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Designing Trigger Mechanisms for Epidemic and Pandemic Financing and Response

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ABSTRACT

Nearly every consequential choice in epidemic and pandemic response requires a trigger of some kind: a set of criteria—often, but not always, quantitative—that determines whether alerts or public health declarations are issued, financing for outbreak containment and response is released, personnel and medical countermeasure deployments are surged, and so on. Triggers are sometimes implicit or internally facing, nested within expert guidance and decision-support processes, but are increasingly public facing to help stakeholders and citizens make sense of public health guidelines and decisions. Consequently, triggers are both increasingly used and increasingly visible, and are the subject of continuous innovation and debate. However, no established frameworks or standards exist to guide the development and integration of triggers into public health decision-making generally, or epidemic and pandemic financing and response specifically. This chapter presents a framework for high-quality trigger design with specific application to pandemic financing and response, with the goals of improving triggers' effectiveness and reliability, and providing clearer communication of their attributes and intended performance to stakeholders, including the public. It also includes a brief case study on the World Bank's Pandemic Emergency Financing Facility.

INTRODUCTION

Nearly every consequential choice in epidemic and pandemic response requires a trigger of some kind: a set of criteria—often, but not always, quantitative—that determines whether alerts or public health declarations are issued, financing for outbreak containment and response is released, personnel and medical countermeasure deployments are surged, and so on. This chapter focuses mainly on the design and development of triggers for prearranged financing mechanisms. It also briefly discusses additional applications for triggers in epidemic and pandemic preparedness and response. The primary focus of this chapter is to explore the trigger design process and propose criteria that can be used to assess the quality of trigger designs, with the goal of supporting technical improvements to trigger designs in public health, especially for financing response activities. This chapter is not an argument to incorporate quantitative triggers into all financing mechanisms or decision processes; the suitability and feasibility of triggers (and of specific trigger designs) vary with different objectives, applications, scenarios, and risks.

A *trigger* is a prearranged mechanism or set of conditions that determines whether (or when) to activate a financial or operational response because an event has occurred or is predicted to occur. Triggers are perhaps best known for their use in insurance contracts, both private market contracts and sovereign disaster risk financing mechanisms that provide capital (typically from multilateral organizations or specialized capital pools) to governments. In the context of insurance, triggers represent a critical element of a contract that binds one party to release capital to another under preagreed conditions; of note, the trigger criteria are designed to correlate with the economic loss that the beneficiary of the financing would incur. The process of trigger design described in this chapter is intended to identify, address, and propose options to reduce information asymmetries that present a fundamental barrier to the quantification (including pricing) of risk and successful contracting to transfer it. However, triggers also have broad application to noncontractual settings, including in the design and implementation of decision processes. In the context of supporting decision-making, triggers can provide a structure to guide policy makers in making difficult choices (for example, whether and when to implement and relax public health restrictions).

Triggers have varying degrees of complexity. For example, a simple trigger could be designed to activate upon an emergency declaration by a ministry of health. A more complex trigger could incorporate multiple parameters that need to meet specific joint thresholds to activate.

The term "parametric trigger" comes from the use of a parameter or combination of parameters—quantitative in nature—that prompts the release of funds; each parameter has a threshold or required value that, if reached (or, in the case of multiparameter designs, collectively reached), triggers the release of funds. A parametric trigger can also take the form of an index, which involves the combination or calculation of a value or values based on measured parameters; data sources can vary greatly, from reported epidemiological data to meteorological data, to remote sensing or satellite data. Triggers can also be based on modeled results, which would be simulated by a model that takes the estimated parameter values as inputs.

Trigger design is currently the focus of technical and creative energy for a broad range of use cases, ranging from the insurance industry, risk modeling, and climate science to humanitarian and development applications. Designing triggers that work well, however, is challenging.

Disaster risk financing has numerous examples of trigger mechanisms—particularly parametric trigger mechanisms. This is especially so for natural hazards such as tropical cyclones, earthquakes, floods, and droughts (Cissé 2021). Despite standing to benefit substantially from preagreed funding mechanisms, the health sector has arguably been slow to consider and adopt these types of constructs.

TRIGGERS FOR EPIDEMIC RISK FINANCING

In the late 2010s and early 2020s, financing mechanisms designed to mitigate risk from epidemics and pandemics began incorporating parametric triggers (refer to table 14.1 for selected examples).[1] In these financing mechanisms, a parametric trigger defines the necessary quantitative criteria for the release of capital during or following the occurrence of an epidemic. In the case of epidemics, the total loss includes the number of lives and livelihoods affected, along with budgetary expenses incurred during epidemic response activities such as contact tracing, vaccination, and clinical case management.

Table 14.1 Attributes of Selected Epidemic and Pandemic Financing Instruments, Including Trigger Elements

Instrument	Objective	Covered perils	Covered geographies	Trigger elements	Potential design challenge(s)
Pandemic Emergency Financing Facility (IBRD 2017)	To provide financing for multicountry epidemics and pandemics (rather than single-country outbreaks)	• Pandemic influenza • Novel coronaviruses • Filoviruses • Lassa Fever • Rift Valley Fever • Crimean-Congo Hemorrhagic Fever Other perils were covered in the cash (contingency) window	• IDA countries (World Bank 2021b)	Triggers were specific to bond class and pathogen group, and included the following: • Cumulative cases • Eligible event period • Total confirmed deaths • Geographic spread • Growth rate • Confirmation ratio for certain pathogens	• Received criticisms due to complex trigger design and timing of payouts for COVID-19 • Did not pay out during Ebola epidemics from the insurance window, but did pay from the cash (contingency) window
African Risk Capacity Outbreaks & Epidemics policy (Böhm 2023)	To provide rapid financing in the earliest stages of an epidemic	• Filoviruses • Meningitis	• Senegal	• Total laboratory-confirmed cases (filoviruses) • Districts in alert and epidemic phase (meningitis)	• Uncertainty about case counts very early in an outbreak

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Table 14.1 Attributes of Selected Epidemic and Pandemic Financing Instruments, Including Trigger Elements (continued)

Instrument	Objective	Covered perils	Covered geographies	Trigger elements	Potential design challenge(s)
Pathogen Rx (ADB 2022)	To provide liquidity for private sector firms facing cash flow and/or operational disruption during an epidemic	"Infectious disease outbreaks"[a]	• Worldwide and regional	• Confirmed outbreak • Infections • Deaths • Sentiment Index (Oppenheim et al. 2019) • Proof of loss	• Coverage limited depending on geographic characteristics of the event • Hybrid trigger, including indemnity component: proof of loss required (Wright and Lacovara 2020)
Munich RE Epidemic Risk Transfer Solutions[a]	To efficiently reallocate epidemic and pandemic risk across various stakeholders	• "Viral epidemic and pandemic outbreaks"[a]	• Worldwide and regional	• PHEIC • Civil authority restriction • Proof of loss	• Reliance on subjective triggers (for example, PHEIC) • Proof of loss required from the insured (long time to assess the claim)
Gavi's First Response Fund (Gavi 2024)	To secure early access to vaccines and to protect existing immunization programs	• Pathogens with PHEIC potential • Pathogens qualified as Grade 2 or 3 by WHO	• Gavi-eligible countries	• Pandemic or PHEIC declaration	• Reliance on subjective triggers (for example, PHEIC) • Lack of predictability and transparency

Source: Original table compiled for this publication.

Note: Pathogen Rx and Munich RE Epidemic Risk Transfer Solutions are private sector insurance structures. IDA = International Development Association; PHEIC = public health emergency of international concern; WHO = World Health Organization.

a. Munich Reinsurance, "Epidemic and Pandemic Risk Solutions," https://www.munichre.com/en/solutions/for-industry-clients/epidemic-risk-solutions.html.

Parametric triggers can be used to develop coverage through parametric insurance, which disburses funding without waiting for a claim assessment on the ground to determine the exact loss suffered by each insured party. This practice contrasts with indemnity insurance, which is defined by post facto reimbursement of actual losses incurred and typically requires proof of loss, such as (in the case of epidemics) evidence of fiscal outlays for containment and response activities. This same logic applies to noninsurance financing mechanisms: formal incorporation of a parametric trigger can release funding rapidly, without the need for expert assessments or ex post humanitarian appeals and response cost estimates from governments affected by disasters. Financing mechanisms may also use a hybrid trigger that combines both parametric and indemnity-based trigger criteria, though hybrid triggers are typically less common because of their complexity. Trigger mechanisms are often progressive or scaled, with additional triggers releasing more funding as an event progresses and more losses and operational costs are incurred.

The main rationale for using a parametric trigger is the predictability and speed at which a payout can be released. Because the payout can occur as soon as the trigger is reached, funds can be disbursed far more rapidly than in the case of an indemnity trigger, which typically requires a lengthy process: waiting until the damage occurs, proof of loss is submitted, the loss is independently assessed, an insurance adjustment is performed, and payment is eventually released. Financing mechanisms based on parametric triggers can pay out in days or weeks, whereas those incorporating indemnity-based triggers would more typically pay out in months or even years after an event has occurred. Some parametric trigger–based financing mechanisms have even been designed to release funds in advance of an event—for example, a novel African Risk Capacity drought insurance instrument (Maslo 2022).

A growing body of evidence confirms the significant welfare benefits of early response to catastrophes (Pople et al. 2021). Those benefits apply to a wide variety of crises, but especially to infectious disease events. Rapid financing can significantly reduce the financial and health impacts caused by epidemics. For epidemics, rapid access to capital can enable more timely and effective reduction and potential containment of disease transmission—for example, by supporting contact tracing; public education and risk-reduction campaigns; and diagnostic, drug, and vaccine distribution. Rapid containment can, in turn, reduce the severity and duration of an epidemic, leading to significant reductions in human and economic losses and, ultimately, preventing events from reaching their full potential magnitude. The effects of early mitigation can be especially significant for epidemics and pandemics, because (unlike other acute natural hazards such as earthquakes or hurricanes) some infectious disease events may last years (for example, the 1918 influenza pandemic and COVID-19 [coronavirus]) and others may last decades (for example, the human immunodeficiency virus and acquired immune deficiency syndrome [HIV/AIDS] pandemic).

The timeliness and predictability of funding can also provide incentives for all actors involved in outbreak detection and epidemic response: to detect and report potential threats to public health quickly, and to develop and maintain operational plans that will guide response activities. Prearranged, predictable financing can provide greater confidence that funding will be available, allowing agencies and leaders to focus on managing response activities rather than fundraising.

Although this discussion has focused primarily on disaster risk financing mechanisms for rapid response and mitigation of biological hazards, these financing mechanisms can serve other functions—for example, containment to reduce the risk of disease spread beyond the initially affected country. Optimal trigger design depends entirely upon the problem that the financing instrument is designed to solve. The following section discusses this issue further.

BEYOND FINANCING: TRIGGERS FOR DECISION-MAKING

Triggers have a wide range of applications beyond financing mechanisms, including providing quantitative, objective criteria for implementing, altering, or ending containment policies, programs, or public declarations of health emergencies.

A key virtue of triggers is that they support the rapid implementation of decisions that have effectively been made in advance; triggers therefore provide both speed and insulation from political pressures that may quickly build up once a crisis occurs. Not all decisions require or necessarily benefit from being implemented via a trigger mechanism. A surprisingly wide range of decision processes are suitable, however, and many if not all policy and decision processes can benefit from the logical process of working through how they might be implemented using a trigger-like mechanism. The following subsections discuss a selection of illustrative, nonexhaustive examples of situations and decision points for which having a trigger mechanism in place could be beneficial during an epidemic or pandemic.

Health Notifications, Alerts, and Emergency Declarations

One important category of decision-making during an outbreak or epidemic is whether to issue health notifications, alerts, or emergency declarations. Notable examples include the issuance of a notification by a health authority (for example, Disease Outbreak News from the World Health Organization [WHO]),[2] the dissemination of an alert (for example, the US Centers for Disease Control and Prevention's Health Alert Network Health Advisory),[3] the declaration of a public health emergency (for example, declaration by WHO of a public health emergency of international concern [PHEIC]),[4] and WHO's declaration of meningitis districts in alert or epidemic based on different disease thresholds (WHO 2014). The process for determining whether to issue a PHEIC has, in particular, been criticized for being complex and nontransparent; an empirical analysis of emergency committee deliberations found inconsistent application of criteria for determining whether to issue a PHEIC declaration (Fan et al. 2023; Mullen et al. 2020).

Public health emergency declaration processes often provide for substantial decision-making flexibility: this flexibility can be a virtue because there may be substantial uncertainty about the characteristics and severity of the potential threat, the speed of its development, and its potential impacts. The virtue of flexibility is that it can allow for scientific judgment to address these points of uncertainty; a vice is that it also allows for political factors—electoral costs, reputational risks, and fears of economic damages—to cloud judgment. Here, incorporation of quantitative triggers can help provide both expert guidance and political insulation, because some potentially "costly" aspects of the emergency declaration process can be addressed through preagreed mechanisms.

Early-Stage Containment Measures

Very early in an outbreak, it may be possible to limit spread and contain the event while it is still relatively small and manageable. A key challenge is that data are often sparse and incomplete at this early stage, so substantial uncertainty can raise the political cost and risk associated with taking potentially costly steps to contain transmission. Data sparsity and uncertainty can also make it difficult to design an appropriate trigger to activate rapid response and containment measures; especially in this early stage of an outbreak, quantitative information may not yet be available or even known, and modeled estimates may have high levels of uncertainty. Therefore, binary parametric triggers or qualitative triggers may play a more important role than during other stages of an epidemic or pandemic. For example, a rapid risk assessment of a new respiratory virus may consider the presence or absence of sustained human-to-human transmission, among other relevant factors (FAO, WHO, and WOAH 2025; Ferguson et al. 2005; Longini et al. 2005), because it could potentially indicate elevated epidemic or pandemic risk. A critical priority during this early stage of an outbreak is to obtain as much relevant data as possible, which is much easier to do when persistent pathogen monitoring systems are already in place before an event.

Epidemic Response and Mitigation If Initial Containment Is Unsuccessful

Once an outbreak has evaded containment and epidemic spread is under way, or seemingly inevitable, authorities—including national governments as well as international and multilateral agencies—need to make critical decisions about how to mitigate spread using a variety of tools.

Targeted and Populationwide Interventions

Once the initial containment has failed, or is at high risk of failure, authorities may consider implementing targeted and populationwide interventions to curtail disease transmission. These measures may be taken with the goal of reducing pressure on health care systems ("flattening the epidemic curve"); protecting specific, vulnerable demographic groups; or limiting further geographic spread. They include the following:

- Implementation (and ending) of populationwide measures to reduce transmission, such as social distancing and mask mandates (refer to chapter 6 in this volume).
- Implementation (and ending) of targeted measures to reduce disease transmission (refer to chapter 7 in this volume), such as school closures (refer to chapter 8 in this volume). For example, a school might close in response to an outbreak or sharp increase in incidence in neighboring schools (Cauchemez et al. 2009). Alternatively, a pooled testing strategy could be used for decision-making based on positivity trends in schools (McKnight and Sureka 2024).
- Implementation of politically sensitive policy measures, such as travel restrictions, border closures, or trade restrictions. Having a predefined trigger in place could reduce the potential for a "knee-jerk" and effectively punitive reaction to a country's early detection and reporting of an outbreak, when such surveillance capability and behavior are precisely what should be incentivized. For example, South Africa suffered adverse consequences during the COVID-19 pandemic for being the first to detect and report the SARS-CoV-2 Omicron variant (Gudina and Gidi 2025).

Medical Countermeasures

The applicability and set of choices regarding the deployment of medical countermeasures vary by pathogen, and by context. In the case of novel pathogens, diagnostics and vaccines need to be developed, tested, and deployed, and therapeutics either developed or identified from existing products. Known pathogens may also mutate, potentially compromising existing countermeasures and altering policy makers' choice sets. Last, countries may have vastly differing levels (and timing) of access to countermeasures, which can greatly influence decisions about deployment. Bearing these factors and constraints in mind, policy makers need to make decisions regarding

- Release of a government stockpile (for example of diagnostics, treatments, vaccines, or personal protective equipment);[5]
- Initiating a 100-day countdown for vaccine development (Pandemic Preparedness Partnership 2021);
- Government interventions to encourage or compel manufacturing of critical materials (masks, ventilators, vaccines, and so on), such as the US Defense Production Act (Hart 2024) and Operation Warp Speed during the COVID-19 pandemic (Lopez 2020); and
- Rapidly expanding clinical capacity, such as the activation of "surge" clinical facilities, emergency conversion of nonmedical facilities to provide care—for example, the Fangcang shelter hospitals built in China during the COVID-19 pandemic (Chen et al. 2020)—or construction of new hospital facilities.

FRAMEWORK FOR HIGH-QUALITY TRIGGER DESIGN

An effective or high-quality trigger must possess the following qualities to be accepted by the involved parties in a financing transaction (the insured, the insurer, the reinsurer, donors, multilateral agencies, and so on) or policy process:

- *Simple*. Complicated triggers make it difficult to have an intuitive sense about whether and under what conditions a policy will trigger, potentially leading to misaligned expectations between counterparties (such as insurers and the insured). If a payout does not occur, does not occur rapidly enough, or does not occur at sufficient scale, it can lead to mistrust and a perception that the trigger and the underlying financial contract have been poorly designed, or even worse, made deliberately complicated to avoid making a payout.
- *Transparent*. So that anyone assessing whether the trigger threshold has been met possesses all the necessary information to perform the required calculations, all the involved parties in the transaction or the decision process must have access to the same underlying data used for calculation, as well as to the trigger calculations themselves.
- *Objective*. The trigger must be based on factors that can be reliably and consistently measured.

- *Verifiable*. It must be possible to independently and objectively corroborate that trigger conditions have been met (or not).
- *Preagreed.* Agreeing ahead of time ensures that the trigger has all the previously listed qualities and avoids confusion and delays during the assessment of whether trigger criteria have been met.

Appropriate trigger design is critical to ensure rapid disbursement of funds and to minimize the likelihood of inordinate and unpredictable payouts. Effective triggers can be developed by first establishing clear criteria for the context (when and for what) in which activation should occur. Crafting good triggers involves balancing the preferences and demands of the stakeholders, technical feasibility, and practical considerations (calculation processes, sources of data for the trigger and their reliability over time, failsafe procedures, and so on).

The trigger design process (part of a larger structuring process) is generally complex and involves the iterative exploration, development, testing, and calibration of various trigger concepts, in an effort to balance multiple design criteria and ensure that stakeholders are aware and aligned on what the instrument is designed to do (and what it is not designed to do). A thorough design process identifies requirements regarding the needs of responders at that specific moment, examines technical possibilities, and addresses potential failure points in advance. For whatever purpose the trigger is being designed, it behooves the developers of the trigger mechanism to follow an analytically sound design process that is transparent and inclusive of all stakeholder viewpoints. Ideally, a collaborative process of trigger design can help build trust and confidence between all the key stakeholders. The following subsections discuss key elements and considerations of the trigger design process.

Event Definition

The foundational element of a trigger is an *event definition*, which clearly defines the types of adverse shocks to which the trigger applies. In the case of epidemic risk, a financing instrument may provide funding only for specific pathogens (for example, viral hemorrhagic fevers such as Ebola, Marburg, or Nipah viruses, which are capable of rapid, sustained transmission and have the potential to cause substantial societal and economic disruption) or only for epidemics of a magnitude that cannot be managed through routine health system functions and health budgets.

An event definition for an epidemic or pandemic may rely on a declaration by a health authority, such as a ministry of health or multilateral body (for example, Africa Centers for Disease Control or WHO). The authority may define the event on the basis of pathogen-specific criteria linked to the epidemiology of the disease and historical patterns in outbreak control. For example, an Ebola virus disease outbreak is declared once there is a single confirmed case based on laboratory testing.[6] Likewise, there may be specific criteria for declaring the end of the outbreak. For Ebola virus disease, the criterion is typically the end of 42 days with no new, epidemiologically linked cases (Djaafara et al. 2021). For other types of diseases, especially more routine occurrences such as meningitis, event definitions may be based on how far incidence has spiked above an established baseline of historical disease levels.

An event definition can also determine whether a series of losses is considered a single event or multiple occurrences. For example, substantial litigation took place over whether the two plane impacts on the World Trade Center in the 9/11 terrorist attacks should be considered separate events or a single attack, with substantial sums of money at stake (Johnson 2010). Similarly, an event definition for an epidemic or pandemic trigger could specify whether a mutation—for example, the emergence of a new variant or strain capable of more efficient transmission or immune evasion—is considered part of an ongoing outbreak or is a distinct event that could trigger a financing mechanism or policy response.

In addition to defining which events are covered, it is also important to define which events are not covered (that is, exclusions). Familiar insurance exclusions include "acts of God," terrorism, and war. In this case of epidemics, exclusions may include ongoing or foreseen events, such as epidemics already under way, as well as infectious disease hazards whose characteristics have not been accounted for in trigger design or pricing. For example, pandemic influenza is sometimes excluded because of its potential to be a systemic risk that could lead to correlated, catastrophic losses across far-flung geographical locations. Also sometimes excluded are biowarfare and bioterrorism, because they would fall more broadly under war or terrorism exclusions, and the accidental release of human-made or manipulated infectious agents, sometimes referred to as "bio-error" (refer to chapter 4 in this volume).

Another aspect of the coverage definition includes the covered geographic area—that is, the area within the geographic scope of the financing mechanism. This area can be defined by country or territorial boundaries, or even could be defined by a polygon (for example, "cat in a box"; refer to Franco et al. 2024). For epidemic or pandemic applications, such a polygon could be applied to a spark risk map and could be used as the basis for triggers following the progressive geographic spread of an epidemic beyond known hot spots.

As a general principle, the event definition should be developed drawing upon knowledge from all parties involved in epidemic preparedness and response, not just the health and finance sectors. Parties should include scientists and technical experts, community-based organizations, civil society, and government officials from the wide range of ministries whose missions and constituents are affected by epidemics (such as the education, labor, and security sectors). Their inclusion allows for incorporation of local context and local knowledge at the most fundamental level of design, ensuring that the trigger solves for real-world scenarios and problems.

Quantitative Triggers

Quantitative triggers rely on measurable data and parameters. Several factors should be considered in determining which data and parameters to include. First and foremost, it must be determined which parameters are correlated to the outcome of interest, such as the loss to the insured. Second, the parameters should be easily measured. Third, the parameter values should be transparent, meaning they should be reported by an official, unbiased source, so that everyone has equal access to the information. Fourth, the source data should be reliable and updated in a timely fashion. Fifth, to ensure appropriate trigger calibration, there should be sufficient historical information to establish baseline levels or normal levels of risk. Sixth, if, for the purpose of designing a trigger, input data are transformed, the transformation methods should be well documented, including any relevant formulas and source code to perform the calculation. Finally, any methods used to fill data gaps (such as imputation), or reliance on alternative data sources, should be transparently described and well-documented.

In the case of epidemics and pandemics, quantitative triggers can be based on a number of parameter values, including reported measures of event severity (for example, laboratory-confirmed deaths or reduction in foot traffic) or reported government policy responses and actions for containment (closing borders, limiting social contact, establishing curfews, and so on) that can be measured categorically or via an index (Hale et al. 2021).

A range of data types and sources may be considered for incorporation into a trigger. The first is one based on independently reported (typically epidemiological) data. This data type is typically considered the most objective, because it comes from a third party (usually official) reporting source that would supply the information independent of any financing considerations. However, epidemiological data reported by a national government can pose potential challenges, most notably when a country that is covered by a disaster risk financing mechanism reports information that could activate a trigger (such as number of cases) and the national government itself is a beneficiary. In such situations, national statistical systems need to be independent, receive adequate financing, and produce high-quality data so that information is considered valid and trustworthy. One solution is to rely on data from other sources such as multilateral agencies. Of course, multilateral agencies, which generally rely on governments to provide data in the first place, can provide quality control and standards but not necessarily independence (World Bank 2021d).

A second type of data used to underpin a quantitative (and specifically parametric) trigger is an index, which is based on a calculated formula from reported data. For example, the Vita series of mortality bonds (Klein 2006) includes a mortality index that weights general population reported mortality to an insurance portfolio, thus building the correlation between the reported data on mortality rates and the estimated losses. Relatedly, a trigger can also incorporate parameters estimated from empirical data: for example R_0 can be calculated from reported epidemiological data and could (in theory) serve as a parameter in a trigger design. A third potential type of data used for a trigger is model output, often from a mechanistic model. In this kind of trigger, certain measured or reported parameter values are entered into a model and generate a modeled outcome, whether a loss estimate or index value, which ultimately will be compared against a trigger criterion.

Among these different types of trigger formulations, it is also important to consider the sources of error and uncertainty that may be present in the selected data and parameters (Mari and Giordani 2015). For example, confirmatory testing in a laboratory will be subject to measurement errors related to the sensitivity and specificity of the test; therefore, in some cases, corroborating the findings of an initial test may require a secondary test. Measurement error for empirical data can be highly variable across events and within events both over space (for example, because different countries have varying capacity or willingness to report accurate epidemiological data) and over time (for example, because of the intensification of surveillance during the course of an epidemic, the development and deployment of new diagnostic tests, or the failure of existing tests). For calculated parameters, these errors may have a complex interplay. For example, the case-fatality ratio (a measure of deaths divided by cases) could have ascertainment errors and biases in both the numerator and denominator (Lipsitch et al. 2015). However, this challenge could be partially mitigated for larger data sets of modeled or calculated parameter values, which could include point estimates and metrics of the uncertainty, such as a 95 percent confidence interval.

Trigger design frequently considers counts of confirmed or probable infections and deaths (refer to table 14.1). Verifying these parameters, however, may prove to be challenging during an epidemic. For example, case counts are often subject to underreporting (Meadows et al. 2022) or may not meet the condition of being verifiable, unless there is a laboratory confirmation. In a cruel irony, capacity for lab confirmation (and thus to meet trigger criteria) may be limited in those very settings, such as low-income and fragile states, that may benefit substantially from a disaster risk financing mechanism to cover response costs and economic losses. Design must also take into account stakeholder needs. For example, it may be difficult to get buy-in from public health stakeholders for a trigger based solely on counts of deaths—which are undesirable metrics from a public health standpoint and potentially present the risk of adverse media coverage (for example, McVeigh 2020)—whereas this may not be an obvious concern for financial stakeholders.

Emerging infectious disease surveillance approaches such as environmental monitoring can potentially unlock novel approaches to trigger design by generating data that could overcome some of the challenges of verifiability and underreporting described earlier. For example, wastewater testing for pathogens of interest could allow for triggers based on the detection of an emerging pathogen with epidemic potential (such as Nipah or Marburg viruses) in municipal sanitation (Grassly, Shaw, and Owusu 2024; Kilaru et al. 2023). However, more sophisticated trigger concepts, such as triggering based on a spike in concentration well in excess of typical levels, would require more established analytical methods for estimating epidemiological metrics of interest (cases, infection rates, and so on) from wastewater epidemiology metrics, along with a sufficiently long time series of data that would allow the establishment of baselines.

In deciding which parameters to include in the trigger design, decision-makers can employ certain methods to evaluate the importance of different components in the trigger calculation. For example, sensitivity testing is often an important step, used to understand which components of the trigger calculation are most influential. Additionally, it is critical to consider the correlation of the parameters and variables with the actual loss; this comparison is often achieved using historical data.

Qualitative Triggers

Qualitative triggers—those based on subjective criteria such as declarations of a PHEIC, the issuance of Disease Outbreak News reports, or an emergency declaration by state actors—have been previously incorporated into trigger designs, including in Gavi's First Response Fund (box 14.1). As noted earlier, because such declarations are based upon expert judgment, political and economic considerations, and other subjective criteria, qualitative triggers can be problematic and thus must be designed with great care. The arbitrary nature of these factors suggests that triggers based on such criteria would not meet the qualities of being transparent and objective (Fan et al. 2023).

Box 14.1

Applying Qualitative Triggers to Vaccine Procurement for Epidemic Response

Qualitative triggers figure prominently in Gavi's First Response Fund. In June 2024, Gavi, the Vaccine Alliance launched the first "day zero" financing mechanism of "US$ 500 million designed to secure early access to vaccines and to protect existing immunization programmes within days of a pandemic or a public health emergency of international concern being declared" (Gavi 2024). The trigger is made such that 80 percent of funding will be disbursed for at-risk procurement of vaccines for pathogens with public health emergency of international concern potential when Gavi has no existing vaccine or outbreak response program. The remaining 20 percent of funds can be deployed for pathogens qualified as Grade 2 or 3 by the World Health Organization (WHO) but for which a vaccination response is needed, or in case routine immunization is at risk given the outbreak (as was the case in the 10th Ebola outbreak in the Democratic Republic of Congo, when routine measles immunizations dropped significantly). The final decision is made by a committee at Gavi using input from technical partners and WHO. What is unclear is whether a formal request from a given country is necessary to activate the discussions of the committee or if this committee meets regardless as long as the WHO classifications are communicated.

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Box 14.1 Applying Qualitative Triggers to Vaccine Procurement for Epidemic Response (continued)

This trigger framework is unusual in that it relies on preagreed, albeit "soft," qualitative triggers that include WHO assessments and a public health emergency of international concern declaration as well as information gathering from other partners for a committee to launch the decision process. Although it is a quite flexible and all-encompassing mechanism—that is, it does not apply to a single pathogen and does not restrict disbursements to any country—it also has no participation cost from countries. Consequently, it retains significant discretion in how the funds are spent. The potential risk is that flexibility may create ambiguity, such that countries may not be able to easily anticipate which events will qualify and which will not, as well as the potential for such a mechanism to be perceived as arbitrary. These potential risks can be best mitigated through transparency, and active communication to countries and other stakeholders that might rely on the mechanism.

Without these types of efforts, such a flexible mechanism might fall short of ensuring the much needed predictability of funding and transparency that would empower countries to make the right decisions during the next epidemic or pandemic.

Moreover, subjectivity presents challenges for modeling, which is often used to inform trigger design in a financing mechanism. Subjectivity in trigger design makes it difficult to use modeling to estimate whether a trigger structure will pay out under the right conditions and whether the risk has been appropriately estimated and priced, leading to potentially higher than necessary risk premiums that incorporate an extra buffer for underestimated activation probability. It could also potentially bias the declaration process itself: decision-makers may become more (or less) likely to declare an emergency if such a declaration will trigger a payout. This bias—or political risk from the potential perception of bias—becomes even more problematic if the agency making the declaration also receives funding from the financial instrument.

Trigger Timing

The timing of the trigger, with respect to the epidemic curve and the pandemic financing cycle (Fan et al. 2024), is a crucial consideration. Early in an outbreak, while it is still small, disease control and response measures have a much greater chance for outbreak containment (refer to chapter 7 in this volume). Consequently, financing provided at this stage is likely to be highly cost-effective. At this early stage, there is also greater uncertainty about the number of cases or the presence of sustained human-to-human transmission: limited information and sometimes incomplete and fragmentary surveillance data can make it difficult to establish the expected trajectory of an outbreak. The African Risk Capacity structure is a notable example of a mechanism designed to trigger very early in an outbreak (refer to table 14.1).

Some triggers, however, may require data stability and a higher level of certainty about the magnitude of outbreak before activation. By the time these necessary criteria are met, several weeks or months might have passed and full containment may not be possible, but the financing could support public health and social measures to flatten the curve—including active case identification, case isolation, and contact tracing—and reduce the burden on the health system and overall impact of the event (refer to chapter 6 in this volume). This approach is probably most similar to the financing mechanism incorporated into the World Bank's Pandemic Emergency Financing Facility, or PEF (refer to table 14.1).

A third potential timepoint around which to build a trigger that is not often implemented is before an outbreak even reaches a country. For example, if an event affects one country, then a neighboring country could be the beneficiary of seed financing that would help support surveillance and containment measures designed to prevent introduction of the pathogen and spread of the epidemic. A potential design for such a concept was discussed previously in an Asian Development Bank report (ADB 2022). Although an anticipatory/containment design of this kind could potentially be effective and worth exploring, a key challenge is that it may be politically difficult to justify allocating response funds to a country that is not (yet) directly affected by a health emergency, especially if funds are limited and response activities in the directly affected country are underfinanced.

Avoiding Recency Bias

A common pitfall in trigger design is to build a trigger for the event that occurred most recently—a behavior analogous to preparing to fight the last war. In the context of epidemic risk, this tendency could, for example, entail limiting the event definition to only those pathogens that have recently caused epidemics, or setting parameter combinations and thresholds based solely on observed data from recent outbreaks rather than modeled risk estimates that consider broader probability distributions (Madhav et al. 2023). Some mechanisms—notably the World Bank's PEF insurance window—have incorporated emerging pathogens (such as Rift Valley Fever virus) with known epidemic and potentially pandemic potential, but that have not caused large-scale public health emergencies to date. Incorporating wholly novel pathogens into a trigger structure is also possible, but doing so introduces challenges to risk modeling because of data sparsity.

Future epidemic and pandemic scenarios may look very different from the most recent events. As such, it is critical to consider the widest relevant range of scenarios that could occur and fit within the conceptual and policy objectives of the financing mechanism or policy process. Scenario planning processes as well as the use of simulation-derived event catalogs can provide structured ways to address and mitigate recency bias (Madhav, Stephenson, and Oppenheim 2021; Schwartz 1997).

Flexibility

Flexibility in trigger design, such as incorporating technical and operational experts into consultation processes, can be advantageous, allowing for local context and local stakeholders' knowledge to be factored in, to "correct" mismatches between a predefined trigger and the reality on the ground. In this sense, a level of flexibility (as opposed to full discretion over the activation of funds for response) can sometimes enhance a mechanism's overall effectiveness.

Trigger mechanisms, especially for nonfinancial applications, could be built into a playbook or tiered response system that would allow some flexibility and adaptability during a crisis. An overly rigid system may be difficult to adhere to during a crisis—and the next crisis may look very different from the previous crises upon which design of the trigger criteria may have been based. It is important to think beyond previous events and to avoid recency bias—that is, over indexing on the most recent event to have occurred. For example, some financing mechanisms have a contingency fund component, which may relax some of the more rigid criteria and design principles that would underpin triggers for insurance-backed financing mechanisms that can come in later, at higher levels of severity of the outbreak.

Adding an element of flexibility can also diminish basis risk (that is, the chance of a false positive or false negative) and ensures that decision-makers have some ownership. To date, notable structures for epidemic risk financing have included asymmetric mechanisms to address basis risk, including cash windows that can (with some parameters and rules) release financing for events that would not otherwise qualify; however, no mechanisms appear to exist that address false positives, though these mechanisms are theoretically possible. The risk is that stakeholders who are unhappy with a specific decision may view flexibility as arbitrariness; this risk should be mitigated to the greatest extent possible with transparency, broad involvement of stakeholder groups in the development of decision-making rules and guidelines, and active communication once a potentially qualifying event has occurred.

Testing, Refinement, and Calibration

During the process of designing the trigger, an important step is to test whether or not it performs as anticipated and desired—for example, whether it correctly activates under scenarios that the financing mechanism (or other policy intervention) is being designed to respond to. This step requires clarity and alignment regarding the types of scenarios that the mechanism is meant to address. Trigger designers should, in close conversation with stakeholders, define the types and severities of events that should trigger the mechanism; it is likely critical that they clearly define the types of scenarios that should not trigger it. In testing, the draft trigger concept would be calculated against historical epidemic events to determine which events would have set off the trigger and which ones would have not. If the results do not lead to the desired outcomes, then it is determined which parameters and thresholds led to the failure. The trigger will then be reformulated to ameliorate the issue and tested again. This iterative process typically entails multiple rounds of testing and refinement—with care given to understand the implications of design changes and ensure that a change to address one apparent failure does not cause other problems (such as causing the mechanism to trigger under undesirable circumstances; refer to the section "Trigger Failure" later in this chapter).

If the occurrence being tested against is a rare event, the trigger is also often tested against modeled or hypothetical scenarios, again to see under which scenarios the trigger conditions are met. When a full range of hypothetical, plausible scenarios is available, such as in a stochastic catalog (Madhav et al. 2023), then additional statistics may be calculated, such as the overall probability of the trigger conditions being met.

Upon completion of the iterative process, there should be agreement by all involved parties that the trigger is measurable, that the payout occurs with appropriate timing and predictability, and that stakeholder incentives and expectations are aligned—keeping in mind that, for triggers incorporated into disaster risk financing instruments, the stakeholders involved often span the public and private sectors (Schanz 2021).

CASE STUDY: THE WORLD BANK PANDEMIC EMERGENCY FINANCING FACILITY

PEF, the first sovereign insurance mechanism for epidemic and pandemic risk, was issued in 2017, in reaction to the slow and initially inadequate donor financing response to the 2014 West Africa Ebola epidemic. It was designed to provide financing for several types of infectious disease risks and was organized into two classes. Class A was configured to release funding in the event of a large, multicountry outbreak of a respiratory pathogen (that is, an influenza virus or a novel coronavirus) that could develop into a pandemic. Class B was designed to provide funding to contain a multicountry epidemic, similar to the 2014 West Africa Ebola epidemic, caused by pathogens including filoviruses, novel coronaviruses, Lassa virus, Rift Valley Fever phlebovirus, or Nairovirus (the causative agent of Crimean-Congo Hemorrhagic Fever).

PEF was explicitly designed to provide financing for multicountry epidemics, rather than sustained epidemics within a single country. This design criterion would later lead to substantial criticism during the 2018–20 North Kivu Ebola epidemic (also known as the 10th Ebola outbreak in the Democratic Republic of Congo), which remained almost entirely contained within the Democratic Republic of the Congo and for which no payout from the insurance window was released (Jonas 2019).[7] However, PEF also included a *cash window*, a funding pool that could be flexibly deployed to support response activities for events that did not meet trigger criteria for either class. The cash window ultimately released funds to support the response to the North Kivu epidemic (World Bank 2019).

PEF had several other notable design characteristics. First, the International Development Association (IDA) countries[8] that were potential recipients of PEF funds did not have to pay for coverage. The World Bank financed the development and implementation of the PEF disaster risk financing mechanism with IDA funds; international donor funding paid the entirety of the premium. The use of IDA funds to finance PEF generated debate, particularly because IDA money flowed to private insurance companies in the form of premium payments (Jonas 2019). Although that critique relates to the source of funds, rather than to the trigger design, it may have amplified later concern over the complexity of the triggers themselves.

Second, the complexity of the triggers led to criticisms about the lack of transparency or verifiability of the triggers. Especially controversial was the complex growth rate trigger criterion, which did not have easily accessible methodological documentation and data that would allow it to be quickly replicated. Trigger complexity, including the growth rate trigger criterion, likely resulted from the interplay between competing stakeholder demands and budget constraints in the design of the trigger. The design of the trigger encapsulates the push and pull between stakeholders: the beneficiaries want to receive the funding as much and as soon as possible and often with minimal criteria, whereas the capital providers (especially if they include insurers and investment professionals) may demand indisputable confirmation of an event and evidence that the funds are needed. In the case of PEF, the growth rate trigger criterion may have arisen as a way to provide evidence that an eligible epidemic event was continuing to worsen, and thus the funds would still be necessary by the time they were disbursed. Other relevant factors in the trigger design were likely misaligned incentives and an attempt to limit the perception of inordinate payout risk on the part of capital market participants who would be more skeptical about a novel financing mechanism.

The COVID-19 pandemic met the trigger criteria for PEF on April 17, 2020, about five weeks after the WHO PHEIC declaration on March 11, 2020. Consequently, by September 30, 2020, beneficiary countries had received a full payout from Class A of over US$195 million. PEF funds were used to support varying response activities, specific to the needs of each beneficiary country. Funding uses included, for example, procurement of diagnostics and personal protective equipment, increasing diagnostic testing capacity in national labs, expansion of hospital bed capacity, investments in oxygen generation and distribution, and funding to mobilize skilled medical personnel (World Bank 2020, 2021a, 2021c). To ensure that the payout amount remains relevant to the stage of the outbreak, this six-month lag from meeting the trigger criteria to the completion of fund disbursement should ideally be shortened in future financing mechanisms for infectious disease risks. For PEF, detractors primarily criticized the payment amount as "too little, too late" for a pandemic of such magnitude. Arguably, however, no financing mechanism in existence at that time could have covered the entire cost of the COVID-19 pandemic, so a more appropriate bar would be to assess if the PEF financing was accretive to the other financing available at the time.

As noted earlier, it is critical to clearly articulate the problem that the financing instrument is designed to solve, which scenarios would lead to a payout, and which would not. Another aspect to be improved in future iterations of such global disaster risk products is the transparency about the rules of distributing the funds between beneficiaries when an event occurs.

PEF provides numerous lessons. As discussed earlier, an effective trigger should be simple, transparent, objective, verifiable, and preagreed. Of these characteristics PEF arguably fell short mainly in the areas of having a simple, transparent, and easily verifiable trigger (Meenan 2020). The first lesson from the PEF experience pointed to the challenges that arise with a complex trigger, which can make it difficult to verify and potentially lead to a lack of trust in the financing instrument as a whole.

A second major lesson involves transparency, pointing to the need for very early, frequent, and informative communication to all stakeholders (including the public) to ensure a high degree of comfort and understanding of the trigger design, the scenarios in which it is expected to trigger (and not trigger), what technical choices were made in the trigger design process, and why those choices were made. As noted earlier, PEF did not trigger a payout from its insurance mechanism for the North Kivu Ebola epidemic of 2018–20, leading to substantial criticism of its complex trigger structure (table 14.1; refer also to Brim and Wenham 2019). Although important lessons can be learned from the practical implementation of the trigger, PEF was fundamentally designed to respond to multicountry epidemics, rather than to sustained events that remained (largely) contained within a single country. Consequently, debate about the North Kivu nontrigger should have focused on the fundamental design and event definition, rather than narrowly on the trigger design. This debate also shows why careful concept testing and discussion regarding the event definition among all stakeholders—beneficiaries, trigger designers, donors, and governments—is so critical.

A third lesson, going beyond the trigger, is that PEF's cash window provided an effective way to maintain flexibility for situations when an epidemic might require rapid financing but when trigger criteria are not met for the insurance window. Maintaining this level of flexibility, both in the circumstances under which funds can be disbursed and in what they can be used for, is critical to ensure that funds can go to unanticipated needs that arise.

A fourth lesson that emerged was the need to closely engage beneficiary countries. Doing so helps build awareness and tie the financing mechanism with the creation of incentives to actions that can prepare for and reduce overall epidemic risk, such as investing in diagnostic capacity and pathogen monitoring programs.

Arguably the final lesson from PEF is one already gained from hard experience in other risk financing domains, such as climate and natural catastrophe risk. That is, designing financing mechanisms for challenges where both the risk (Meadows et al. 2023) and the fundamental science are rapidly evolving is difficult and requires a commitment to ongoing learning and dialogue. Ultimately, a proper independent evaluation will provide the most thorough assessment of the successes, challenges, and lessons learned from PEF.

TRIGGER FAILURE

Parametric triggers can fail in many ways, which often fall in one of two main categories: false positives and false negatives. A *false positive* in the context of a financing instrument is an event that meets the criteria for release of funds but for which the actual losses incurred are zero or less than the payout amount. In this case, the providers of the capital "suffer" from a loss of their capital. This situation also potentially sends a signal that the trigger has inadequate science or design rigor behind it, thus the financing mechanism could be perceived as a "lottery." A *false negative* occurs when the trigger criteria are not met even though substantial losses are incurred. In this case, the beneficiary or insured suffers, because they are affected by real losses and expenses that they expected to have covered by the financing mechanism. The goal during the trigger design and calibration phase of the structuring process is to minimize the probability of both types of errors, also described by practitioners as "basis risk." During this process, and to minimize basis risk, the trigger criteria will be tested and configured using historical data and model estimates so as to maximize correlation to actual loss.

Ambiguous situations also arise. Consider, for example, a scenario in which a trigger is designed to support early response and containment of Nipah virus disease epidemics in South Asia, and is configured to pay out when 20 deaths caused by Nipah virus occur. An outbreak subsequently occurs in Bangladesh: 40 people are infected, 20 people recover, and 19 people die within the first three weeks; the final infected person remains in the clinic for a week, then dies. The policy pays out, but the outbreak is over. Capital providers may view this event as a false positive, because the outbreak is no longer active. However, the policy could still be effective, because it could provide financing to the country for response and containment activities initiated earlier in the outbreak, and prospectively for any ongoing surveillance to ensure rapid detection of any additional cases. Capital providers and the recipient countries may have honestly diverging points of view over whether the financing mechanism and trigger structure were successfully designed. The converse problem could occur under a more complex trigger structure—for example, one that includes infections, deaths, and the growth rate (that is, trajectory of the epidemiological curve). In such a circumstance, case or death trigger criteria could be met slowly enough that the growth trigger is not reached, which could lead to complaints—as in the case of PEF—that the policy should nevertheless have triggered.

Triggers could potentially be manipulated or gamed, or the presence of a financing mechanism may create perverse incentive structures that alter the probability of a payout. First, having a financing mechanism in place may, in theory, create a *moral hazard*, an incentive to take riskier actions or forego risk-reducing actions

(Rowell and Connelly 2012). In the context of epidemics, moral hazard—that is, misaligned incentives—could conceivably include relaxing disease control measures until the trigger is met (a risk that could become more substantial as the proximity of breaching the trigger point increases). A perhaps more plausible version of this risk could be that a country applies tentative or inadequate populationwide measures to reduce disease transmission, knowing that such measures may be economically damaging and that additional financing support is more likely to be triggered if the partial measures are unsuccessful.

A more plausible—and, indeed, a positive externality—incentive created by a financing structure may be to intensify surveillance and case detection efforts. From the perspective of the insurer or capital provider, however, this incentive may be problematic, because trigger design or pricing efforts would not have taken more intensive surveillance (and, presumably, case identification) into account. These dynamics may vary by disease. For example, for endemic diseases with incomplete surveillance—such as Lassa Fever in portions of West Africa—the presence of a sufficiently large financing mechanism could lead to investments in surveillance that increase the probability of detecting baseline levels of endemic transmission and, therefore, of triggering a payout. In contrast, the investment case for a country to recoup surveillance expenses by detecting less frequent occurrences, such as a spillover of Nipah virus in Malaysia, may be more limited.

Importantly, the risk that surveillance improvements will lead to unanticipated increases in the likelihood of triggering a financing mechanism depends entirely on the size (and perceived probability) of the payout relative to the cost of surveillance, including potential negative consequences and disincentives for outbreak reporting, for example international trade restrictions. This situation is unlikely given the cost of sustained, high-quality surveillance relative to the typical, relatively modest payouts built into disaster risk financing mechanisms for epidemic risk.

The risk associated with false positive payout can be mitigated by various approaches, including by limiting the use of funds to preagreed uses that will not apply if an epidemic response is not warranted, by designing a policy that reimburses for already incurred expenses, or by requiring that the beneficiary provide proof of loss before the funds are released. These limitations, however, turn a relatively simple parametric mechanism into a more complicated, indemnity-like mechanism, potentially preserving the speed with which financing can be released but adding complexity and auditing requirements to the postdisaster recovery phase. Because false positives have effectively been priced into the mechanism design, another approach can be to roll unspent funds from false positives into a cash window, to be expended on other crisis response activities, including payment for false negatives. Although theoretically feasible, such mechanisms would be operationally and politically challenging, and could potentially increase the scope for miscommunication and misaligned expectations between stakeholders.

Mitigating the risk from false negatives—that is, payouts that should occur but do not—is perhaps more challenging. One option previously tested in disaster risk financing instruments is to include a cash window or contingency window—that is, a pool of capital that can be flexibly deployed for a variety of purposes, including supporting response costs for an event that meets the stated intent of the financing mechanism but that, because of some unforeseen complexity or challenges, does not meet the trigger criteria (World Bank 2021b). To build trust and predictability for the beneficiary, cash windows must also have a detailed operations playbook explaining what they are intended for and who makes the payout decision using either a set of criteria or parametric logic to channel and delimit the use of funds—for example, a cash window could require at least *N* reported, laboratory-confirmed deaths caused by a viral pathogen.

CONCLUSIONS

Well-defined triggers can provide clarity and speed to complex decision-making processes that often take place, unrehearsed, in the midst of an active crisis. Parametric triggers have been most frequently employed in insurance and natural hazards risk financing instruments. That said, many decision processes and financing mechanisms in the health sector resemble these instruments, in the sense that they formally incorporate variables; transparent, measurable thresholds; and other objective criteria to guide or even bind complex decision-making processes based on preagreed terms.

This chapter is not a call to blindly adopt triggers, parametric or otherwise, in epidemic financing and policy processes.[9] Rather, it urges readers to use and learn from sound design principles in the development of triggers, whether qualitative, quantitative, or a mixture of both. The most fundamental design principle is to design with care and incorporate diverse knowledge—especially practical, operational knowledge—about the risk context. Doing so means designing with broad participation, as well as transparency, to ensure that the purpose of the trigger is clear, understood, and accepted by all involved. All other design principles are, in an important sense, technical and can be addressed through careful and iterative analysis, testing, and refinement.

This chapter has focused primarily on the design of triggers for financing mechanisms. Importantly, no single comprehensive crisis financing structure will be applicable for all future threats, including biological threats (Centre for Disaster Protection and Airbel Impact Lab 2021). Instead, triggers should be designed to address specific, well-defined problems and risks, using a clear event definition and appropriate technical design. Triggers can also be designed to support policy decisions once an epidemic or pandemic has occurred, notably whether and how intensely to apply populationwide disease control measures, and when to relax or end such measures. A primary virtue of triggers is that they can be built into a range of playbooks tailored to specific scenarios and risks, helping guide policy makers to determine which decision frameworks are sound, and perhaps alerting them to scenarios in which prior guidance—and the factors and thresholds that it is rooted in—may not be fit for purpose.

Finally, if designed with care, triggers offer an efficient, objective, and predictable way to mobilize money to contain crises and save lives and livelihoods. Ultimately, what is needed is strong, credible, and consistent commitment from funders to provide adequate prearranged financing for epidemic preparedness and response in a predictable and timely way. Without that commitment, effective containment and response to epidemics and pandemics will remain impossible to achieve. With it, a more secure future is possible.

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1. Of note, mortality bonds incorporating index-based parametric triggers, such as Vita bonds, were introduced before this period (as discussed in the subsection "Quantitative Triggers").
2. WHO, "Disease Outbreak News (DONs)," https://www.who.int/emergencies/disease-outbreak-news.
3. US Centers for Disease Control and Prevention, "Health Alert Network (HAN)," https://www.cdc.gov/han/php/about/index.html.
4. WHO, "Emergencies: International Health Regulations and Emergency Committees," https://www.who.int/news-room/questions-and-answers/item/emergencies-international-health-regulations-and-emergency-committees.
5. Biomedical Advanced Research and Development Authority, "Influenza & Emerging Infectious Diseases Pandemic Vaccines and Adjuvants Program," https://medicalcountermeasures.gov/barda/influenza-and-emerging-infectious-diseases/pandemic-vaccines-adjuvants.
6. WHO, "Ebola and Marburg Virus Outbreak Toolbox," https://www.who.int/emergencies/outbreak-toolkit/disease-outbreak-toolboxes/ebola-and-marburg-virus-outbreak-toolbox.

7. Apart from four deaths in Uganda, which occurred when a family crossed the border from the Democratic Republic of Congo into Uganda to seek treatment.
8. Countries eligible for grants and concessional loans from IDA, which provides support to countries that cannot borrow funds at the market rate.
9. That is to say, it does not propose a hegemonic parametric agenda but, rather, thoughtful application of parametric approaches when appropriate.

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