Public health challenges and opportunities after COVID-19

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Abstract

With hindsight, the main weakness behind the ineffective response to the coronavirus disease 2019 (COVID-19) pandemic in some countries has been the failure to understand, and take account of, the multilayered systemic interdependences that spread the effects of the pandemic across social, technological, economic and healthcare dimensions. For example, to respond to the COVID-19 pandemic, all people were required to rapidly adjust to social distancing and travel restrictions. Such a complex behavioural response entails adaptation to achieve a full recovery from the systemic shock. To capitalize on the positive effects of disruption to the status quo, much more complex socioeconomic modelling needs to be considered when designing and evaluating possible public health interventions that have major behavioural implications. We provide a simple example of how this reasoning may highlight generally unacknowledged connections and interdependencies and guide the construction of scenarios that can inform policy decisions to enhance the resilience of society and tackle existing societal challenges.

Unexpected shocks

In October 1973, as a result of the sudden embargo called by Arab Members of the Organization of the Petroleum Exporting Countries in retaliation against countries supporting Israel in the Yom Kippur War, oil prices increased greatly in a few months, leading to an overall fourfold increase at the end of the embargo 6 months later. The speed and size of the change took the global economy by surprise and forced the public to face unprecedented social conditions such as empty city streets because of bans on using cars. Even if not apparent at the time, this event was a turning point which had not only short-term effects, but profound long-term ones, such as contributing to the emergence of the green economy and to the increasing economic and political relevance of concerns about environmental sustainability. An unintended consequence...
of the event was that it became a sort of natural experiment because the public worldwide had a
direct experience of what a less fossil-fuel intensive economy and society would look
like – something that would have been impossible within any business-as-usual policy agenda,
however ambitious or disruptive.\textsuperscript{5}

The current coronavirus disease 2019 (COVID-19) pandemic can, to a large extent, be
seen as a new example of a large-scale unexpected shock, which is likely to have many complex
and long-term consequences on several areas of society and the global economy.\textsuperscript{6,7} Even more
than the car-free weekends of the 1970s, we have faced an unprecedented situation in this
pandemic with entire countries having prolonged restrictions, such as curfews, school closures
and gathering and travel restrictions. Only a couple of years ago, this kind of event would have
been confined to the realms of science fiction. And yet, such conditions have now become the
status quo and the starting point from which we have to design new strategies and policies for
development. The pandemic crisis can therefore be seen as an important opportunity for large-
scale, deep-seated structural change, far beyond, in scale and scope, what could have reasonably
been possible through conventional stakeholder negotiations on typical policy issues. Moreover,
the potential level of structural change that could result from the pandemic is far more diverse
and multifaceted than the greening of the economy as a result of the 1970s energy shock because
the extent and complexity of current technological development exceeds that of half a century
ago.\textsuperscript{8}

However, the very reason why this shock provides new opportunities for societal
development is also the reason for its serious social and economic consequences: the fact that it
was unthinkable by pre-pandemic standards. Although many experts in the past few decades
repeatedly warned that the occurrence of a global pandemic was a near certainty,\textsuperscript{9,10} these calls
were not taken seriously enough. Furthermore, with a few exceptions, the COVID-19 pandemic
found many public health and social systems unprepared, including the systems of most
socioeconomically developed countries such as the United States of America.\textsuperscript{11} People seem
unable to consider major catastrophic changes as a real possibility before they happen, and to
take into account their knock-on effects.\textsuperscript{12} With hindsight, the main weakness behind the
ineffective response to the pandemic has been the failure to understand, and take account of, the
multilayered systemic interdependences that spread the effects of the pandemic across social,
technological, economic and health-care dimensions. In other words, policy failures in the
context of the current pandemic can be traced to the inability to think in terms of the emergent 
behavioural responses that are typical of all kinds of complex adaptive systems.\textsuperscript{13} This inability 
is a particularly serious flaw in a world built around globalization which interlinks global and 
local dimensions,\textsuperscript{14} whose effects simultaneously appear over many different (and previously 
considered largely distinct) layers of human activity.

**Unintended consequences**

In the case of the COVID-19 crisis, acknowledging how the epidemic dimension coevolved with 
an infodemic dimension, that is, an excess of not necessarily reliable information, is easy.\textsuperscript{15} 
These dimensions created complex feedback loops between the dynamics of infection on social 
behaviour and the dynamics of media content production, dissemination and news consumption. 
Exposure to a large amount of information, often contradictory, about the pandemic and its many 
effects on almost all aspects of human existence has deeply influenced individual and social 
behaviours and, through them, the economic and financial systems, education, the retail industry, 
logistics and entertainment, and even religion, to mention a few obvious examples. Travel 
restrictions are forcing work and education to be restructured and decentralized through ad hoc 
digital platforms, while global travel bans are forcing business and science to move from 
physical to digital meetings. This situation has led to a rethinking of communication and 
organizational methods, and probably business models themselves, while accelerating the 
development of digital technologies that will remodel economic, learning, professional and 
social systems and environments.

However, we argue whether such structural changes will facilitate the achievement of 
environmental and social sustainability goals or make their attainment harder, with consequent 
effects on the related socioeconomic inequalities. Possible advantages of such changes might 
include an improvement in the work–life balance from new mixed or integral forms of 
teleworking, which, by reducing work-related movement, might reduce the human impact on 
climate, thus saving human lives and contributing to a lower the risk of future pandemics.\textsuperscript{16} For 
instance, in China\textsuperscript{17} and northern Italy,\textsuperscript{18} the extensive restrictions which saw a sudden stop to 
most industrial activity and private motorized transportation, brought about an immediate 
 improvement in the air quality. The pandemic has also had a noticeable effect on sociopolitical 
trends. In Italy again, the crisis abruptly disrupted the previous populist, xenophobic orientation
of the public discourse, making space for a new dialogue that has shifted to a recovered sense of human solidarity and cohesion.\textsuperscript{19} Other observed effects concern the rebuilding of national pride on the basis of cultural excellence, generosity and the selfless dedication of health professionals,\textsuperscript{20} as an example of the deep roots of Italy’s social and cultural values. Furthermore, a regained sense of respect for the authority of experts, not only in the health professions, has been observed. At the same time, fringe but very vocal social circles such as groups opposed to vaccination and more generally believers in conspiracy theories have lost momentum in the broader public opinion.\textsuperscript{21} However, not all changes have been for the good. Some other countries, such as the USA, where governance of the response to COVID-19 has been problematic, have instead witnessed a substantial escalation of conspiratorial thinking\textsuperscript{22} and a strong politicization of the pandemic crisis, which have greatly affected viral transmission and the consequent death rate.\textsuperscript{23}

Moreover, any reported positive effects, however encouraging, only highlight specific aspects of the impact of the crisis. Other, concurrent aspects might have serious negative effects, to the point that they more than counteract desirable changes. These effects include for example increasing social isolation, mental health illness, redundancies, financial difficulties and permanent closure of many businesses. The people more likely to be affected by such adverse outcomes are the ones who were already having social, financial and educational deprivation before the pandemic crisis struck. Furthermore, such negative effects are likely to have more impact the less effective a country’s response has been overall. Therefore, we need a systemic approach in both assessing the consequences of the pandemic crisis and in designing adequate response policies, while taking social sustainability goals into account. A good illustration of this point comes from considering the social distancing measures that are necessary to mitigate the impact of the pandemic and to limit infections to levels that the health system has the capacity to manage. Claiming that social distancing is necessary and even inevitable does not imply that it is also socially sustainable. In fact, the social sustainability of social distancing ultimately depends on seemingly unrelated cultural variables, such as widespread perceptions of economic fairness and social privilege. As social distancing prevents many people from earning an income and confines them in their homes, factors such as the availability of savings, quality of living space and family relations inevitably become serious problems, not only politically, but also in terms of effectiveness of public health measures.\textsuperscript{24} If people in disadvantaged positions refuse to comply
with social distancing instructions because they perceive them as an unfair toll on their social condition, the effects of an objectively useful and important public health measure could be partly or totally jeopardized.

Despite the wide differences in socioeconomic and cultural characteristics, and tone and topics of the public discourse across countries, such major crises will probably have a considerable impact on sociocultural orientations and the evolution of the public discourse itself. On the other hand, the late and often contradictory and ill-organized reaction to the crisis by most governments illustrates how many political decision-makers are unprepared to react effectively and promptly to shocks characterized by the functional interdependencies of the social, economic and public health systems. To capitalize on the positive effects of disruption to the status quo, much more complex socioeconomic modelling needs to be considered when designing and evaluating possible public health interventions which have major behavioural implications.

**Post-pandemic scenarios**

The speed and size of change caused by large systemic shocks such as the COVID-19 pandemic require a clearly different policy approach to complexity. How can we anticipate and, to some extent, drive such changes if we have no pre-existing experience of the new situation? To what extent are existing theories able to guide our understanding? A suitably designed system-thinking that is able to deal with uncertainty about both the obvious and latent interdependencies of our society might be of help here, if it enables us to analyse and classify the entanglement of its subsystems or layers,\(^{25,26}\) and to predict their evolution. This task is so challenging that it should only be tackled through computational approaches and not top-down reasoning. What could therefore be seen as an exceptional approach to science to address major, unexpected changes would thus become the so-called new normal, namely, the most appropriate way to do science in an era of hyper-connectedness.

Developing a full model of the inter-relatedness of the various kinds of systems in a pandemic crisis is beyond the scope of this article. However, we provide a simple example of how this line of thinking may highlight generally unacknowledged connections and guide the construction of possible scenarios that can inform policy evaluations and decisions. Based on Google mobility data from March to early December 2020, we report the impact of pandemic-
related movement restrictions and social distancing on various dimensions of socioeconomic activity in Italy and a few countries representative of different continents (Fig. 1 and Fig. 2). We see a substantial shift in mobility behaviour compared with the pre-pandemic baseline, with a collapse of work-, retail- and recreation-related movement in favour of residential- and nature-related movement. Moreover, in various countries, such changes in movement seem to have stabilized considerably under baseline levels, especially in socioeconomically advanced countries such as the United Kingdom of Great Britain and Northern Ireland and the USA (Fig. 2). On the other hand, in less socioeconomically developed countries, such as Brazil and India where most people have much smaller savings’ buffers and less possibility to make use of technology to reorganize their business in the context of low levels of movement of people, the level of movement tends to return to the baseline even though the pandemic crisis is far from over. In fact, movement is increasing, as in the case of Brazil and India (Fig. 2).28,29

We built this example using a single data source. However, it shows how, by only considering movement, much can be understood about the complex dynamic of behavioural change that is triggered by a large, unexpected crisis, the persistence of its effects and the possible important determinants.

What these examples show is that, after the initial shock and the systemic failures from policy unpreparedness (e.g. in public health, finance, politics and society), there is a crucial phase of adaptation and innovation, the management of which determines the recovery scenario that is likely to emerge. Several scenarios are plausible, depending on initial resilience and, overall, on the ability to adapt to changes (Fig. 3). If a prompt, effective redesign of the whole system of socioeconomic interdependencies has been done and mapped by an appropriate multilayered model, there is an opportunity to capitalize on the disruption of the status quo and put in place structural changes that would not have been feasible through business-as-usual policy negotiation, which is generally much more limited in scope and with a relatively narrow focus. Clearly, the best recovery scenario requires a speedy and targeted response that minimizes damage. Given that socioeconomic inequality has a negative effect on people’s behavioural responses to policy measures, the best scenario will be facilitated by low levels of inequality.30 A high level of social coordination and governance is required to enable best-response scenarios. This coordination and governance must be carefully pursued as a precondition for effective public health interventions and not only regarded as an exit strategy from the current crisis;
indeed, it is even more important in the post-pandemic context. The less systematic the redesign of the system, then: the slower and more ineffective the response will be; the deeper the socioeconomic inequalities will become; the more the structural adjustment will be limited; and the more the recovery will fall into less and less effective scenarios. We briefly outline three possible recovery scenarios after COVID-19 in Box 1.

**Integrative approach**

From the perspective of systems science, we are probably in the middle of a critical phase of transition, where small differences in choices may accumulate into very different long-term trajectories. Pandemics have often been turning points, for better or for worse. Whereas the end of the Roman Empire was greatly accelerated by the effects of the perhaps first historically recorded pandemic, the so-called plague of Justinian, historians point out how the Black Death pandemics of the late Middle Ages not only paved the way to the human flourishing of the Renaissance period, but are at the origin of public health as a scientific discipline.

If policy preparedness is key to resilience against large systemic shocks, how should we move forward now? Over-simplifying the lessons learnt by a straightforward application of linear thinking must be avoided. For instance, while it is still to be understood why the response to the pandemic in European and North American countries was slower than in Asia, one could speculate that the quick response of Asian countries was due to command-and-control mechanisms that are only available to authoritarian governments. The implication would then be that democracies are less capable of implementing the quick targeted policy responses that are needed after a large, unexpected crisis. This assumption would be a naive interpretation built on the characteristics of a single-system layer and linear cause–effect relationships, and the available evidence does not support this opinion. The responses of Hong Kong Special Administrative Region, Republic of Korea and Singapore were exemplary and all based on proactive and extensive contact-tracing through technology and mass adoption of protective face masks. These countries have different levels of democratic orientation but a common culture that emphasizes personal responsibility in the public interest.

To arrive at a truly integrative approach to public health in a hyper-connected global socioeconomic environment such as the present one, we need to assign a new, pivotal role to computational social science as an analytical toolbox for data-driven policy design through a
self-reinforcing cycle of model making, analysis, simulation and post-validation. Relying on simple explanations and the isolation of a small number of domain-relevant factors while not considering the big picture does not allow an effective response to large systemic shocks such as the COVID-19 pandemic. Furthermore, this limited approach works even less well in imagining innovative recovery strategies that exploit the disruption of the status quo to achieve important sustainability goals, which otherwise may have been unreachable. To achieve an integrative approach requires a new dialogue and alliance between many different fields such as public health, medicine, social sciences, applied physics, economics and possibly more. Computational social science may offer the appropriate transdisciplinary platform to bring about this dialogue to flourish and allow us to tackle, in the public interest, the formidable social challenges ahead of us with a new spirit and renewed energy.

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References


### Box 1: Plausible recovery scenarios after COVID-19

#### Scenario 1: suboptimal

The aftermath. The global economic system fails to coordinate for a successful economic recovery. Long periods of economic stagnation occur with mounting social unrest. Populist political narratives increase locally, threatening the global architecture of free trade and division of labour. Socioeconomic inequalities are exacerbated and concern for environmental challenges is played down.

#### Scenario 2: optimal

The so-called new normal. A substantial economic recovery package is successfully deployed on a global scale and pre-crisis levels of economic activity gradually return. New guidelines for public life in a post-pandemic scenario are developed and successfully implemented. The organization of social and economic life adapts to the new challenges with no major organizational breakdowns.

#### Scenario 3: above optimal

A coordinated, multilayered innovation push. A great wave of social and technological innovation with strong public support starts a new growth cycle. Innovations in working, education and movement redesign the organization of cities, living and working spaces, with a positive impact on climate. Public policies comprehensively target socioeconomic inequalities.
Fig. 1. Effects of travel restrictions and social distancing on human movement during the COVID-19 pandemic, Italy, March to early December 2020


Note: We used Google to measure the effects of travel restrictions and social distancing on human movement through the location history of its users.²⁷
Fig. 2. Effects of travel restrictions and social distancing on human movement during the COVID-19 pandemic in selected countries, March to early December 2020


Note: We used Google to measure the effects of travel restrictions and social distancing on human movement through the location history of its users.27
Note: The plausible recovery scenarios are explained in Box 1.