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How to Balance Lives and Livelihoods in a Pandemic

Matthew Adler, Richard Bradley, Maddalena Ferranna, Marc Fleurbaey, James Hammitt, Rémi Turquier, and Alex Voorhoeve

9.1 Introduction

Control measures, such as "lockdowns", have been widely used to suppress the COVID-19 pandemic. Under some conditions, they prevent illness and save lives. But they also exact an economic toll. How should we balance the impact of such policies on individual lives and livelihoods (and other dimensions of concern) to determine which is best? A widely used method of policy evaluation, benefit–cost analysis (BCA), answers these questions by converting all the effects of a policy into monetary equivalents and then summing them up. A different method, social welfare analysis, proceeds by determining the effects of a policy on individual wellbeing and then applying an aggregation formula to them to evaluate the overall effects of a policy. In this chapter, we survey these methods and argue that social welfare analysis has important advantages. One crucial advantage is that it enables ethical considerations relating to the impact of policies on individual wellbeing and its distribution to be incorporated into policy assessments in a transparent way. We illustrate this with a simple numerical model for evaluating pandemic policies that vary in terms of the stringency of the controls that they impose on individual behaviour, showing how the evaluation depends on the ethical significance accorded to their impact on the wellbeing of different age and income groups.

9.2 Benefit–Cost Analysis

Benefit–cost analysis of policies that seek to reduce the mortality risks imposed on individuals by a pandemic involves assigning a monetary value to the consequent reduction of the number of people that die. The monetary measure of the value of saving lives most widely used is the Value of a Statistical Life (VSL).

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When the individuals whose lives would be saved are not known, each of the people at risk would be willing to pay some money to increase their chance of survival. VSLs describe the monetary values that individuals attribute to a reduction in their own mortality risk. To be precise, these monetary values are derived from the rate at which people are willing to trade off small changes in their income against small changes in their risk of death. This, in turn, is estimated from individuals' reported preferences or from those that they reveal in workplace and consumption behaviour, such as the choices they make amongst jobs involving different levels of risk or their purchases of risk-reducing equipment. For example, if someone would accept a pay cut of $1,000 per year to reduce their annual risk of mortality by 0.1% (but would not accept a larger pay cut), then we say that the monetary value of their statistical life is $1,000,000. Note that this is not the same as saying that they would be willing to accept $1,000,000 in return for certain death or would pay this amount to guarantee their survival. Rather, it means that each of 1,000 people, identical in all relevant ways, would, considering their self-interest alone, be willing to pay an equal share of a $1,000,000 cost for something that reduces the number of them expected to die in the year by one. In this simple example, in a binary choice between (a) implementing a policy that reduced the risk of death in a year for each of 1,000 people by 0.1% and (b) not undertaking any such risk reduction policy, benefit–cost analysis would recommend implementing the risk reduction policy if and only if the aggregated monetary cost of doing so was less than $1,000,000.

A person's VSL can depend on characteristics such as their age, their income and wealth, or the overall level of risk they face. This can have unacceptable consequences for evaluating policies. In particular, the fact that someone who is well off is likely to place a higher monetary value on risk reduction than someone who is less well off implies that if individual-specific VSLs are used in a benefit–cost analysis of policies, the interests of the well-off will count for more than those of the less-well-off (because the monetary value the better-off place on reducing their risk of death is higher).

By using a single VSL, such as the population average rather than individual-specific ones, this problem is avoided. But others are then created. In particular, it seems reasonable to treat people in different age groups differently when assessing policies. Death is commonly considered a more serious loss from the societal and ethical perspective when it occurs earlier in life. Reasoning in terms of life years preserved rather than lives saved appears to better take account of this widespread sentiment. The skewed age distribution of COVID-19 fatalities makes this problem especially pressing.

A common solution is to use a different measure for policy evaluation: the Value of a Statistical Life Year (VSLY). The VSLY is obtained by dividing the average VSL of the population by the average life expectancy remaining (an individual's current life expectancy remaining is the number of additional years she can be expected to live, if she doesn't die now). The value of saving the life of someone in any particular age cohort is then given by the product of the VSLY and the life expectancy remaining for the cohort. This yields a value of life saving that varies by age.

One criticism of both VSL and VSLY measures is that they do not take into account quality of life. Many people would not regard a year of life spent bedridden as equivalent to a year of life in excellent health, for instance. Quality-Adjusted Life Years (QALYs) are a way of allowing the value attributed to a life saved to depend on both its remaining length and its quality. The value of living in an impaired health state—say, with diminished lung function due to COVID-19—is derived from people's preferences. These preferences may be elicited in a number of ways. Individuals may simply be asked to assign a numerical value to life in a particular health state in comparison to both death and life in full health. Alternatively, they may be asked how they would balance a longer life in an impaired state against a shorter, healthier life, or asked what risk of death they would be willing to run in order to be fully cured of their impaired health. These preference-based assessments can be questioned (Hausman 2015). For example, there is evidence that healthy people are poor predictors of what life would be like in states of impaired health (Dolan and Kahneman 2008, Walasek et al. 2019). Nonetheless, even rough indicators of the quality of life in impaired health states can be better than measures that neglect quality altogether. This is particularly clear in the pandemic, in which it is important to take into account the effects of contracting the illness on those who do not die from it. For this reason, the use of QALYs in public health to determine resource allocation is widespread.

It is also controversial. One key concern is that, when it comes to life extension, the use of QALYs regards as more valuable the life years gained by people who would, if saved, be in good health than the life years gained by people who would, if saved, live with disabilities or in poor health, because extending the lives of the former would generate higher health-related quality of life (National Council on Disability 2019). Arguably, this objection is best addressed not by rejecting the use of QALYs but by assigning special value to improvements in the quality (and length) of life of those who are worse off (John, Millum, and Wasserman 2017).

Estimates of VSL and VSLY vary considerably between countries. Part of this variation is due to differences in income per capita. For example, Robinson et al. (2019) recommend estimating a VSL for a country by adjusting estimates for the USA for the difference in income, and a VSLY by dividing the VSL by the average remaining years of life. For the USA, the typical VSL is around $10,000,000, and the VSLY a little over $300,000 (see also Kniesner and Viscusi forthcoming). By way of illustration, for a country with per capita income of $10,000, a VSL of around $1,650,000 and a VSLY of around $50,000 are suggested by this approach. (These quantities are in international dollars, that is, corrected for differences in purchasing power between different countries.)

A similar variation is observed in the monetary costs that public actors regard as reasonable to incur to gain one QALY. One approach is to estimate the value of a QALY by dividing the VSL by the average remaining QALYs (Hirth et al. 2000). This produces values modestly larger than the VSLY. By contrast, the World Health Organization (WHO) has suggested that interventions that generate a QALY for less than 1 times per capita income are good value for money and that interventions that generate a QALY for up to 3 times per capita income may be worth the cost (Bertram et al. 2016). These values are much smaller. The ranking of policies to deal with the pandemic based on benefit–cost analysis may well depend on which values are adopted. It is therefore critical that attention be given to the justification of any particular choice.

9.3 Social Welfare Analysis

An alternative approach to BCA, social welfare analysis, proceeds by measuring the joint health and economic impact of policies on individual wellbeing and then aggregating individual wellbeing gains and losses to yield an overall measure of how beneficial a policy is. This method has a singular advantage over BCA. Unlike population-average VSLs, the individual-specific wellbeing values that social welfare analysis uses are sensitive to individuals' characteristics, such as their age and income. And while the individual-specific VSLs, VSLYs, and values of QALYs of the well-off are inflated, relative to those of less well-off individuals, by the fact that money has relatively lower marginal value for the well-off, this is not true of individual wellbeing or social welfare values. So, the aforementioned bias in favour of the well-off that the use of individual-specific monetary values introduces into BCA does not plague social welfare analysis.

There are three basic elements to any social welfare analysis of a policy: (1) a measure of the level of wellbeing associated with different possible lives, determined by bundles of the goods that matter to individuals—income, health, longevity, and so on; (2) a representation of the effects of the policy in question on the wellbeing so measured of different individuals at different times; and (3) an assignment of a value to the policy on the basis of these effects (the social welfare function).

Many different methods are used to obtain an interpersonally comparable measure of wellbeing (for a comprehensive review, see Adler and Fleurbaey 2016). Subjective wellbeing approaches draw on individuals' reports of their mental and emotional state to identify their current wellbeing or on lifetime satisfaction scores to identify the determinants of their wellbeing (Clark et al. 2018). Preference-based approaches derive a wellbeing measure from individuals' preferences, on the basis of an ethically grounded normalization of levels of satisfaction. One such approach (Adler 2019) relies on preferences between probability distributions (lotteries) over alternative possible lives, normalizing wellbeing to equal zero and one at two benchmark lives. The equivalent income approach, by contrast, uses income or wealth, corrected for the value of non-market aspects of life, such as longevity, on the basis of individuals' preferences over these aspects (Fleurbaey and Blanchet 2013). Finally, in the capability approach, wellbeing is associated with the attainment of functionings—states and activities recognized to be of value—and with the opportunities to achieve them (Sen 1999).

In social welfare analysis, a policy is modelled as a probability distribution over the comprehensive wellbeing outcomes that it induces. A reduction in a risk to an individual brought about by a policy will be marked by the increase in the expected lifespan (longevity) of the individuals and, taking into account the costs associated with it, the probability of achieving different levels of wellbeing in the future (relative to not enacting the policy). Policies then have to be evaluated against these effects across the entire population. The effect of a policy that reduces the risk of contracting COVID-19 by some percentage and at some financial cost, for instance, can be modelled by the shift in the probability distribution of population wellbeing levels generated by the bundles of longevity, health, and income mentioned above. Since this shift captures not just the impact of the policy on individuals' longevity and health but also how these factors, together with income, co-determine changes in individuals' wellbeing, it provides all the information required for a comprehensive analysis of the overall effects of implementing the policy.

To determine these effects of a policy, social welfare analysis proceeds by aggregating the set of individual wellbeing values achieved by implementing this policy. It does so by means of a social welfare function (SWF) that assigns to each distribution of individual wellbeing a measure of social value. A commonly used SWF is the utilitarian one, which assigns to each set of individual wellbeing values the total (or the average) of the values. This way of aggregating individuals' wellbeing allows for sensitivity to inequalities in the population in the distribution of the bundle of goods determining individuals' wellbeing, but it is insensitive to inequalities in the distribution of wellbeing itself. In other words, it is indifferent to whether a given increment in wellbeing accrues to a well-off or a badly off person. In this respect, it is in tension with the common conception that policymakers should be inequality-averse, i.e. should favour policies that, *ceteris paribus*, result in less unequal distributions of wellbeing.

This limitation can be addressed by using distribution-sensitive SWFs that prefer policies that produce more equal distributions over those that produce more unequal ones. Different kinds of such SWFs reflect different moral views about what is at stake. Egalitarian SWFs commonly care about both inequality and total wellbeing. On these SWFs, a gain to a worse-off person is especially valuable because it reduces inequality (Atkinson 1970). Prioritarian SWFs, in contrast, treat a given improvement in the wellbeing of the worse-off as mattering more than the same improvement to the well-off, *not* because this reduces inequality but on the grounds that the former improves a person's wellbeing from a lower absolute level (Adler 2019). In numerical implementations, the two approaches often involve the same functional forms, especially the additive function popularized by Atkinson (1970). Because of this commonality in functional form (despite the difference in rationale), the literature often follows Atkinson (1970) in using the terms "inequality aversion" and "priority for the worse off" interchangeably. We do so here too.

SWFs that show special concern for the worse-off are divided on the question of whether, in circumstances in which policy outcomes are uncertain, what matters is the expected social value of the distribution of wellbeing that individuals will end up with once a policy has been implemented (the *ex post* approach) or the social value of the individuals' *expected* wellbeing levels associated with the policy (the *ex ante* approach).[1]

The choice of SWF is fundamentally an ethical one, as it requires balancing the wellbeing losses and gains of (classes) individuals with different characteristics. It is important to note that the implications of a choice of SWF for aggregating wellbeing also depends on the underlying measure of wellbeing, so such ethical evaluation has to include all aspects of the analysis. In our opinion, this is a second important advantage of social welfare analysis: it allows for unavoidable ethical choices to be made much more explicitly and transparently than does BCA.

To illustrate how social welfare analysis can be applied to the assessment of policy responses to the pandemic, we develop a numerical model which allows us to explore in some detail the impact on different age groups of various policy responses to the pandemic and the sensitivity of the assessment of policies to the disvalue attached to inequalities. In developing the model, one very important simplifying assumption is that we assume away any uncertainty about pandemic parameters (e.g. emerging variants of the virus, or the effectiveness of lockdowns on the spread of disease) that policymakers actually face. One further important limitation of our numerical analyses is that policy parameters are assumed to remain constant throughout the pandemic, whereas in practice adjustment of these parameters depending on the state of immunization of the population is likely to be recommended.

We also make two important ethical choices. Firstly, we adopt an *ex post* approach, that is, we focus on the anonymized final distribution of individual

[1] To illustrate the difference, consider a simple case in which two individuals, Ann and Bea, face death unless they are offered a vaccine, which would ensure they live in full health for a normal lifespan. Unfortunately, only one vaccine dose is available. Suppose that death would be equally bad for Ann and Bea, and Ann's wellbeing if vaccinated would be equal to Bea's wellbeing if she were vaccinated instead. Suppose we can either give the vaccine to Ann outright or instead flip a fair coin. An *ex post* approach would be concerned solely with how individuals end up. Hence, it would be indifferent to these two distribution methods (supposing that the method itself had no effects on Ann and Bea's final wellbeing). In contrast, an *ex ante* approach that was concerned with improving the prospects of those with worse prospects would strictly prefer the coin flip.

wellbeing. In doing so, we rely on the fact that when the pandemic's parameters are given, there is no uncertainty about this distribution. Secondly, we follow the "equivalent income" approach in using a monetary measure of lifetime wellbeing. This approach measures an individual's actual lifetime wellbeing by the annual income they would require in a benchmark situation with a guaranteed longevity of a hundred years in good health, in order to be as well off in their own estimation as they currently are. (For example, suppose that Charles would after careful deliberation be indifferent between his actual situation, in which he will live in good health and with an annual income of $70,000 until the age of 65, at which point he will die, and a hypothetical situation in which he lives in good health until the benchmark age of 100 with an annual income of $40,000. Then his equivalent income is $40,000.) This measure of wellbeing mimics BCA when social welfare is simply the sum of equivalent incomes, i.e. when inequality aversion in equivalent income is zero in the social welfare function, but departs from it when the social welfare function incorporates a special concern for the less-well-off. Jointly, these choices imply that the modelled inequality aversion reflects a concern with the inequalities in equivalent income that in fact arise from the implementation of a policy (once uncertainty has been resolved). Other preference-based measures of wellbeing (as in Ferranna et al. 2022) incorporate diminishing marginal value of income at the individual level, so that social welfare analysis with such measures is very similar to social welfare analysis with equivalent incomes and greater inequality aversion. For instance, utilitarianism in Ferranna et al. (2022) corresponds to a form of prioritarianism over equivalent incomes. The conclusions that we draw about the implications of different SWFs (in particular, the contrast between results obtained for various degrees of inequality aversion) need to be understood with this in mind. Evidently, the exercise could be done with different choices and with potentially different conclusions. Since our analysis here is not meant to provide policy prescriptions but rather to illustrate the proposed approach to policy evaluation based on a social welfare function rather than VSL, we will here review the sensitivity of policy evaluation only for a limited range of value judgments *within* the *ex post*, equivalent income framework. However, one lesson we emphasize is that policy evaluation should also involve an analysis of the robustness of conclusions with respect to variations in these aspects of the framework, e.g. to a different choice of wellbeing measure.

9.4 Evaluating Policies: a Numerical Illustration

The model we develop here draws on the prior work of Ferranna et al. (2022) and Adler et al. (2020). The former makes a comparison of three approaches to policy evaluation in the context of the pandemic: benefit–cost analysis, utilitarianism, and prioritarianism. They simulate a scenario without any policy intervention and compute the cost that society would be willing to bear to completely avoid the pandemic as depicted in this scenario. The larger this willingness to pay, the more willing the policymaker should be to implement stringent control policies to suppress the pandemic. In order to evaluate effects on inequalities, they introduce two age groups (young and old) and five income groups (quintiles) and assume that the COVID-19 mortality risk increases with age and decreases with income. They show, in particular, that BCA implies a greater social willingness to pay to avoid the pandemic, because the other two approaches are sensitive to inequalities (inequalities in income for utilitarianism, inequalities in wellbeing for prioritarianism) and because pandemic suppression policies would impose costs on low-income groups which loom large in social welfare. They observe that, among the worst-off groups (i.e. the young and poor who die prematurely), the *ex post* distribution of welfare pits the potential victims of the pandemic who would survive due to pandemic suppression against those who would not benefit from suppression and would die whether or not suppression was practised (from COVID-19 or other causes). They note that, perhaps surprisingly, a strong priority to the worse-off may reduce the social willingness to pay to avoid the health impacts of the pandemic, since the very-worst-off—the people who would die at a relatively young age during the pandemic of other causes or of the pandemic despite any measures to control it—would bear the cost of such a policy (i.e. a loss of income due to lockdown) without reaping any benefit. However, they also observe that, independently of the value framework, a redistribution of the policy costs towards the richer (e.g. through the implementation of unemployment benefits and other COVID-19-related public transfers) increases the social willingness to pay to avoid the pandemic. One message of their analysis is that concern for the less-well-off can motivate strong support for suppression policies when the costs of these policies on the incomes of the poorest are substantially mitigated but may not do so otherwise.

The exercise in Ferranna et al. (2022) highlights the importance of both inequalities and ethical evaluation of these inequalities in the evaluation of COVID-19 control policies. In particular, it points to a careful consideration of the cost side of the policies, and the identification of which individuals are likely to experience larger net benefits from the policy. However, the framework is too simple to allow inferences about the ideal policy to control the pandemic. For example, should we aim at a strict control policy that completely suppresses the pandemic or at a laxer policy that mitigates the consequences of the pandemic without completely suppressing it? In addition, even though the willingness to pay to avoid the pandemic decreases with the degree of priority to the worst-off, this willingness to pay might still be higher than the willingness to pay to mitigate the pandemic without suppressing it. In other words, the framework in Ferranna et al. (2022) is not informative about the ranking of alternative COVID-19 control policies. Nor does it permit us to explore how that ranking varies according to the adopted value framework.

Here we expand their numerical model in two directions. First, we examine a range of policy parameters through scenarios of policy interventions taking the form of repeated lockdowns. We focus on two policy dimensions that would be involved in such a policy. The first is the reduction of contacts through lockdowns. This reflects how "tight" the lockdowns are, e.g. the number of businesses and individuals that are affected, or the extent of indoor capacity restrictions (e.g. the number of people allowed in a restaurant). The second policy dimension involves the strictness of the thresholds of the impact on population health for triggering (and then eventually ending) lockdown episodes. We assume that the occupancy rate of intensive care units (ICUs) would be used to determine when to start and end a lockdown, with a higher threshold for the start of a lockdown and a lower one for ending it. The population is more often under a lockdown when these thresholds are lower. We can then compare the outcomes of policies that are more or less stringent in terms of both the tightness of lockdowns and the strictness of the trigger thresholds.

The second direction in which the illustration is extended beyond Ferranna et al. (2022) concerns the description of inequalities. We introduce eight age groups (rather than two) and attempt to compute their lifetime wellbeing in a way that takes account of macroeconomic growth and the usual profile of income through the life cycle. This may be quite an important matter in order to analyse the relative priority of different age-income groups in the pandemic context. Indeed, a suppression policy is generally thought to oppose the self-interest of younger groups who suffer from income losses in the economy to the self-interest of the elderly, who are much more vulnerable to COVID-19 and who stand to benefit much more from the health effects of the policy. However, the picture may actually be more complex. First, the young victims of COVID-19, even if their numbers are small, lose a lot because their premature death deprives them of many more years of life than the older individuals. Second, past and (likely) future economic growth implies that the lifetime living standard of the young cohorts is (likely to be) much higher than the older cohorts' living standards.

As in Ferranna et al. (2022), the US population is used to simulate the various scenarios. The model of the pandemic is similar to their model as well as the model in Adler et al. (2020), with a few changes.[2] Contagion through contacts is modelled with a variant of the susceptible-infected-recovered (SIR) model, which takes account of the fact that at high levels of infection the contagion is less than

[2] Details of the model and the dataset construction are available from the authors. We thank Siméon Campos for help in building the data set.

proportional to the number of infected people,[3] and that people spontaneously reduce their contacts when contaminations rise. The economic slowdown is assumed to be directly proportional to the reduction in contacts (which is partly spontaneous and is reinforced by lockdown measures). Lifetime wellbeing is computed on the basis of past growth rates for previous periods, and a growth rate of 2% per year in real income is assumed for the remainder of the century. The pandemic is assumed to fade out after two years and policy is thus tested only over this time span (2020–1). The infection rate and infection-fatality rate are kept at levels estimated for the initial variants of the COVID-19 virus. Some simulations for a milder but more contagious virus like the Omicron variant are presented at the end of this section.

In the simulations, a permanent testing policy is assumed to be implemented throughout the period, in which symptomatic people are tested and isolated if positive, with the accuracy of the testing process assumed to be 70%.[4] The contact reduction due to lockdown that we consider ranges from 50% to 90% and refers to the number of people that anyone meets, not to the frequency of going out.[5] Regarding the lockdown trigger threshold, we will restrict attention to two policies. Our "strict" policy triggers a lockdown when 30% of ICU capacity is occupied by those ill with COVID-19 and ends it when this level of occupancy falls to 20%. Our "lax" policy has a starting threshold of 70% of ICU capacity being so occupied, and a stopping threshold of 60%.

Individuals are divided into different age-income-longevity groups depending on their current age, their income group,[6] and the longevity they ultimately realize. As we take an *ex post* approach to policy evaluation, what matters is the realized longevity of individuals, not their life expectancy. Thus, a 60-year-old individual in the lowest income group who dies at age 70 ends up in a different category, for social welfare, than a 60-year-old individual in the lowest income group who dies at age 80. Individual lifetime wellbeing is computed as the undiscounted sum of a power utility function including an additive term representing a critical level of income below which utility is negative.[7] As already explained,

[3] This is because the probability of avoiding becoming infected is the product of the probabilities, for each contact with another person, of not becoming infected as a result of the contact. This product is not linear in the proportion of infected people.

[4] This includes the precision of the test and the compliance with the testing request for symptomatic people.

[5] This means that no specific assumption is made about the technology of contacts (quadratic or otherwise). When people go out to meet other people in a public place, reducing the frequency of going out by half divides the number of people anyone meets by four, a quadratic relation. In contrast, when people go out to meet specific people, cutting visits by half reduces contacts by half, a linear relation. Our modelling parameter is the number of contacts, not the frequency of going out.

[6] We assume that there is no social mobility, i.e. individuals remain in the same income group throughout their entire life (although income increases over time).

[7] Specifically, the per-period (one year) utility is $u(c)=\frac{c^{1-\gamma}}{1-\gamma}-\frac{c_0^{1-\gamma}}{1-\gamma}$, where $\gamma=1.25$ and $c_0=\$1,000$. The parameter γ is taken from Becker et al. (2005), but c_0 is taken to be greater than their \$353 value, which is very low for the USA.

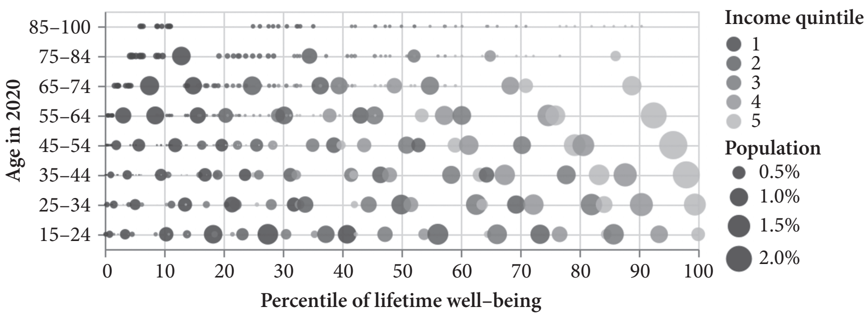

Figure 9.1 Distribution of the various age-income-longevity groups. Note: Each bullet represents an age-income-longevity group. Grey hues depict the income quintile to which the group belongs. Bullet sizes reflects the size of the group in percentage of the total population. For each age group, the rightward spread of bullets of the same shade of grey reveals the overall wellbeing induced by greater longevity within an income group. (For example, among the 15–24-year-olds in the lowest income quintile—the dark grey bullets along the bottom horizontal line—the shortest-lived will be in the lowest centile of lifetime wellbeing, and the longest-lived in the 40th centile.) This graph is made under a stringent policy.

wellbeing is measured not in "utils" but in money-metric terms as the annual income that, received every year over a 100-year lifetime, would yield the same lifetime utility as the contemplated income-longevity profile of any individual. This measuring rod (equivalent income) yields the same ranking of wellbeing in different age-income-longevity groups as the common utility function.

The inequalities in the population can be described in terms of where the different age-income-longevity groups are spread over the distribution of lifetime wellbeing (Figure 9.1). To focus on one group in particular: the elderly appear everywhere in the distribution, including among the most disadvantaged, but neither at the very bottom nor at the very top. This is due to the fact that they enjoy the benefit of longevity, but their life has been spent mostly in poorer times.

Let us first briefly review the macro-scale health and economic consequences of a suppression policy, for the different policy parameter values. Figure 9.2 depicts the total number of deaths over the two years of the pandemic as a function of how tight the lockdown is in terms of percentage of contact reduction (x-axis) and of its ICU thresholds (different lines for the "strict" 30%–20% start–stop thresholds and the "lax" 70%–60% thresholds). Three main observations can be made. First, by and large, a more stringent policy (tighter and more readily triggered lockdowns) reduces fatalities. Second, there are exceptions for the tightness of lockdown, because, for example, an 80% reduction in contacts, compared to 60%, may crush a first wave more effectively but also keep the population more vulnerable to a second wave (see the dashed line). Third, there are complementarities between tightness and more readily triggered lockdowns, as the more readily triggered lockdowns reduce fatalities more markedly when they are tighter.

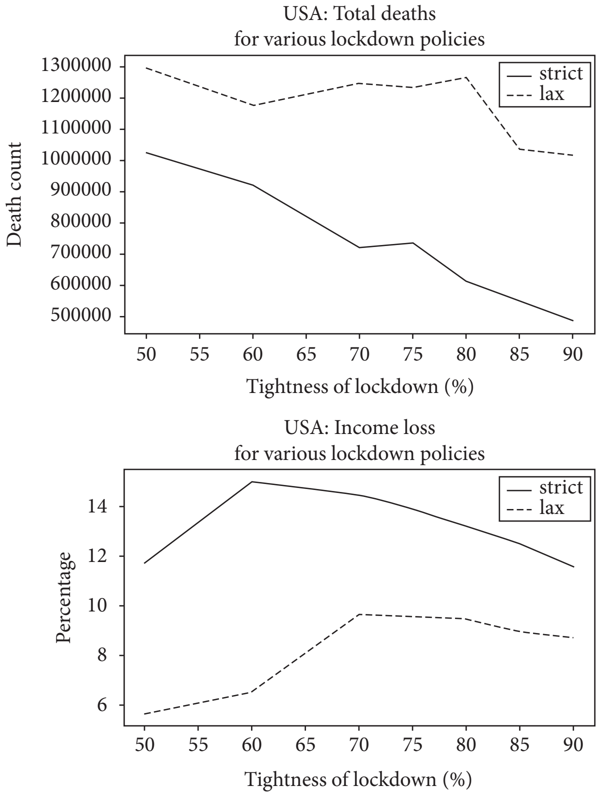

Figure 9.2 Health and income consequences of policy parameters.

In Figure 9.2, the lower panel shows an interesting inverse U-shape for the economic impact. While a minimally restrictive policy (relatively loose lockdown and lax triggering thresholds, i.e. the dashed line bottom left) implies moderate costs (which occur mostly due to spontaneous reduction in contacts and economic activity undertaken by people), a very restrictive policy (in particular, tightening lockdowns when they occur) can also moderate the economic costs by enabling economic activity to restart after very substantially suppressing the pandemic. Together, the two graphs suggest that middle-of-the-road policies (e.g. relatively loose lockdowns) may be particularly ineffective, as they fail to produce good health outcomes and nevertheless induce the highest economic costs.

How do these patterns of health and income effects combine to determine social welfare when inequalities are taken into account? Figure 9.3 shows social welfare levels for the same policies as the previous figure, but under different degrees of priority to the less-well-off (inequality aversion), with a moderate degree of priority modelled in the upper panel, and a larger degree modelled in the lower panel.

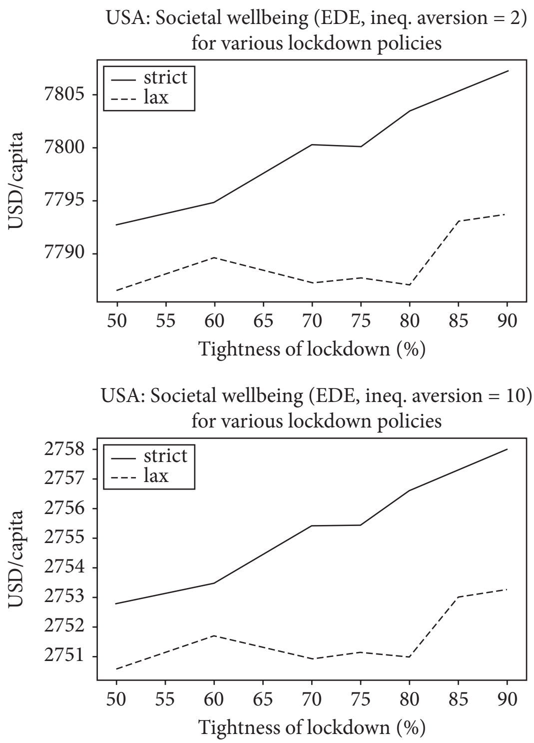

Figure 9.3 Social welfare impact of various policies. Note: Social welfare is measured here as the equally-distributed equivalent (EDE) of the distribution of wellbeing. The EDE is the level of wellbeing that, if equally enjoyed by all the population, would yield the same level of social welfare as the contemplated situation. A degree of inequality aversion equal to x means that increasing the level of wellbeing of a person who is half as well off as another is 2^x times more valuable.

Comparing Figure 9.3 to Figure 9.2 reveals that health outcomes loom large in our social welfare analysis. A stricter policy for triggering lockdowns generates higher social welfare because the health gains outweigh the losses in income. Together with the fact that both lines reach their highest point when lockdowns are at their most tight (in terms of contact limitation) this indicates that, despite being relatively more expensive, the most stringent policies prevent sufficiently more deaths to make them more beneficial from a societal point of view. We note, however, that in line with the results reported in Figure 9.2, if a laxer threshold for triggering lockdown is used, as indicated by the lower, dashed line, then tightening lockdowns from low to moderate is not, on balance, advantageous, because over time it does little to lower deaths, but it does have higher economic costs.

It is noteworthy that the social welfare analysis of policies in our model is not very sensitive to changes in the degree of priority for the worse-off (i.e. the degree of inequality aversion). Indeed, the ranking of policies seems barely affected by the coefficient of inequality aversion. It is interesting to compare this finding to that of Ferranna et al. (2022).[8] They find that an increase in inequality aversion reduces somewhat society's maximum willingness to pay to eliminate the pandemic. For example, in a scenario with a regressive distribution of both the deaths from COVID-19 and the costs of lockdown, they find that a utilitarian SWF (zero inequality aversion) is willing to incur up to a 15% reduction in GDP to avoid the loss in health induced by the pandemic, while a prioritarian SWF with inequality aversion equal to 2 is willing to incur no more than an 11% reduction.[9] The differing effects of inequality aversion as between the current exercise and Ferranna et al. (2022) are not, on reflection, very surprising. Ferranna et al. (2022) seek to identify a precise cut-off value: the maximum GDP reduction that is no worse than an uncontrolled pandemic. By contrast, Figure 9.3 shows the ranking of lax versus strict lockdown triggers for different levels of lockdown tightness. While increasing inequality aversion does change (somewhat) the Ferranna et al. (2022) cut-off, it does not change the ordinal ranking of the different types of policies. Another difference is that Ferranna et al. (2022) ignore the influence of income growth over a lifetime, which this chapter does take into account. As a consequence, in Ferranna et al. (2022) older individuals represent a greater share of the better-off than they do in our chapter, which has a greater share of the elderly among the less-well-off because they experienced poverty when they were young. Because in our analysis a more substantial share of the older population is ranked low in the distribution of lifetime wellbeing, the benefit of reducing their mortality looms larger. This comparative finding therefore brings home the importance of the choice of lifetime wellbeing as a metric of concern, as well as of taking full account of the hardships endured by older generations when incomes were much lower than they are now.

We can now compare these results with what would be obtained with a more conventional benefit–cost analysis based on the value of a statistical life (VSL), multiplied by the number of COVID-19 fatalities to assess the total value of health loss, and also adding up the total loss of income over the two years. The results are depicted in the upper panel of Figure 9.4. As should be expected, the analysis yields similar results as the social welfare analysis with zero inequality aversion over equivalent incomes. (The latter is not shown here, but the shape of

[8] In making such comparison, one must account for the fact that they employ a somewhat different metric of individual wellbeing, on which equivalent income (which is our metric) has diminishing marginal wellbeing impact. But, fortunately, our study and Ferranna et al. (2022) are fully comparable if one relates a coefficient of inequality aversion of x in this chapter with a coefficient of $x+1.25$ in Ferranna et al. (2022).

[9] To be precise, Ferranna et al. (2022) find an 11.1% maximum GDP reduction for ex post prioritarianism, and a 10.6% maximum GDP reduction for ex ante prioritarianism. Recall that utilitarianism (resp., prioritarianism) in Ferranna et al. (2022) corresponds to inequality aversion around 1.25 (resp., 3.25) over equivalent incomes.

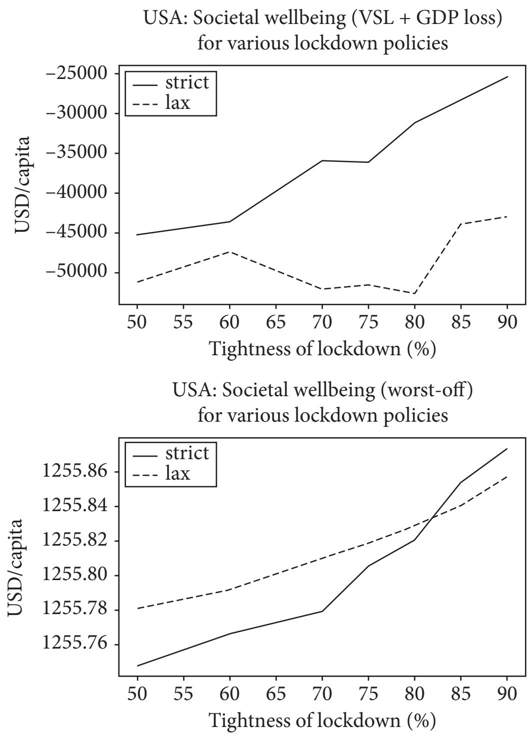

Figure 9.4 Cost-benefit analysis of policy options, based on VSL (left) or the worst-off (right).

the graphs is virtually identical and displays a similar pattern to the upper panel in Figure 9.3.)

Going to the other extreme of inequality aversion, the lower panel of Figure 9.4 displays an evaluation based on the situation of the very-worst-off in the population, i.e. the youngest who die at the end of the first year of the pandemic. Their situation is determined solely by the economic costs in the first year, since, *ex post*, they do not benefit from the reduction in mortality rates. The curves are thus quite different, making strict trigger thresholds appear undesirable for moderate tightness levels of lockdown. Nonetheless, making lockdowns tighter is always preferable in the model. This is because tightening them when they do occur means they can last less long, which generates economic benefits for the worse-off.

There remains an interesting question about how the net benefits and burdens of policies are distributed among the young and old as well as among the poor and the rich, and extent to which their interests align. To investigate it, one can compute the average level of equivalent income for age-income groups under different policies. This averaging operation ignores the *ex post* inequalities induced by the random distribution of sickness and death across the population during the pandemic and focuses on the average wellbeing offered by the policies to these various age-income groups. Consider three policies: a lenient policy (with lockdown bringing a mere 50% contact reduction and start–stop thresholds for lockdowns of 70% and 60% of ICU capacity, respectively), a middling policy (70% contact reduction during lockdown, with start–stop thresholds of 50% and 40%), and a stringent policy (90% contact reduction during lockdown and thresholds of 30% and 20%).

Figure 9.5 depicts who gains or loses (negative signs in cells mark losing subgroups, all others gain) and the relative gain or loss in average equivalent income (grey hues) for each group, when moving from the lenient to the middling policy in the left panel, and from the middling to the stringent policy in the right panel. It shows that the younger and poorer groups suffer from the implementation of a middling policy compared to a lenient policy, which confirms the widespread perception in many countries in which a middle-of-the-road policy has been implemented. In contrast, all groups gain when moving from a middling to a stringent policy. In both cases, the relative gains are concentrated among the rich elderly (right-hand panel, darker squares indicate concentrated gains).

These results are obtained under the assumption that the distribution of fatalities and economic costs is unfair, with fatality rates and the ratio of economic costs to income being lower for richer groups.[10] If measures were taken to guarantee that fatality rates from the pandemic were independent of income and

Figure 9.5 Gains and losses from lockdown policy for the various age-income groups.

[10] To be precise: fatality rates are assumed to be inversely proportional to the square root of income, and costs are assumed to be proportional to the square root of income.

costs were distributed in a progressive fashion, then the gains of policy would be even more concentrated on the rich, because they would benefit more from health outcomes in both moves, and more from the improvement in economic outcomes when moving from middling to stringent policies, due to their greater share in the benefit of a reduced macroeconomic cost. However, only the very youngest and poorest group would lose when moving from the lenient to the middling policy.

Finally, we briefly examine how policies compare under a pandemic which is more like the Omicron variant, i.e. with three-times greater contagion rate and three-times lower infection-fatality and hospitalization rates, and with a contagion rate for recovered patients that is no longer zero but similar to the contagion rate of the initial virus for susceptible patients. This makes for a quicker succession of waves over the considered time horizon (two years), with a greater number of total fatalities due to many more cases. Figure 9.6 shows the main results, which still display a preference for tighter lockdowns but no longer so clearly for more stringent ICU thresholds, especially when high priority is put on the worse-off populations. (Importantly, these results should not be considered directly relevant to the case of a late variant that, like Omicron, emerges after a significant proportion of the population has been immunized or has antibodies from earlier variants; they merely illustrate how trade-offs depend on some key non-policy parameters of pandemics.)

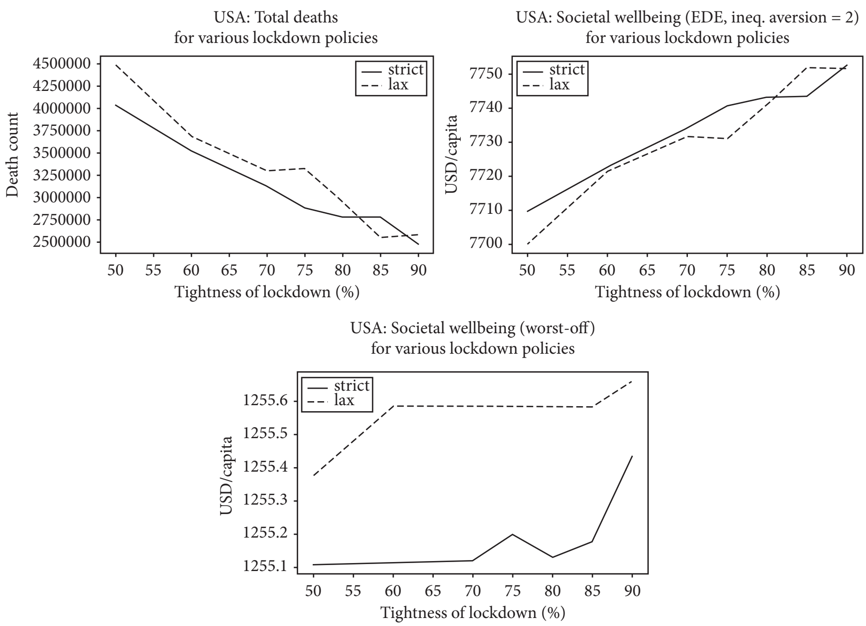

Figure 9.6 Policy evaluation under a pandemic that is like Omicron from the start.

9.5 Conclusion

Roughly speaking, the COVID-19 crisis involves a trade-off between lives and livelihoods. Lockdown or other control measures to limit the uncontrolled spread of the virus reduce deaths, but they come with an economic cost. This statement is imprecise in three ways, however. First, a laissez-faire policy of doing nothing to combat the pandemic may itself have net economic costs, relative to some control policy, insofar as laissez-faire induces individuals to reduce their risks via uncoordinated efforts at social isolation, with consequent economic costs.

Second, governments have many options to combat a pandemic other than the extreme options of laissez-faire and a maximally stringent lockdown. It is quite possible that a given policy intervention P^* is actually a "win/win" relative to another policy intervention P: that P^* not only reduces deaths relative to P but also reduces economic costs. This possibility is demonstrated by our numerical illustration. A policy of implementing a tight lockdown under a sufficiently strict ICU threshold leads not only to fewer deaths but also to lower costs, relative to a policy of a moderately contact-reducing lockdown for the same threshold (see Figure 9.2).

Third, the impact of policies on individuals' fatality rates and incomes, and the overall effect on individuals' wellbeing, may well differ for different population groups. For example, Figure 9.5 shows that younger and poorer individuals lose on balance in moving from a lenient policy to a middling policy, while other groups benefit.

One general lesson is therefore that evaluating pandemic policies requires careful efforts to model the effect of policies on different groups. Of course, such modelling is itself costly and yields uncertain results, but it would seem that reasonable modelling efforts would at least differentiate individuals by both age and income—as in our numerical simulation. Different age groups differed dramatically with respect to the fatality costs of COVID-19: older individuals faced a much higher risk of dying if infected but would lose less life expectancy if they did die. The costs of lockdown tended to fall more heavily on people with lower income who cannot work from home, but these costs can be reallocated toward richer individuals through taxes and government assistance.

Evaluating COVID-19 policies also requires an evaluation methodology, which permits an assessment of the policies once modelled. This chapter has argued in favour of the social-welfare-function approach, as opposed to valuing life-saving with VSL, VSLY, or QALYs. As explained, VSL and VSLY measures do not take account of quality of life, and these measures also overweight the interests of the rich relative to others because the rich are willing to pay more for risk reduction. Meanwhile, a policy assessment based on simple cost-per-QALY places a greater weight on life extension for those in better health and ignores the distribution of income—problems which can be avoided by using a measure of wellbeing that takes account of both health and income and a social welfare function that assigns extra weight to the worse-off.

The social welfare methodology requires normative choices of two kinds. We need to specify a procedure for wellbeing measurement—so as to assign a numerical value to a given individual bundle of whichever attributes are being modelled as the source of wellbeing (income, longevity, health, etc.). We then need to specify the type of social welfare function. In this chapter, we have focused on social welfare functions which differ in their degree of priority to the worse-off. There is, however, one kind of case in which this degree of priority does not matter: if all groups are better off with one policy than a second, any SWF which respects the Pareto principle will favour the first policy regardless of the priority assigned to the worse-off.[11] In short, the level of priority to the worse-off matters only in determining how to trade off wellbeing gains to one group against losses to another.

Even when there are such trade-offs, the level of priority to the worse-off need not matter very much. This will depend on the specifics of the policies being compared. For example, our numerical illustration found that the ranking of policies that impose very tight restrictions on people's contact during lockdowns versus policies that have looser restrictions during lockdowns was independent of the degree of priority for the worse-off. A policy recommendation that is invariant to both changes in the degree of special concern for the worse-off and the choice of wellbeing measure is especially robust. Conversely, to the extent that the recommendations of the SWF framework depend upon these moral judgments, the framework makes transparent just where normative deliberation needs to occur.

The next pandemic will be different from the COVID-19 pandemic. But the types of interventions that may be useful to moderate it will likely be similar in that they will involve trade-offs between economic costs and health benefits, and in that these costs and benefits will be distributed unequally in the population. When we face such trade-offs, social welfare analysis provides a valuable framework for evaluating which of the many possible policy responses are most consistent with a concern for greater wellbeing and its fairer distribution.

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[11] The Pareto principle is that if everyone is at least as well off under policy P* as under policy P, then P* is at least as good as P.

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