaution should be consistent with other policies adopted in the past (European Commission 2000). But I disagree that this is a fundamental condition, especially in emergencies where the situation is rapidly evolving. Sometimes it is reasonable to overturn precedent. What is important, by contrast, is that *the response does not generate a new threat that itself calls for a precautionary response*. This sense of "consistency" has been emphasized by Steel (2015). The sort of "consistency" at issue here is deontic: we cannot simultaneously have a duty to do an action *A* and to cancel/undo *A.*

Note that, to generate a real problem of consistency, the new threat must be serious enough (that is, grave, urgent and credible enough) to itself call for a precautionary response. Sometimes the new threat will not clear this bar. For example, closing borders will disrupt many people's travel plans, leading to many holiday and event cancellations, but an appropriate democratic process might well judge that this new threat is not serious enough to require a precautionary response at all, as long as reasonable compensation is paid to those affected.

An important qualification: sometimes a precaution generates a new threat, but this new threat can be controlled (i.e. held at an acceptably low level) compatibly with the original threat. In such a case, the existence of the new threat is not a good reason to avoid the original precaution. For example, COVID-19 lockdowns created a threat of mass unemployment. But, in wealthy countries, this new problem could be managed compatibly with the original response by means of government-backed job retention schemes that paid a large fraction of employees' wages (Tetlow et al. 2020). Controlling the new threat did not require an undoing of the precautions taken against COVID-19, but could instead be achieved by complementary measures of a different kind.

Genuine problems of consistency arise when this is not possible. In other words, they arise when a precaution generates a new threat that itself calls for a precautionary response, and where there is *no feasible way to control the new risk except by at least partially cancelling the original precaution*. To briefly preview an example discussed later, some have argued that school closures put children at risk of terrible harm, and that there is no way to control that risk except by reopening schools, thereby undoing the original precaution (Lewis et al. 2021). If we accept the premises of this argument, it poses a problem of consistency: a measure that may help control a public health threat does so only at the cost of generating a new threat of grave harm—a threat that would justify cancelling the measure.

Defining consistency in terms of the generation of a "new threat" raises the question of what constitutes a *new* threat. In the early stages of the COVID-19 pandemic, it was often feared that aggressive suppression measures would merely postpone mass infection rather than preventing it, since the virus would return as soon as the measures were lifted (see **Figure 1**

and SAGE 2020). If a postponed epidemic is a "new threat", then all aggressive suppression measures generated a new threat and failed the test of consistency.

However, I think we need to a distinguish threats in a coarser-grained way than this to make consistency a workable and sensible element of proportionality. We need to look for *qualitatively distinct* threats, not the same threat with modified properties, such as modified timing. We should interpret a delayed epidemic as the *same* threat shifted to a different time, not a new threat. The concern about the virus surging back when measures are lifted can then be interpreted as a concern about the *adequacy* of the proposed measures as a way of managing the threat (more on this in a moment), not their *consistency*.

The definition also raises the question of what it takes to *generate* a threat. Requiring that the new threat never previously existed in any form seems too demanding: a precaution may significantly exacerbate an existing risk, moving it from an acceptable level to an unacceptable level, and this may be enough to create a problem of consistency. Yet if a precaution makes only a very slight difference to the magnitude of an existing risk, that seems insufficient. Problems of consistency arise when a precaution exacerbates a second threat enough to push it across the (vague, qualitative) thresholds of gravity, urgency and credibility that justify a precautionary response. This is what we need to avoid.

The fourth pillar is ***adequacy***. Informally, the precaution must *do enough*. Again, care is needed here, because it is too much to require that the precaution completely removes the identified risk, or even that it renders it negligible or no longer urgent. This is often unachievable, as we have often seen in the COVID-19 pandemic. A further problem is that we can't simply specify a quantitative amount of risk reduction that must be achieved (e.g. the probability of the threat materializing must be reduced to 10% or less) because we often find ourselves in a situation where objective, precise probabilities cannot be placed on scenarios or outcomes.

So what is required? A proposal: *across an appropriate range of credible scenarios, the response either reduces the risk to an acceptable level or, if this is unachievable, delivers a level of risk reduction no worse than that delivered by other serious alternatives.* A serious alternative is a feasible one that satisfies absolute rights compatibility and consistency.

This proposal requires that experts are able to make comparative judgements about risk reduction that are relative to specific scenarios, characterized by specific sets of assumptions. That is, it requires judgements of the form: "in this scenario (given these assumptions), this course of action will reduce the risk more than this one." This does not amount to a cost-benefit analysis, but it does involve a concession that we cannot do wholly without judgements of comparative risk. Comparative judgements of this type are often available even when scientists rightly baulk at the idea of assigning objective probabilities to scenarios or outcomes. An example will be considered later in the discussion of school closures: in early 2020, scientific advisers were in a position to advise that a package of measures involving school closures would deliver a level of risk reduction at least as great as any

option that avoided school closures, even though they were not in a position to give quantitative estimates of the magnitude of risk reduction.

This question of adequacy may sound like a purely scientific question—one that could be left to the advisers, without input from citizens—but it is not. Like the other conditions, it calls for mixed judgements. The judgement of an *acceptable* level of risk is clearly an evaluative judgement. A risk level should not be considered acceptable unless a democratic process has judged it to be acceptable. More subtly, the judgement of the *appropriate* range of scenarios across which robustness is desired is an evaluative judgement.

For example, early response planning in the UK made a variety of pessimistic planning assumptions (Birch 2021a). It assumed that no vaccine or effective treatment would become available before herd immunity was achieved through natural infection. Moreover, it assumed that no long-term behavioural changes could be instilled, that no effective testing and contact tracing system would become available, and that behavioural interventions (such as lockdowns) could not be repeated or sustained for longer than about 13-17 weeks. In this "reasonable worst-case scenario", the only choice was between allowing mass natural infection in the near future (Summer 2020) or delaying it until later in the year (Autumn 2020). Given these pessimistic assumptions, advisers understandably felt that tolerating a vast epidemic in the summer would be preferable to allowing an even larger epidemic in the autumn, and advised accordingly (as shown in **Figure 1**, and as discussed in detail in Birch 2021a).

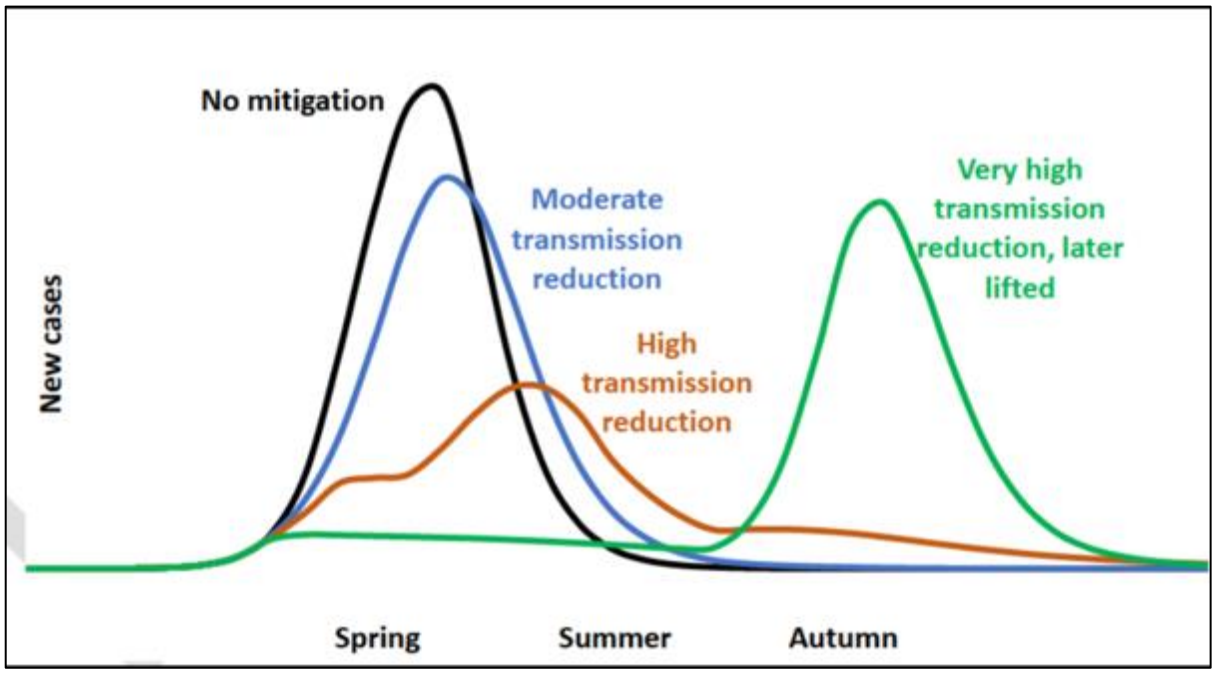

Figure 1: A sketch of a graph from the UK government's Scientific Advisory Group for Emergencies, dated 9 March 2020 (SAGE 2020). *The "high transmission reduction" line depicts a strategy in which herd immunity is achieved by the summer through natural*

infection (i.e. without vaccines). The "very high transmission reduction" line depicts a strategy in which aggressive suppression in the spring leads to a disastrous wave of infection in the autumn, again leading to herd immunity through natural infection.

The decision to plan on the basis of these pessimistic assumptions was a mixed judgement with an evaluative component. It involved a judgement about what it was *appropriate* to assume about human behaviour (e.g. how long interventions could be sustained, and how many times they could be repeated), and this judgement was not purely factual. It was also a judgement that deserved to be challenged. Eventually, it was challenged. Around 16 March 2020, advisers switched to a very different strategy, based on the new assumptions that measures *could* be sustained for over a year (and/or repeated multiple times): a new set of mixed judgements, reflecting a limited degree of cautious optimism about the possibility of sustained behavioural change.

Although I see the second strategy as more reasonable than the first, I suggest that, ultimately, scientific advisers should not have to make such enormous calls without input from citizens. It is right to seek democratic input on those judgements, of a type that might be provided by a citizens' assembly. This is especially true when the judgements involve assumptions about the citizens' *own behaviour*. The question of whether behavioural measures could or could not be sustained for over a year, and whether they could or could not be repeated as required, is one on which it would have been feasible and right to consult the public. A citizens' assembly can be epistemically valuable in this context—it can be a source of evidence about what behavioural changes are possible—but it can also be a source of democratic legitimacy for the value judgements involved.

The fifth pillar is ***non-excessiveness***. Precautions should not impose harms or costs (including suspensions of non-absolute rights, such as the right to education) that go beyond what is reasonably necessary to meet the other four conditions. There will often be a temptation to tack extra measures on to a package that is already adequate. For example, it is tempting to think: let's not just ban neonicotinoid pesticides. Let us also *punish* the companies that created this threat by imposing a tax levy, and let's use the levy to fund research into new, better pesticides. The tacked-on measure may be beneficial to society, but it is also excessive in relation to the specific threat that was identified. This does not mean it cannot be justified at all. It may be justifiable, but we should not try to push it through using a framework designed for another purpose, namely the precautionary management of major risks. It should instead go through the usual, slower processes for that type of measure (e.g. parliament or the courts).

I suspect that these five pillars will often be enough to get us to a point where only one proposed package of measures remains on the table. I think in many cases the package will be a combination of measures that are likely to be more effective together than in isolation. It is possible, though, that we will be left with two or more options that cannot be combined and that are tied with respect to adequacy. This situation could arise if there is insufficient

evidence to reach a decision about which option would deliver greater risk reduction across the desired range of scenarios. For example, the evidence may indicate that one option will do better in some relevant scenarios and another option will do better in others, with no basis on which to discount these scenarios and no basis for regarding one set of scenarios as less important to the adequacy judgement than the other.

In a case where two or more non-combinable options meets the five conditions, we need a tie breaker, and I suggest the tie breaker should be ***efficiency***. The response that is the least costly, in economic terms, should be preferred. This gives a circumscribed role to economic considerations in selecting a response. The role is much more limited than in cost-benefit analysis. The role for democratic input here is to assess whether the economic costs of different options have been assessed in a fair way (for example, to assess whether an appropriate level of priority has been given to people on low incomes).

An idea that I take to be at the heart of a precautionary approach to risk management is that if *all* of the policy responses that meet the five fundamental conditions are very costly in economic terms, their high economic cost does not render them disproportionate or justify inaction. The duty to act overrides the need for economic and fiscal caution that will often win the day in normal times, and the least costly of these expensive options should still be taken. The only exception would be if the policy has such high economic costs that it generates a problem of consistency, because the potential economic harms are deemed (by an appropriate democratic procedure) to themselves justify a precautionary response. For example, a threat of total economic collapse, mass unemployment or serious food shortages could itself justify a precautionary response.

In the case of COVID-19, I do not think *wealthy* countries were genuinely in this situation, because of their ability to mitigate the economic consequences of public health measures through spending financed by borrowing. Moreover, it is far from clear that partially undoing public health measures would have been an effective way to mitigate economic loss. It has been argued, somewhat tentatively, that economic losses were generally worse in countries that responded less aggressively to the public health threat (Alvelda et al. 2020, but cf. Casey 2020). By contrast, countries in the Global South with less secure economies, and less ability to borrow to protect their citizens against the costs of public health measures, may have faced real problems of consistency (Broadbent & Smart 2020; Smart et al. 2021). I see it as a virtue of a precautionary approach that it takes the need for consistency seriously in these cases and does not attempt to sweep it under the rug.

The idea that high economic cost does not imply disproportionality, together with the absence of any attempt to weigh cost against benefit, has some implications for how we should understand gravity, credibility and urgency. In deciding a threat to be grave, credible and urgent to the required degree to warrant a precautionary response, we are deciding the threat to be so serious that there is no upper bound on what it is worth spending to manage that threat, as long as the response is proportionate in the sense just outlined. Clearly, threats really should be exceptionally grave, credible and urgent (as COVID-19 was) to justify this

type of response. This type of approach should not be taken across the board to all threats, including speculative or slow-developing threats.

The initial letters of the six tests spell ARCANE. I hope this can be taken as an ironic label for the account, since the conditions themselves are intended to be far from arcane. The overall proposal is summarised in **Table 1**.

Before moving on, I want to comment briefly on how this proposal compares to Daniel Steel's in *Philosophy and the Precautionary Principle* (2015). My account of proportionality is influenced by Steel's, but the differences are worth highlighting. Steel identifies two components of proportionality: efficiency and consistency. To recognize the importance of consistency is a breakthrough, because it cuts off, in a straightforward way, the often-heard criticism that the precautionary principle leads to inconsistent recommendations (e.g. Sunstein 2001, 2005).

However, I do not think proportionality is fully captured by efficiency and consistency. These criteria can be satisfied by precautions that are inadequate or excessive. A measure could be consistent and the least costly of the consistent options, and yet still be inadequate. After all, compromising on adequacy will often be a good way to secure value for money. Perhaps it is not so obvious that a measure could be consistent, the least costly of the consistent options, and yet excessive. But consider a case of the type we used to motivate non-excessiveness: a case in which a measure aimed at recouping some of the cost of a precaution is tacked on to it. Such a precaution might be consistent, efficient and excessive. So, we need the conditions of adequacy and non-excessiveness: they are not redundant.

Moreover, the criteria of consistency and efficiency can be satisfied by measures that violate absolute rights (e.g. by involving forced experimentation) or avoid paying reasonable compensation to non-culpable victims. These too are important, non-redundant criteria. An explicit requirement for reasonable compensation is needed to ensure the drive for efficiency does not lead to policy-makers to withhold merited compensation, and an absolute-rights-compatibility requirement is needed to ensure the drive for adequacy does not lead to policy-makers compromising absolute rights.

Condition	*Description*	*Aspects calling for expert input*	*Aspects calling for democratic input*
Absolute rights compatibility	The response does not violate anyone's absolute (non-derogable) rights, such as freedom from medical or scientific experimentation without consent.	Whose rights will be violated, and which rights? Are the rights absolute?	Not required, since this is a legal test.
Reasonable compensation	Those harmed by the response will be compensated where this is reasonable. It may not be reasonable if they are culpable for creating the risk.	Who will be harmed? What harms and costs will be imposed on them? What compensation is possible?	Who is morally culpable for creating the threat? What level of compensation is reasonable?
Consistency	The precaution does not generate a new threat that (i) itself calls for a precautionary response and (ii) could not feasibly be controlled except by at least partially cancelling the original precaution.	Will a new risk be generated? Could it be controlled other than by partially undoing/obstructing the proposed precaution	Is the new risk also grave, credible and urgent, justifying the undoing/obstructing of the proposed precaution?
Adequacy	Across an appropriate range of credible scenarios, the response either (i) reduces the risk to an acceptable level or, if this is unachievable, (ii) delivers a level of risk reduction no worse than that delivered by the other feasible, consistent and absolute-rights-compatible alternatives.	What levels of risk reduction (comparative or absolute) are delivered, given appropriate assumptions about human behaviour? (Often only comparative judgements will be possible).	What assumptions about human behaviour (i.e. *our behaviour*) are appropriate? What level of optimism/pessimism is reasonable? When has the risk been reduced to an acceptable level?
Non-excessiveness	The precaution does not impose harms or costs (including suspensions of non-absolute rights) beyond those that are reasonably necessary to achieve adequacy.	What harms/costs will be imposed, and on whom? Whose qualified rights will be overridden and in what ways?	Can these harms and costs be justified as *reasonably necessary* to achieve adequacy?
Efficiency (tie-breaker)	If multiple non-combinable options meet the other conditions, the most proportionate option is the one that is least costly in economic terms.	What are the economic costs of the live options?	Have the costs been estimated in a fair, unbiased way (e.g. giving appropriate weight to those on low incomes)?

Table 1. The ARCANE analysis of proportionality. A response is proportionate to an urgent and credible threat of grave harm if it meets the first five conditions. If multiple non-combinable options meet these conditions, the most proportionate option is the most efficient.

4. Two examples from the COVID-19 pandemic

The ARCANE account of proportionality is intended as a tool for evaluating precautions in real time, during a crisis. What it tries to do is capture the pivotal questions on which expert and public input should be integrated in order to assess proportionality. It is not primarily intended for the *retrospective* evaluation of past actions. Nonetheless, I think looking at two examples from the COVID-19 pandemic will be helpful as a way of motivating the account.

4.1 Strict border closures

Border closures have been a major element of the global response to COVID-19. 348 countries introduced either partial or complete border closures in the week of 11 March, and 189 countries have, for at least a short period, introduced a near-complete border closure, where all non-citizens are denied entry (Shiraef 2021). Several countries have also compelled some or all travellers to spend two weeks in a quarantine facility, usually a co-opted hotel (Walsh 2021). When a country both completely closes its borders to all non-citizens *and* compels all returning citizens to quarantine in an approved facility, let us call this a "strict border closure".

Australia, New Zealand and Taiwan have been notable for their early and sustained use of strict border closures. All three closed their borders to foreign nationals on 19 or 20 March 2020, bringing in hotel quarantine for all returning citizens. Was this proportionate? One point of contrast is the UK, which initially took a very different approach, before bringing in a limited form of hotel quarantine in 2021 (Walsh 2021). In February 2020, the UK's Scientific Advisory Group for Emergencies (SAGE) had advised that it would be "draconian" to close the UK's borders entirely (SAGE 2020). "Draconian" does not imply "unjustified", but it is not an evaluatively neutral term either. It suggests excessiveness in relation to the risk. The ARCANE account of proportionality cannot, by itself, settle the question of whether strict border closures were justified. What it does is provide a framework within which the considerations that matter—on both sides—can be expressed and systematized.

Regarding absolute rights compatibility: strict border closures can preserve absolute rights, as long as the quarantine conditions are not cruel, inhuman or degrading. The right to travel is not absolute. Even the right to return to one's own country, though generally recognised as an important right, is not an absolute right under international law. The UN Human Rights Council has commented that "there are few, if any, circumstances in which deprivation of the right to enter one's own country could be reasonable" (UN HRC 1999), leaving open the possibility of pandemics creating such circumstances (Martha & Bailey 2020). So, although the Australian government in particular has been criticised for partially suspending this right in practice by setting a cap on the number of international arrivals at any given time, this is not automatically disproportionate (Evershed 2021). The question then becomes whether it is excessive, or whether it is reasonably necessary to achieve adequate risk reduction.

Regarding reasonable compensation: those forced to quarantine when travelling with good reason are not, generally speaking, culpable for creating the risk that the measures are

designed to mitigate. A person travelling with the intention of bringing COVID-19 into a country would be culpable, and perhaps the same could be said of a traveller who has been reckless or negligent (e.g. by ignoring a mandatory testing requirement) but the vast majority will surely not be culpable. Moreover, quarantine can be considered at least a small harm even if the conditions are good, due to the temporary curtailment of freedom of movement and the mental health risks associated with confinement in a small space (Blaine 2021). So, those forced to quarantine are subjected to a harm as part of a response to a threat they were not culpable for creating. The ARCANE account of proportionality suggests that people in such a situation should be compensated.

Taiwan initially pursued such a model, covering the costs of quarantine and paying 35 USD per day in compensation (Lee et al. 2020). Australia and New Zealand initially took a less generous approach, covering the costs of quarantine but not positively compensating those affected. However, as the pandemic continued, Taiwan, Australia and New Zealand all introduced upfront charges for quarantine in at least some cases (Thiessen 2020; Habershon 2021; Ferré 2021). This seems problematic from the point of view of proportionality. People who deserve to be compensated are instead being charged. The public have not been meaningfully involved in the decision-making processes that led to these changes.

Regarding consistency: do sustained border closures create a new threat that itself calls for a precautionary response? There is a risk that they will merely delay the epidemic until borders are reopened but, as discussed earlier, this is best seen as a challenge to the adequacy of border closures rather than their consistency, because a delayed epidemic is not a "new threat" in the relevant sense. In some cases, border closures can create a risk of food shortages in countries that are far from self-sufficient regarding food (Charumbira 2021; Thomas 2020), and this should be taken seriously when evaluating consistency.

Regarding adequacy: at the time strict border closures were first introduced, there was a clear risk that borders would have to be reopened before any vaccine or effective treatment had become available, and, in such a case, they would merely have postponed a disastrous epidemic rather than preventing one. However, all this shows is that border closures do not completely remove the risk of a disastrous epidemic. This makes it proportionate to combine border closures with other preparatory measures that also satisfy the other conditions (such as building up healthcare system capacity, testing and tracing capacity, and vaccine distribution capacity), so that the country is as well prepared as possible for the time border closures end. It remains plausible that a package of measures containing border closures will perform at least as well as any other package in reducing that risk, which is what adequacy requires.

Regarding non-excessiveness: the crucial question here is whether strict border closures do more than is reasonably necessary to satisfy the other conditions. This seems to have been the view of SAGE in describing this approach as "draconian". However, border closures do appear to have been effective in the early stages of the pandemic as a means of preventing the import of SARS-CoV-2 (Grépin et al. 2021). It is less clear at present that persisting with

border closures is effective (e.g. for preventing import of new variants) once there is already sustained community transmission of the virus.

As noted above, the practice of setting caps on the number of international arrivals, as Australia has done, in order to keep arrivals within the capacity of designated quarantine hotels, also raises a concern about excessiveness. Could an acceptable level of risk reduction have been achieved while removing the cap and allowing some returning citizens to quarantine at home? This is an issue that only a democratic process could settle in an appropriate way. As with so many of the issues concerning the response to COVID, the answer depends partly on what it is appropriate to assume about human behaviour: to what extent can people be trusted to self-isolate properly at home, without enforcement and monitoring? Those on both sides of the debate about the proportionality of strict border closures should be able to agree that a public-involving process could and should have been involved in that judgement call.

4.2 School closures

On 4 March 2020, the Italian government ordered the closure of all schools and universities. By 16 March, most European countries had closed their schools. The UK did so on 20 March. Schools were closed for around three months (see Aspinall 2020 for a timeline). The aim was to suppress the reproductive rate (R) of the virus to below 1, so as to prevent the healthcare system becoming overwhelmed by exponential growth in the number of cases. Was this proportionate? Not all governments agreed that it was. A notable exception was Sweden, which partially closed its schools but kept them open for children up to the age of 15 (Vlachos et al. 2021).

Regarding absolute rights compatibility: the right to education is an important human right, but not an absolute one. It is generally recognized that it could be permissibly suspended in exceptional circumstances, such as a public health emergency.

Regarding reasonable compensation: schoolchildren are clearly not culpable for creating the risk posed by COVID-19, so they should be compensated. But the compensation need not take the form of monetary payments to schoolchildren: it could take the form of additional funding for their education. In the UK, a £1.4bn "education recovery plan" aimed at providing catch-up services (including tutoring) has been announced, amounting to around £310 per pupil over three years (UK Department for Education 2021). Yet critics of the scheme have argued that something closer to £15bn would be needed to genuinely cancel out the lost time in education during 2020 and 2021 (Siddique 2021).

Regarding consistency: Lewis et al. (2021) object to the proportionality of school closures on the grounds that they create a risk of grave harm to children, including "learning loss, reduced social interaction, isolation, reduced physical activity, increased mental health problems", "potential for increased abuse, exploitation, and neglect", and "reduced future income and life expectancy". They conclude that "the precautionary principle would be to

keep schools open to prevent catastrophic harms to children" (Godfrey-Smith 2021 has defended a similar view).

This objection should be taken seriously. The "suppression" strategy laid out on 16 March in an influential paper by the Imperial COVID-19 Response Team (Ferguson et al. 2020) involved *indefinite* school closures for two-thirds of the time until a vaccine was developed. A graph in the paper, reproduced as **Figure 2**, illustrates the strategy by depicting *seven* periods of prolonged school closure, but more than seven could have been needed, had vaccines taken longer to develop. This strategy, as depicted, was never pursued. If it had been, the objection from consistency would have been very strong indeed. A defender of school closures could reply that the long-term effects on learning, income and life expectancy of a one-off school closure, or two of them, can be effectively prevented by a good enough recovery package. Some harms, though, are immediate, especially mental health problems and the potential for increased abuse, exploitation and neglect, so the objection is not so easily defused.

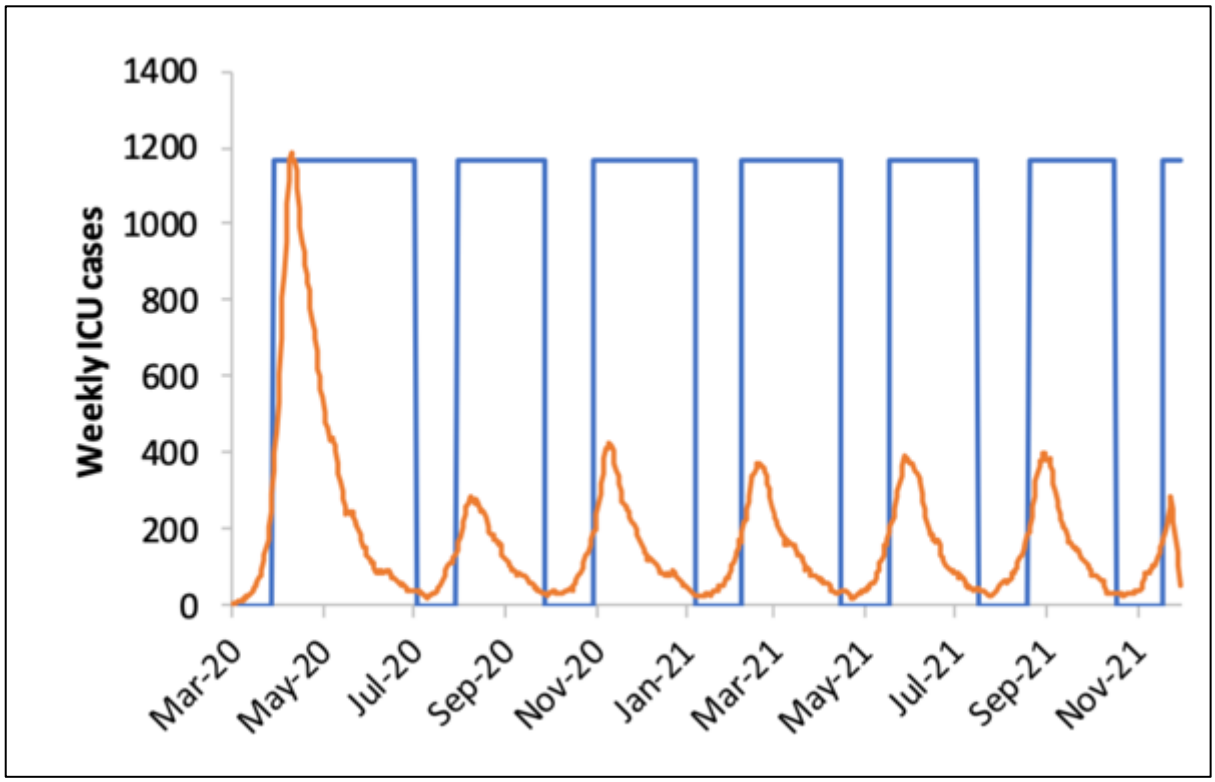

Figure 2: A graph from Ferguson et al. (2020), in which the blue-outlined blocks represent periods of school closure*. This is a projection of the consequences of closing schools for about two thirds of the time, indefinitely, until a vaccine is developed.*

Regarding adequacy and non-excessiveness: no government has suggested that school closures are adequate by themselves, but many have regarded them as a reasonably necessary (and thus non-excessive) component of an adequate package of measures for bringing *R* below 1. On 17 March 2020, SAGE's subgroup on epidemiological modelling, SPI-M-O,

produced a "consensus statement" that contains a crisp statement of the justification for school closures:

> It is almost certain that school closures will not make the epidemic worse, and that they would reduce both the epidemic peak and expected number of cases. Our best assessment is that they would reduce the reproduction number by between 10% and 20%. We do not know how likely it is that this will change the reproduction number from being above 1 to below 1 (SPI-M-O 2020)

The combination of all *other* measures put together was judged "likely or highly likely" to lead to the critical care capacity of the health service being exceeded. School closures could tip the balance (though no probability is attached to the claim that they will), and they would not make things worse. The claim is implicitly that a package of measures including school closures would deliver a level of risk reduction at least as great as any other package. The advisers were in a position to be confident of this comparative judgement, despite being unable to estimate the absolute probability of the strategy succeeding.

With the virus again resurgent, the UK closed schools for a second sustained period in early 2021. By this time, more evidence both for and against school closures had become available. On 28 January 2021, SAGE cautioned that:

> The opening of primary and secondary schools is likely to increase effective R by a factor of 1.1 to 1.5 (10% to 50%) (medium confidence). Options with fewer children in attendance (such as selected year groups or cohorts) are likely to fall towards the lower end of this range. While prevalence is falling and vaccinations are continuing, a later opening of schools would result in less community transmission and fewer hospitalisations. Attending school is important for the wellbeing of children and SAGE advises that reopening schools should be a priority when infection rates allow it. (SAGE 2021).

The non-excessiveness condition of proportionality, combined with the significant harms imposed by school closures, points to the need to prefer partial school closures over full closures, and to close as little of the school as possible in order to achieve critical epidemiological goals (in this case, $R < 1$). SAGE's advice recognizes this. At the time, however, R was estimated by SAGE to be in the range 0.7 and 1.1 with schools currently closed. This implied that, in their opinion, scenarios in which $R > 1$ or ≈ 1 remained credible, suggesting no scope at that time for reopening schools even partially without compromising adequacy.

I find it plausible that a public-involving process (such as a citizens' assembly) would have accepted these rationales for the adequacy and non-excessiveness of a lengthy one-off school closure in 2020 and another in early 2021. I find it less likely that it would have accepted the idea of indefinite, repeated school closures, as floated in Ferguson et al. (2020). What troubles me is no such democratic exercise took place. Arguments for the proportionality of

these measures are implicit in the SAGE minutes and related documents, but the public had no input on this momentous question in the UK or, to my knowledge, any other country. Here too, those on both sides of the debate about the proportionality of school closures should be able to agree that a public-involving process could and should have been involved in the decision.

4.3 Reflections on the two examples

In considering these examples, my aim has not been to declare some actions proportionate and others disproportionate. To do so would be in tension with my view that proportionality is a matter for public-involving procedures, such as citizens' assemblies, to decide. I have no reason to think that such an assembly would share my own views. My aim has been to show that the ARCANE account of proportionality captures the *right questions to ask*: the mixed judgements that should properly be at the heart of decision-making when credible, grave and urgent risks are identified. In relation to border closures and school closures, the questions that crucially matter in relation to the normative justification of the policy are indeed questions about absolute rights compatibility, reasonable compensation, consistency, adequacy and non-excessiveness.

5. Managing the risk of future pandemics

Once a novel pathogen is spreading freely from one human to another, a proportionate response to the threat is very likely to involve substantial harms, costs, and suspensions of qualified human rights, as COVID-19 has shown. By contrast, proportionate management of the risk of a future pandemic *before* the pathogen emerges may be achievable at far lower cost. I want to close with some reflections on this risk.

Since the early 2000s, countries around the world have identified pandemic influenza as one of the gravest threats they faced. H5N1 has been a source of particular concern. H5N1 is a highly pathogenic subtype of the influenza A virus. When H5N1 has infected a human (and this has happened a few hundred times), it is estimated to have had an infection fatality rate of somewhere around 60% (Akhtar 2021). The world is spared, for now, because H5N1 cannot transmit between humans, just as, prior to late 2019, SARS-CoV-2 could not spread between humans.

We can hope that a virus as pathogenic as H5N1 would be easier to contain than SARS-CoV-2, because there would be fewer asymptomatic cases, but there is no guarantee of this. We know from the 1918-1919 influenza pandemic (driven by another subtype of influenza A, H1N1) that influenza viruses can combine high fatality rates (the case fatality rate of the 1918 influenza virus was over 2.5%, with an unusually young age profile; those aged 25-35 were at very high risk) with very high transmissibility. A widely cited review concluded in 2006 that:

> Even with modern antiviral and antibacterial drugs, vaccines, and prevention knowledge, the return of a pandemic virus equivalent in pathogenicity to the virus of 1918 would likely kill >100 million people worldwide. A pandemic virus with

> the (alleged) pathogenic potential of some recent H5N1 outbreaks could cause substantially more deaths. (Taubenberger & Morens 2006)

Is this a risk we can mitigate now? It is, because many of the main drivers of the emergence of new zoonotic pathogens are anthropogenic (UNEP 2020; see also **Figure 3**). The risk arises from interaction between humans and animals, and between wild and domesticated animal populations, and we have substantial influence over both types of interaction. The wildlife trade is a crucial risk factor, as is the destruction of natural habitats that brings humans into closer contact with wildlife. Another risk factor is surging global demand for meat, combined with intensive methods of meat production (UNEP 2020). The dense packing of genetically similar animals into small spaces creates conditions that can increase the likelihood of a virus evolving into a more pathogenic form, as appears to have happened with H5N1 (Akhtar 2012). When potential new hosts are everywhere in the immediate environment, a virus is no longer under selection to spare its host's life while it awaits a new transmission opportunity, and the conventional wisdom that viruses evolve to become less pathogenic need not apply (Sober 2020). A third type of risk factor is laboratory research in which the transmissibility of pathogens is deliberately enhanced (Ord 2021).

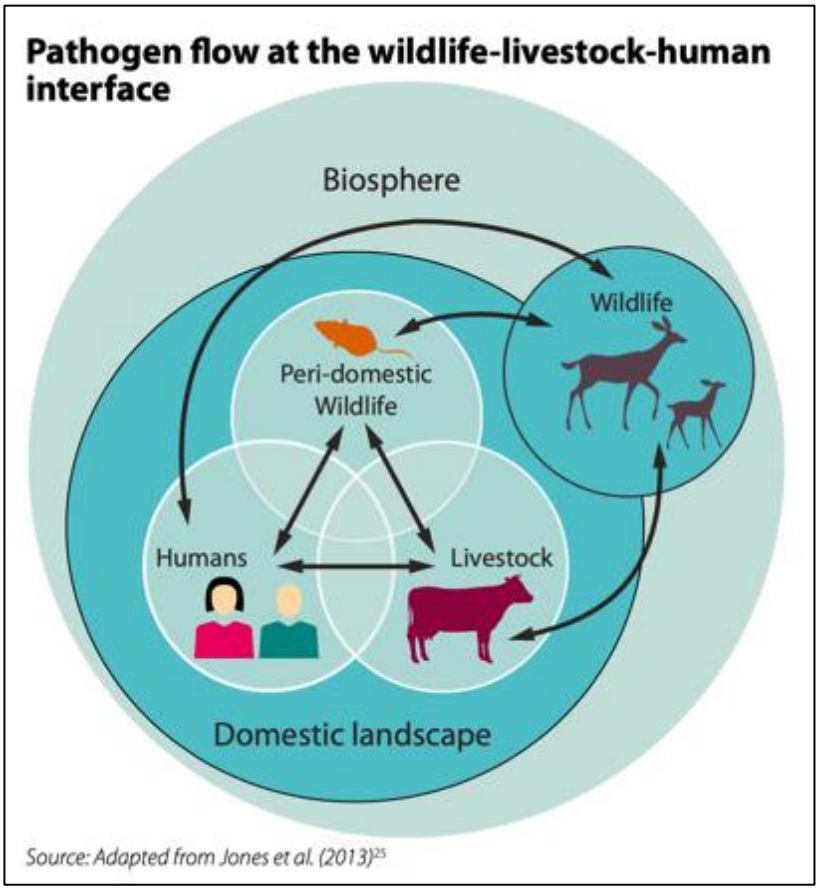

Figure 3: Figure reproduced from UNEP (2020), adapted from Jones et al. (2013). *The risk of zoonotic transmission can be managed by reducing the amount of interaction between each group shown, or by improving the biosecurity of the interactions.*

There is an urgent need for meaningful democratic reflection and decision-making, either in the form of citizens' assemblies or in some other form (such as referendums), on the question of what steps would be proportionate to this risk. We can see that, if the risk is allowed to develop to the stage of human-human transmission, proportionality will justify imposing substantial harms on billions of people. If we can control the risk by imposing proportionate measures now, with much less harm, there is a clear case for doing it.

Given my emphasis throughout this paper on democratic processes, I do not take my own view on these questions to be decisive. Nonetheless, in the interests of provoking discussion, I will state my own view anyway.[2] I think measures taken up to now to mitigate the risk of the emergence of new pathogens have been far from proportionate, and that proportionality in fact justifies much more ambitious action. More ambitious steps might include a total worldwide ban on the wildlife trade and the farming of wild species for any purpose (with reasonable compensation for those who have previously relied on it), very strict biosecurity protocols for all animal farming, removal of government subsidies for meat production and a shift towards subsidising plant-based alternatives, other actions aimed at reducing demand for meat (such as campaigns to make one day of the week a meat-free day), and a moratorium on "gain of function" laboratory research while tighter international biosecurity norms are developed.

There would be significant costs to all of these steps. Compensation will be appropriate for those affected but not culpable for creating the risk. Yet these costs are likely to be far lower than the costs of a future pandemic of H5N1 or another highly pathogenic influenza virus. At present, the world is akin to a drunk driver who, after one bad accident, is back on the road again, still drunk.

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References

Akhtar, A. (2012) *Animals and public health: Why treating animals better is critical to human welfare*. Basingstoke: Palgrave Macmillan.

Akhtar, A. (2021, 5 March) COVID-19 is the consequence of our cruelty to animals. *LSE Covid-19 Blog*. https://blogs.lse.ac.uk/covid19/2021/03/05/lse-festival-2021-covid-19-is-the-consequence-of-our-cruelty-to-animals/

Alexandrova, A. (2018). Can the science of well-being be objective? *British Journal for the Philosophy of Science*, 69, 421-445.

[2] See also Birch 2021b; Whitmore 2021; Cao 2021 and Akhtar 2021 for more discussion-starters on these issues.

Alvelda, P., Ferguson, T., Mallery, J. C. (2020, 18 November). To save the economy, save people first. *Institute for New Economic Thinking*. https://www.ineteconomics.org/perspectives/blog/to-save-the-economy-save-people-first

Appleby, J. (2020). Tackling Covid-19: are the costs worth the benefits? *British Medical Journal* 369, m1496. http://doi.org/10.1136/bmj.m1496

Aspinall, E. (2020). COVID-19 timeline. *British Foreign Policy Group*. https://bfpg.co.uk/2020/04/covid-19-timeline/

Blaine, J. (2021). Exploring the psychosocial consequences of mandatory quarantine during the COVID-19 pandemic in Hong Kong. *Psychology and Behavioral Sciences*, 10, 96-103. http://doi.org/10.11648/j.pbs.20211002.13

Birch, J. (2021a). Science and policy in extremis: the UK's initial response to COVID-19. *European Journal for Philosophy of Science*.

Birch, J. (2021b, 9 March). Humans, animals and pandemics: What needs to change? *LSE Philosophy Blog*. https://www.lse.ac.uk/philosophy/blog/2021/03/09/animals-humans-and-pandemics-what-needs-to-change/

Bradley, R., & Bright, L. K. (2020). Managing our uncertainty amidst the crisis. *The Philosophers' Magazine*, 90, 32-35.

Broadbent, A., & Smart, B. (2020, 23 March). Why a one-size-fits-all approach to the COVID-19 pandemic could have lethal consequences. *The Conversation*. https://theconversation.com/why-a-one-size-fits-all-approach-to-covid-19-could-have-lethal-consequences-134252

Cao, D. (2021, 5 March) To avoid more pandemics, we need to stop eating wild and factory-farmed animals. *LSE Covid-19 Blog*. https://blogs.lse.ac.uk/covid19/2021/03/05/lse-festival-2021-to-avoid-more-pandemics-we-need-to-stop-eating-wild-and-factory-farmed-animals/

Carrington, D. (2013, 29 April) Bee-harming pesticides banned in Europe. *The Guardian*. http://www.theguardian.com/environment/2013/apr/29/bee-harming-pesticides-banned-europe

Casassus, B. (2021, 18 February). Vaccine-wary France turns to citizens' panel to boost trust in COVID-19 shots. *Science*. https://www.sciencemag.org/news/2021/02/vaccine-wary-france-turns-citizens-panel-boost-trust-covid-19-shots

Casey, B. H. (2020, 18 December). Covid-19: Is there a trade-off between economic damage and loss of life? *LSE European Politics and Policy (EUROPP)*. https://blogs.lse.ac.uk/europpblog/2020/12/18/covid-19-is-there-a-trade-off-between-economic-damage-and-loss-of-life/

Charumbira, S. (2021). Landlocked Lesotho faces food crisis amid Covid border closures. *The Guardian*. https://www.theguardian.com/global-development/2021/jan/19/landlocked-lesotho-faces-food-crisis-amid-covid-border-closures

Climate Assembly UK (2020). Report: The path to net zero. https://www.climateassembly.uk/report/

Evershed, N. (2021, 7 July). Data reveals Australia's new international arrivals cap is harshest yet. *The Guardian*.

https://www.theguardian.com/news/datablog/2021/jul/07/australias-travel-restrictions-how-the-cap-on-international-arrivals-has-changed

European Commission (2000). *Communication from the Commission on the precautionary principle*. https://op.europa.eu/en/publication-detail/-/publication/21676661-a79f-4153-b984-aeb28f07c80a/language-en

Ferguson, N. M., Laydon, D., Nedjati-Gilani, G., Imai, N., Ainslie, K., Baguelin, M., Bhatia S., Boonyasiri, A., Cucunubá, Z., Cuomo-Dannenburg, G., Dighe, A., Dorigatti, I., Fu, H., Gaythorpe, K., Green, W., Hamlet, A., Hinsley, W., Okell, L. C., van Elsland, S., Thompson, H., Verity, R., Volz, E., Wang, H., Wang, Y., Walker, P. G. T., Walters, C., Winskill, P., Whittaker, C., Donnelly, C. A., Riley, S., & Ghani, A. C. (2020). Impact of non-pharmaceutical interventions (NPIs) to reduce COVID-19 mortality and healthcare demand. Retrieved from: https://www.gov.uk/government/publications/impact-of-non-pharmaceutical-interventions-npis-to-reduce-covid-19-mortality-and-healthcare-demand-16-march-2020

Ferré, M. E. (2021, 11 July). In response to rising COVID-19 cases, Taiwan continues banning foreign nationals. *The Mobile Workforce*. https://www.mobilework.law/2021/07/in-response-to-rising-covid-19-cases-taiwan-continues-banning-foreign-nationals/

Fishkin, J. S. (2018). *Democracy when the people are thinking: Revitalizing our politics through public deliberation*. Oxford: Oxford University Press.

Godfrey-Smith, P. (2021). Covid heterodoxy in three layers. https://petergodfreysmith.com/wp-content/uploads/2021/08/Covid-Heterodoxy-PGS-v4D.pdf

Grépin, K. A., Ho T.-L., Liu, Z., Marion, S., Piper, J., Worsnop C. Z., Lee, K. (2021). Evidence of the effectiveness of travel related measures during the early phase of the COVID-19 pandemic: A rapid systematic review. *BMJ Global Health*, 6, e004537. http://10.1136/bmjgh-2020-004537

Habershon, S. (2021, 27 March). New Zealand's Covid quarantine fee change puts politics over a citizen's right to return. *The Guardian*. https://www.theguardian.com/world/commentisfree/2021/mar/27/new-zealands-covid-quarantine-fee-change-places-politics-over-a-citizens-right-to-return-sarah-habershon

Jemrosik, E., & Selgelid, M. J. (2020). COVID-19 human challenge studies: Ethical issues. *Lancet Infectious Diseases*, 20, E198-E203. https://doi.org/10.1016/S1473-3099(20)30438-2

John, S. (2010). In defence of bad science and irrational policies: An alternative account of the precautionary principle. *Ethical Theory and Moral Practice*, 13, 3–18.

John, S. (2019). The politics of certainty: The precautionary principle, inductive risk and procedural fairness. *Ethics, Policy & Environment*, 22, 21-33 http://doi.org/10.1080/21550085.2019.1581418

Jones, B.A., Grace, D., Kock, R., Alonso, S., Rushton, J., & Said, M.Y. (2013). Zoonosis emergence linked to agricultural intensification and environmental change. *Proceedings of the National Academy of Sciences of the United States of America*, 110, 8399–8404. https://doi.org/10.1073/pnas.1208059110

Kitcher, P. (2002). *Science, Truth and Democracy*. New York: Oxford University Press.
Kitcher, P. (2011*). Science in a Democratic Society*. Buffalo, NY: Prometheus.
Lafont, C. (2019). *Democracy without shortcuts: A participatory conception of deliberative democracy.* Oxford: Oxford University Press.
Lakdawalla, D. N., & Phelps, C. E. (2020). Health technology assessment with risk aversion in health. *Journal of Health Economics*, 72, 102346. https://doi.org/10.1016/j.jhealeco.2020.102346
Landemore, H. (2020). *Open democracy: Reinventing popular rule for the twenty-first century.* Princeton, NJ: Princeton University Press.
Lee, P-C., Chen, S-C., Chiu, T. Y., Chen, C. M., Chi, C. (2020, 21 July). What we can learn from Taiwan's response to the covid-19 epidemic. *The BMJ Opinion*. https://blogs.bmj.com/bmj/2020/07/21/what-we-can-learn-from-taiwans-response-to-the-covid-19-epidemic/
Lewis, S. J., Munro, A. P. S., Smith, G. D., Pollock, A. M. (2021). Closing schools is not evidence based and harms children. *British Medical Journal*, 372, n521 http://doi.org/10.1136/bmj.n521
Martha, R., & Bailey, S. (2020, 23 June). The right to enter his or her own country. *EJIL:Talk!* https://www.ejiltalk.org/the-right-to-enter-his-or-her-own-country/
Montague, P. (1998, 19 February). The precautionary principle. *Rachel's Environment and Health Weekly*, 586. https://ratical.org/co-globalize/REHW586.html
MRC Centre for Global Infectious Disease Analysis [MRC-CGIDA]. (2020). *Timing and local triggering of non-pharmaceutical interventions (NPIs) to reduce COVID-19 mortality and healthcare demands.* https://www.gov.uk/government/publications/timing-local-triggering-of-non-pharmaceutical-interventions-npis-to-reduce-covid-19-mortality-and-healthcare-demands-5-march-2020
Norheim, O. F., Abi-Rached, J. M., Bright, L. K., Bærøe, K., Ferraz, O. L. M., Gloppen, S. & Voorhoeve, A. (2020). Difficult trade-offs in response to COVID-19: the case for open and inclusive decision making. *Nature Medicine*, 27, 10–13. https://doi.org/10.1038/s41591-020-01204-6
O'Riordan, T., Cameron, J. (Eds.) (1994). *Interpreting the precautionary principle*. London: Routledge.
O'Riordan, T., Cameron, J. & Jordan, A. (Eds.) (2001). *Reinterpreting the precautionary principle*. Berlin: CMP Publishing.
Ord, T. (2021). *The precipice: Existential risk and the future of humanity*. London: Bloomsbury.
Pettit, P. (2010). *On the people's terms: A republican theory and model of democracy*. Cambridge: Cambridge University Press.
Plutynski, A. (2017). Safe, or sorry? Cancer screening and inductive risk. In Elliott, K. & Richards, T. (Eds.) (2017). *Exploring inductive risk: Case studies in values in science*. Oxford: Oxford University Press., pp. 149-169.
Munthe, C. (2011). *The price of precaution and the ethics of risk*. Dordrecht: Springer.
Science for Environment Policy (2017) *The Precautionary Principle: decision making under uncertainty*. Future Brief 18. Produced for the European Commission DG Environment

by the Science Communication Unit, UWE, Bristol. http://ec.europa.eu/science-environment-policy

Scientific Advisory Group for Emergencies [SAGE] (2020). *SAGE 3 minutes: Coronavirus (COVID-19) response, 3 February 2020.* https://www.gov.uk/government/publications/sage-minutes-coronavirus-covid-19-response-3-february-2020

Scientific Advisory Group for Emergencies [SAGE] (2021). *SAGE 78 minutes: Coronavirus (COVID-19) response, 28 January 2021*. https://www.gov.uk/government/publications/sage-78-minutes-coronavirus-covid-19-response-28-january-2021

Shiraef, M. A. (2021, 18 March). Closed borders, travel bans and halted immigration: 5 ways COVID-19 changed how – and where – people move around the world. *The Conversation*. https://theconversation.com/closed-borders-travel-bans-and-halted-immigration-5-ways-covid-19-changed-how-and-where-people-move-around-the-world-157040

Siddique, H. (2021, 2 June). Covid catch-up plan for England pupils 'pitiful compared with other countries'. *The Guardian*. https://www.theguardian.com/education/2021/jun/02/union-criticises-pitiful-covid-catch-up-plan-england-pupils

Smart, B., Combrink, H., Broadbent, A., & Streicher, P. (2021). *Report: Direct and Indirect Health Effects of Lockdown in South Africa*. Center for Global Development. http://www.jstor.org/stable/resrep30890

Sober, E. (2020). Infectious diseases and the evolution of virulence. *Auxiliary Hypotheses Blog*. http://www.thebsps.org/auxhyp/evolution-of-virulence-sober/

SPI-M-O (2020). *SPI-M-O: Consensus view on the impact of mass school closures, 17 March 2020*. https://www.gov.uk/government/publications/spi-m-o-consensus-view-on-the-impact-of-mass-school-closures-17-march-2020

Steel, D. (2015) *Philosophy and the precautionary principle: Science, evidence, and environmental policy*. Cambridge: Cambridge University Press.

Stirling, A. (2017) Precaution in the governance of technology. In Brownsword, R., Scotford, E., & Yeung, K. (Eds.), *The Oxford Handbook of Law, Regulation and Technology*.

Sunstein, C. R. (2001). *Risk and reason: Safety, law, and the environment*. Cambridge: Cambridge University Press.

Sunstein, C. R. (2005). *Laws of fear: Beyond the precautionary principle*. Cambridge: Cambridge University Press.

Taubenberger, J. K., & Morens, D. M. (2006). 1918 Influenza: the mother of all pandemics. *Emerging Infectious Diseases*, 12, 15-22. http://doi.org/10.3201/eid1201.050979

Tetlow, G., Pope, T., Dalton, G. (2020). *Coronavirus and unemployment: a five-nation comparison*. Institute for Government. https://www.instituteforgovernment.org.uk/publications/coronavirus-unemployment-five-nation-comparison

Thiessen, T. (2020, 13 July). Australia hotel quarantine: You will pay $3000-$5000 returning home, here are state details.

https://www.forbes.com/sites/tamarathiessen/2020/07/13/australia-nsw-hotel-quarantine-travelers-pay-3000/?sh=1954d17f4283
Thomas, D. (2020). Supermarkets try to calm food shortage fears amid border chaos. *BBC News*. https://www.bbc.co.uk/news/business-55393076
UK Department for Education (2021, June). *Education Recovery Support for early years settings, schools and providers of 16-19 education*. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/993053/Education_recovery_support_June-2021.pdf
UK Government (2021a). *Coronavirus (COVID-19) in the UK: Deaths*. https://coronavirus.data.gov.uk/details/deaths
UN Environment Programme (2020). *Preventing the next pandemic: Zoonotic diseases and how to break the chain of transmission.*
UN General Assembly (1966, 16 December). *International covenant on civil and political rights*. https://www.ohchr.org/en/professionalinterest/pages/ccpr.aspx
UN Human Rights Committee [UN HRC] (1999, 18 October). CCPR/C/21/Rev.1/Add.9. https://tbinternet.ohchr.org/_layouts/15/treatybodyexternal/Download.aspx?symbolno=CCPR%2fC%2f21%2fRev.1%2fAdd.9&Lang=en
Vlachos, J., Hertegård, E., Svaleryd H. B. (2021). The effects of school closures on SARS-CoV-2 among parents and teachers. *Proceedings of the National Academy of Sciences of the United States of America*, 118, e2020834118 http://doi.org/10.1073/pnas.2020834118
Whitehead, S. J. & Ali, S. (2010). Health outcomes in economic evaluation: the QALY and utilities. *British Medical Bulletin*, 96, 5–21. https://doi.org/10.1093/bmb/ldq033
Wilkes, G. (2020, 27 November). The doubtful case for an impossible Covid-19 cost-benefit analysis. *Institute for Government Blog*. https://www.instituteforgovernment.org.uk/blog/doubtful-case-impossible-covid-cost-benefit-analysis
Walsh, D. (2021, 30 March). Quarantine hotels: Which countries are using them to stop arrivals spreading COVID? *Euronews*. https://www.euronews.com/travel/2021/02/24/quarantine-hotels-which-countries-are-using-them-to-stop-arrivals-spreading-covid
Whitfort, A. (2021, 5 March) China should ban the farming of wild animals now. *LSE Covid-19 Blog*. https://blogs.lse.ac.uk/covid19/2021/03/05/lse-festival-2021-china-should-ban-the-farming-of-wild-animals-now/
Worldometer (2021). *COVID-19 coronavirus pandemic*. https://www.worldometers.info/coronavirus/