The Economics of Viral Outbreaks

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Human populations are more urbanized and interconnected than ever before. These long run trends, along with rising global temperatures, have driven a parallel rise in viral epidemics, with tens of millions of cases of viral infection having been recorded in nearly all countries since 1980 [Smith *et al.* 2014]. The mortality toll from viruses is severe: over the last century, they have been responsible for more deaths than all armed conflict [Adda 2016 and citations therein]. In consequence, the economic costs of outbreaks are severe: this is not only because of increased morbidity and mortality, but also because viral outbreaks – representing aggregate health shocks – can severely restrict social interaction and economic exchange. Indeed, estimates suggest the annual global cost of moderately severe to severe pandemics is .7% of global income, in line with the estimated economic costs from climate change [World Bank 2017]. Such aggregate health shocks lead to behavioral and prevalence responses along many margins. We describe some important response channels, discuss emerging empirical results on these margins from a nascent literature, and stress important avenues for future work.

Risk and Uncertainty Viral outbreaks expose households to increased risk. Since the seminal work of Townsend [1994], a body of work has documented the *ex ante* and *ex post* mechanisms households use to insure against idiosyncratic risk. Such mechanisms typically break down when households face aggregate risk. In such times, households might engage in extreme behaviors that allow them to smooth consumption in the short term, but reduce their welfare in the long term. Documented examples include selling productive assets [Rosenzweig and Wolpin 1993], pulling children out of school [Jacoby and Skoufias 1997], or engaging in transactional sex [Dupas and Robinson 2012]. Naturally, dynamic responses to aggregate shocks will depend on how households expect a crisis to unfold. Understanding how beliefs evolve is complicated because households might rationally hold inaccurate or motivated beliefs [Oster *et al.* 2013], and viral outbreaks themselves increase the uncertainty households face: they will be unsure of whether any outbreak represents a transitory or permanent change in the economic environment, as the length and severity of epidemics is typically only understood over time.

Contagion and Trust In many viral outbreaks, the most important transmission mechanism is human-to-human contact. The nature of social interactions can thus be altered during aggregate health shocks. Individuals might be less likely to meet or communicate, and this can start to re-shape the set of network ties that individuals have. The breaking of established social ties has been documented in a sample of 4700 young women during the 2014 Ebola crisis in Sierra Leone by Bandiera *et al.* [2018]. If permanent, this restructuring of social networks can impact both micro- and macroeconomic outcomes [Fogli and Veldkamp 2019].

A second dimension of social interaction that can be impacted is that between individuals and the state. If public health infrastructure is seen to be inadequate to deal with viral outbreaks, or health facilities become associated as places where infection risk is highest, this can reduce trust in the state provision of health, and lead to behavioral responses that make outbreaks worse. For example, the Ebola epidemic had severe consequences for health care provision in Sierra Leone. Health workers were under-equipped and under-prepared. This left them exposed to infection during routine contact and enabled further transmission to other health workers. Evans *et al.* [2015] document how Ebola deaths were disproportionately concentrated among health personnel. Moreover, health facilities became associated with Ebola as some were transformed into holding centers. Combined with huge uncertainty, confidence in the health system collapsed, leading families to keep sick members at home, further spreading the virus.[1]

Little is currently known as to whether falls in trust spillover onto other areas of state activity, causes individuals to seek alternative and sometimes informal sources of health care and advice, and whether these impacts persist post crisis.[2] However, Christensen *et al.* [2019] present intriguing evidence from the Ebola outbreak in Sierra Leone on how trust in health facilities can be maintained even in times of aggregate crisis. Specifically, they find that locations where health clinics that had earlier (a year pre-crisis) been randomly assigned to some incentive scheme (either community monitoring of clinics or status awards for nurses), had substantially

[1] Bennett et al. [2015] document how during the 2003 SARS crisis in Taiwan, concerns that SRAS would spread through the public health care system led to a 30% decline in outpatient visits in a matter of weeks. They provide evidence that information cascades generated by social learning can explain the speed and magnitude of response.

[2] Aguero and Beleche [2009] do examine longer term consequences. They show that following the 2009 H1N1 influenza pandemic in Mexico, there were changes in health behaviors (as measured three years post-crisis), such as improved hand-washing behaviors. This helped reduce diarrhea-related cases among children for example.

higher numbers of reported Ebola cases – a result shown to be driven by the increased likelihood that patients would seek care (rather than higher incidence or improved Ebola surveillance). In short, by improving the perceived quality of healthcare pre-crisis, these treatments encouraged patients to report and receive treatment during the crisis.

Policy Responses Similar policy responses to contain the spread of viruses have been used for centuries, including quarantines, shutting down transport networks, and closing other locations where humans interact. Such responses impact economic activity (within and between countries). The closure of parts of public infrastructure - such as schools - impacts the human capital accumulation of youth: it does so mechanically in the short run, but these effects can persist depending on what activities youth engage in when not in school and whether in turn, this increases the costs of switching back to school once the crisis passes.

Bandiera *et al.* [2018] study these issues during the 2014 Ebola outbreak in Sierra Leone, tracking 4700 young women before and after the crisis. The government implemented three core policies to combat rapid contagion: (i) village lock-downs and travel bans; (ii) all primary and secondary schools were closed through the 2014-15 academic year; (iii) health workers were mobilized to record door-to-door cases and track contagion, and as described above, some health facilities were transformed into Ebola holding centers. The epidemic represented a tremendous loss of economic opportunities: in a year, GDP growth plummeted from 8.9% to -2.0%, border closures shut down international trade (predominantly in agriculture), internal travel bans resulted in the breakdown of domestic trade, all periodic markets were forced to close, and tens of thousands of jobs were lost in self and wage employment.

The schooling policy response had particularly acute impacts on young women. As schools reopened, the government reinstated a ban on pregnant girls enrolling in school. This is important because without the protection of time in school during the crisis, young women might have become more vulnerable to sexual abuse and becoming pregnant, that under the new policy, would then severely limit their ability to get back into school and accumulate human capital. Bandiera *et al.* [2018] find, using a randomized control trial, that the provision of safe spaces for girls during the crisis allowed them to be significantly less likely to become pregnant and as a result, significantly more likely to reenroll back into school post-crisis. This example shows the complex interplay between a loss of economic opportunity for all, and vulnerability for some, in a time of aggregate health shocks. There remains a large knowledge gap in understanding how the economic and health dimensions of viral outbreaks interact.

As information accumulates during epidemics, governments often issue public health alerts, warning individuals of dangers and suggesting measures to prevent viral infections from spreading (so encouraging prevalence responses). Yet how households respond to such information in times of crisis is less well understood. Junior and Rasul [2019] present such evidence from the 2015 Zika epidemic in Brazil, using millions of administrative health records. They evaluate how households (and health personnel) responded to an official alert that recognized the link between Zika and congenital disease (most notably the incidence of microcephaly). They show the alert triggered a 7% reduction in pregnancies, a prevalence response triggered immediately after the alert. They are able to use their records to document heterogeneous responses to the information alert: (i) more educated mothers have greater reductions in pregnancy rates; (ii) there is a U-shaped gradient between pregnancy rate responses and age – women in their 30s respond most to the alert, and the lack of response among older women can reflect the cost of delaying pregnancy being higher for them if it leads to an inability to conceive later. In each age cohort, higher SES mothers have larger reductions in pregnancy rates. These pattern of responses fits the narrative that higher SES women were better informed of the risks, or face lower costs of altering their fertility timing, and so delayed pregnancy more during the post-alert period. More work needs to be done to understand heterogeneous responses to new information on health/disease risk, how the credibility of information is perceived, and consequences for the design and targeting of public health campaigns.

Dynamics A recurrent theme in our discussion has been how persistent behavioral change can be driven by short-lived crises. Much remains to be understood on how quickly economies recover from such aggregate shocks. A macro literature has developed suggesting financial and political crisis may have long lasting impacts while conflicts might have relatively short lived impacts [Cerra and Saxena 2008], although there is mounting evidence over the persistent psychic costs of exposure to conflict [Bauer *et al.* 2016]. Whether exposure to aggregate health shocks, and any associated economic upheavals, represent the former or latter case is yet to be understood.

Next Steps Viral epidemics will continue to impact human populations, perhaps with ever increasing frequency and complexity. The nascent literature in this area is beginning to shed light on the microeconomic mechanisms through which individuals respond to these aggregate shocks, and when policy can be effective or counterproductive in times of such crises. Continually integrating this body of evidence on such behavioral responses into epidemiological models of disease spread [Kremer 1996, Philipson 2000] – factoring in a range of potential household and health worker responses – might enable future policy makers to better predict the short and long run spread of epidemics and how to respond to them.

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