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Sensemaking and learning during the Covid-19 pandemic: A complex adaptive systems perspective on policy decision-making

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ABSTRACT

Governments worldwide are under enormous pressure to effectively and promptly address the increasingly complex crisis presented by the Covid-19 pandemic. To understand the difficulties inherent to policymakers' sensemaking and learning processes during this unprecedented challenge, this article develops a perspective rooted in complexity theory. We highlight that, just as complex adaptive systems, societies affected by the pandemic and by the subsequent containment policies present non-linear and unpredictable outcomes, which highly depend on the social systems' initial states and on the behavioral rules governing the actions and interactions of the agents composing the systems. This analysis underlines that any decision-making process in a highly complex crisis such as the Covid-19 pandemic is inherently inaccurate and short-sighted. Far, however, from suggesting a policy paralysis, with this perspective we highlight the need to embed complexity thinking in policy decision-making and we present a roadmap for learning based on a flexible and adaptive approach, locally optimal solutions, and the need for international cooperation and transparent dissemination of data.

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1. Introduction

As of today, few would disagree that the Sars-CoV-2 virus and the resulting Covid-19 acute respiratory syndrome are causing an unprecedented, highly complex crisis. Governments and international organizations have been called to quickly react to a huge public health emergency by devising effective and proportionate policy actions. This effort, however, requires a fast-tracked sensemaking process that is cognitively prohibitive. While some observers have argued the possibility to 'learn lessons' from the early experience of countries like China, South Korea and Italy (Pisano, Sadun, & Zanini, 2020), we caution towards the possibility – and the potential dangers – to expect and demand a clear learning trajectory and to therefore blame and shame those who seem to fall behind the curve – be it national governments or international bodies such as the World Health Organization. We do so by analyzing the current situation through the lens of 'complex adaptive systems', which provides a theoretical standpoint that is particularly apt to understand the behavior of social systems affected by Covid-19. Among many defining characteristics, complex adaptive

systems are *non-linear*, they are *highly dependent on their initial conditions*, and are constituted by a *high number of interactions* among agents whose behavioral rules (schemata) are in continuous evolution (Morel & Ramanujam, 1999, e.g. Zimmerman, 2010).

2. The Covid-19 pandemic as a non-linear phenomenon

Pandemics should be considered in the broad class of non-linear phenomena, in that one small system perturbation may trigger disproportionate, exponential systemic reactions. This is visible in the case of an epidemic contagion, where one infected individual may pass the disease to an $R0$ number of individuals which ranges from 1.5 to even 6.49 in the case of Covid-19 where no social distancing is applied (Liu, Gayle, Wilder-Smith, & Rocklöv, 2020), starting a geometric progression of rapidly increasing infected cases. However, humans' cognitive models are not likely to represent non-linear phenomena efficiently, as these events progress far quicker than usual decision-making processes. Unfamiliarity with non-linearity causes two dreadful effects: it hinders learning and distorts *mental rehearsal,* which is a well-explored and fundamental step to set up robust *intuitive* decision-making processes (Kahneman, 2011, Klein, 2004). While intuition is necessary when the previous experience is insufficient to deal with current events, when stakes are high it is critical to mentally rehearse the possible

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effects of decisions. Unfortunately, because humans are unused to non-linear thinking, such mental expectations are likely to follow a linear pattern: a small variation in causes is expected to trigger a small variation of outcomes and vice-versa, while disproportionate, unexpected, longer-term effects are disregarded. In the case of Covid-19, school closures have been enforced in most countries, even though the children's role in the community spread of the virus is still widely debated (Bayham & Fenichel, 2020, Mandavili, 2020, Viner et al., 2020). In some settings, the disadvantages of school closures might disproportionally override the benefits, especially in contexts where schools constitute a safe harbor from domestic abuse towards disadvantaged children (The Economist, 2020). Moreover, the longer-term effects of schools' closures on children's mental health are now under increased scrutiny (Lee, 2020). Variations in the sensemaking processes of such disparate outcomes have produced policy decisions on school reopening that differ widely across countries. While Italy will reopen its schools only in September, the Netherlands has reverted to the pre-Covid19 school service already on June 8.

Thinking linearly in non-linear situations also hinders learning, especially where non-linear causality involves feedback loops, delays and dynamic behaviors (Sterman, 2002). When X causes Y we also need to consider the influence of Y on X, hence the adaptive responses of systems and individuals based on 'performance feedback'. This learning mechanism relies on three pillars: first, the availability of adequate and reliable performance information, that can inform action; second, the identification of realistic performance aspirations, that are negotiated among relevant stakeholders; third, the availability of a solid conceptual and empirical link between input and systemic output (Gavetti, Greve, Levinthal, & Ocasio, 2012). As for the latter, decision-makers often try to explain outputs through inputs, without considering internal effects and the system's history, stored in state variables (Sterman, 2002). This problem may lead to seemingly well-working systems going out of control because the controller can neither influence nor measure relevant variables: they are simply out of the learning feedback loop. In the case of Covid-19, it is increasingly clear that some organizations, institutions and countries have been non-transparent with respect to state variables, such as the number of infected cases in nursing homes (The Guardian, 2020) or the actual death toll (BBC, 2020). However, keeping information outside the feedback loops hinders their learning efficacy. It is, thus, crucial to favor transparency, cooperation and to guarantee psychologically safe environments, even in international relationships (Edmondson, 2018).

The case of Covid-19 highlights also the learning difficulties related to unreliable measures of the output itself - failures and successes. The Covid-19 mortality rate, as the ratio between casualties and number of registered infections, is still dramatically different across countries, reflecting the variation in the testing capacity of healthcare systems. Italy and the UK – where mortality rates are around 14% at the time of writing - have carried out a limited and strictly necessary number of Covid-19 swabs (mostly around hospitalized patients) while Germany has chosen for a more widespread testing policy, which allowed for a more realistic estimate of the number of infected individuals and for more effective isolation (Münchau, 2020). Unsurprisingly, Germany has a registered mortality rate of 4.6%, also explainable by the 29.2 ICU beds every 100.000 inhabitants against 12.5 of Italy and 6.6 of the UK (Bittner, 2020). Doubts about the nominator of the mortality ratio also have arisen, due to cross-country inconsistencies around the attribution of casualties to Covid-19. Significant variations across countries exist, for example, in relation to post-mortem testing policies and to accountings of non-hospital Covid-19 deaths in, for instance, nursing homes (Booth, 2020). When comparing the 2020 mortality to the average of previous years, the picture again

changes, and highlights a much higher Covid-19 mortality toll than the one registered in almost every country (Burn-Murdoch & Giles, 2020).

Third, what can – and should – policymakers reasonably aspire to? The Covid-19 crisis poses the problem of longitudinal interdependent goals, where saving lives in the short-term might sacrifice lives, social order and well-being in the longer-term due to the risk of an unparalleled economic recession and the mental health consequences of prolonged lockdown and social distancing measures. Lockdown measures have also important ethical ramifications, as they restrict individual freedom, strengthen surveillance (Harari, 2020), increase gender-based and domestic violence, and generally raise concerns of human rights infringement (United Nations, 2020). Moreover, despite the substantial 17% fall in CO_2 emissions due to populations' confinement and travel restrictions, the epidemic runs the risk of dangerously diverting attention from climate change goals, and without structural change, the temporary environmental benefits are unlikely to last (Hook & Wisniewska, 2020, Le Quéré et al., 2020).

3. Social systems' dependency on initial conditions

Governments' Covid-19 containment measures should be considered as complex interventions in complex social systems, which are highly dependent on their initial conditions. The complex interventions theory rests on a realist idea of causality that considers the interaction between an expected mechanism with its context, to produce a specific outcome (Pawson, 2006, Sanderson, 2000). Likewise, the evolution of a pandemic like Covid-19 and of the subsequent containment policies cannot be considered outside its national context, intended as political circumstances as well as socio-economic and socio-cultural makeup of the affected population.

Complex adaptive systems feature a high number of interactions between agents whose behavioral rules (schemata) evolve over time. Measures such as social distancing, face-masks and hand-washing are conceived to bend social and individual behavior in a way that hinders the contagion. Achieving behavioral change is however a complex endeavor, highly moderated by cultural habits. Adaptation and variations of individual behaviors are likely to be easier in countries that have already learned from the experience of MERS and SARS, like South Korea and Honk-Kong. The past experience raised the awareness of today's risks, while making behavioral schemata available to both act and adapt (Rerup & Feldman, 2011). At the same time, interventions that have succeeded at containing the virus dissemination in China – an authoritarian regime – can hardly be replicable in a context such as the EU and Italy. Likewise, measures implemented in South Korea, the Netherlands or Sweden, that largely rely on individual, voluntary responsibility rather than on sanctions, might not be applicable in contexts where the average citizen is less confident in governmental actions, and thus less compliant. Only mechanisms that are aligned, socially acceptable, and attuned with the local context will lead to the desired outcome. In this light, the widespread calls to 'learn' from the experience of other countries should be considered with extreme caution, and carefully adjusted by the multiple factors – and their interactions - that jointly create the idiosyncratic local context.

Initial conditions refer also to the amount of knowledge available to decision-makers at the point of decision. When Italy discovered its first patient, the risk of an outbreak of Covid-19 in Europe was still low, and no cognitive attention or mental alertness – by medical personnel, healthcare providers and the public – was cast on recognizing the symptoms of a Covid-19 infection. As a result, in the span of 48 h, 160 new cases were discovered in Lombardy and

it became apparent that the deadly infection had spread unrecognized for some time. In the wake of what happened to Italy, countries with a similar socio-cultural and socio-economic background but far later in the infection curve had more time to make sense of the pandemic threat and managed to contain the disease by imposing lockdown measures even before their first Covid-19 death – such as Greece (Smith, 2020).

4. Conclusions

With the analysis above, we highlight the compelling need for a complexity-oriented theoretical lens to understand the challenges of policy decision-making in a complex crisis such as the Covid-19 pandemic. Far from suggesting a policy paralysis, we underline that it is of utmost importance to pursue learning, by continuously analyzing newly available data, and adjusting available solutions. However, we draw attention to four main caveats, in evaluating current policies and in designing future ones as the pandemic progresses.

First, policy measures only offer a local optimum and are valid only at a specific point in time, while new emerging data – or unexpected consequences – might disconfirm the initial assumptions and impair the validity of earlier decisions. Second, decision-makers should be aware of non-linear processes and of non-measurable system states, and hence be ready for the possibility of unpredictable and disproportionate consequences of their actions. Future policies should explicitly address these two points, by understanding the importance – and enhancing the acceptance - of a flexible, highly adaptive, decision-making approach. *Fast and frugal* decision-making – that does not aspire at incorporating all available information – might be acceptable in fast-changing, complex situations, to avoid the paralyzing effect of pursuing fully informed choices that are cognitively too burdensome (Dosi, Napoletano, Roventini, Stiglitz, & Treibich, 2020, Gigerenzer & Brighton, 2009). Third, because of the systems' high dependence on their initial conditions and idiosyncratic behavioral rules of agents, applying interventions that have been successful elsewhere will almost certainly trigger different outcomes, so measures should always be corrected for the characteristic of the local system. The complexity perspective emphasizes the need for interventions that are tailor-made around local experiences, and that consider how individuals and societies have historically been able to cope with and ethically accept the restrictions. At the same time, policymakers should be aware that local optimal solutions (regional or national) could collide with systemic aims and impair decision-making and conflict resolution at the higher decisional level (national or international). Fourth, because of the inherent decision-making complexity, a *blame-and-shame* mindset should be avoided, as it hinders the transparency of outcomes and causes, and worsens the chances to understand the system and predict its behavior. It is therefore compelling for national governments and international organizations to learn to behave systemically and cooperate, with a view to sharing information as transparently as possible, while strengthening the infrastructure to improve data gathering and processing. International collaboration and the development of shared protocols will be of paramount importance to achieve sustainable solutions, in this unprecedented global policy effort.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

The authors whose names are listed immediately below certify that they have NO affiliations with or involvement in any organization or entity with any financial interest (such as honoraria; educational grants; participation in speakers' bureaus; membership, employment, consultancies, stock ownership, or other equity interest; and expert testimony or patent-licensing arrangements), or non-financial interest (such as personal or professional relationships, affiliations, knowledge or beliefs) in the subject matter or materials discussed in this manuscript.

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